ANNUAL REPORT

1968

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

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BARRACKPORE

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This report includes unprocessed or semi-processed 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.

CONTENTS

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CENTRAL INLAND FISHERIES RESEARCH INSTITUTE,

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

BARRACKPORE.

1. DIRECTOR'S INTRODUCTION

The Central Inland Fisheries Research Institute, established in March, 1947, at Calcutta, under the Ministry of Food and Agriculture, Government of India, is since June, 1959, housed in its own buildings at Barrackpore, 23 km north of Calcutta, on the left bank of the Hooghly estuary, on an area covering about 5.2 ha. The Institute's administrative control was made over by the Ministry of Food and Agriculture, Government of India, to the Indian Council of Agricultural Research on October 1, 1967, with a view to bring about greater co-ordination in the field of agricultural research.

The objectives of the Institute are to study and elucidate the scientific principles which could be applied for the utilization of all available inland waters for maximum production of fish for food in the country. To solve some of the urgent problems facing fish culture development and management of the capture fisheries, the Institute has established four substations, one each at Barrackpore, Cuttack, Allahabad and Hospet (later shifted to Konar and thence to Hazaribagh) to deal with the problem of estuarine, pond culture, riverine and lacustrine fisheries respectively. The northern frontiers of India having attained an added importance on account of defence needs, a unit for the studies of the fisheries of the cold waters was also established at Kangra (Punjab) in November, 1963, which has since been shifted to Srinagar (Jammu and Kashmir State). Investigations on the reported depletion in the Chilka lake and survey of the fisheries of the Narbada and the Tapti rivers having been completed, the research units established at Balugaon (Orissa) and Hoshangabad (Madhya Pradesh) were wound up.

The present position of the various divisions of the Institute and the work being conducted at different centres is given below.

The Estuarine Division, located at Barrackpore, has two constituent units, one at Kakdwip (West Bengal) and the other at Ponneri on the Pulicat lake

(Madras State). The Division is conducting investigations on the fisheries survey and prospecting of brackish water fish and prawn seed in the estuaries of West Bengal and dealing with problems and techniques of fish farming in brackish water ponds, besides studies on the fisheries of the Pulicat lake, the Adyar estuary and the Ennore backwaters. Work on fish pathology, experimental culture of fish food organisms and sewage fed fish culture is also being conducted at Barrackpore. Work has recently been started in connection with the survey and reclamation of mangrove swamps in lower Sunderbans with a view to developing brackish water fish culture.

The Pond Culture Division, located at Cuttack, has been dealing with the development of suitable fish culture techniques, production of fish seed through hypophysation, efficacy and economics of different types of fertilizers for increasing productivity of fish ponds, control of aquatic weeds in culture fishery waters, frog culture, etc. The two units of the Pond Culture Division, located at Calcutta and Panna (Madhya Pradesh), are engaged with the work on fish pond productivity and weed control, and work relating to establishment of a central fish farm respectively.

The Riverine Division has its headquarters at Allahabad with three units, one located on the Godavari river at Rajahmundry (Andhra Pradesh), the second on the Ganga river at Bhagalpur (Bihar) and the third at Rewa (Madhya Pradesh). This Division is concerned with the carp spawn prospecting in the river of the country, problems of the development of riverine fishery, investigations on the riverine hilsa and problems on the development of fisheries in medium sized reservoirs.

The Lacustrine Division has been shifted from Konar to Hazaribagh in May, 1968 and is engaged in making a comparative study of the fisheries of the Konar and the Tilaiya reservoirs of the Damodar Valley Corporation. The Cold Water Fisheries Research Unit is functioning at Srinagar and is engaged in studies relating to improving the techniques of trout culture, while the Documentation Unit continues to remain attached to the Director at Barrackpore.

Library and Documentation :

An increase in the library collections during 1968 has already used up a major portion of the additional shelving facilities provided last year. Since an extension of the shelving facilities will no longer be possible in the present hall, an additional room will have to be provided for housing further collections. As the present catalogue cabinet has been filled up completely, orders for two more cabinets have been placed to file the cards which are being added everyday.

During the year, 125 books, 264 reprints and 1,459 issues of periodicals (including 18 new titles) have been added to the library. The library purchased one micro-film and made 4 photo-copies departmentally. In 1968, the Institute subscribed 32 Indian and 40 foreign journals. The present library holdings comprise 2,150 books, 1,383 bound periodicals 2,251 reprints, 1,013 miscellaneous publications, excluding the stock of loose issues of journals, pamphlets, maps, departmental publications and reprints of the papers by the staff of this Institute.

The exchange of publications with various organizations was continued and further exchange relationships were established with 18 new institutions and organizations, both Indian and foreign.

The Documentation Unit continued to compile the 'Bibliography of Indian Fisheries' and brought out Vol. **6** (4) of 1967 and Vol. **7** (1-3) of 1968, covering 1,025 articles. Quarterly Accession Lists of additions to the library were brought out and circulated amongst various Institutions, both within the country and abroad. Two supplementary lists of publications by the staff of the Institute were also circulated.

The number of inquiries is on the increase as 97 technical and non-technical requests were attended to by the Documentation Unit during 1968 as against 70 last year. The Institute lent a number of publications to Indian Association of Special Libraries and Information Centre, Indian National Scientific Documentation Centre and to some state fisheries departments on an inter-library loan basis.

Distinguished visitors :

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

Mr. T. Backiel	:	F.A.O., Rome Inland Fisheries I-te Zabieniec, p-ta Piaseczno, Poland.
Mr. Keir Campbell	:	Winston Churchill Memorial Trust, London.
Mr. Carl E. Bond	:	Oregon State University, Corvallis.
Shri K. N. Das	:	Fish Seed Syndicate Ltd., Howrah.
Mr. John W. Parsons	:	U.S. Aid, Fisheries Development Advisor to the Government of East Pakistan.

Prof. Satyendra Nath Bose	:	National Professor, Calcutta.
Dr. H. Srinivasa Rao	:	Ex-Directors, Central Inland Fisheries Research Institute, Barrackpore.
Dr. B. S. Bhimachar	:	
Shri M. Ahmed	:	Additional Secretary, Indian Council of Agricultural Research, New Delhi.
Shri G. N. Mitra	:	Joint Commissioner (Fisheries), Govt. of India, New Delhi.

Important events of the year :

A seminar on "Production of quality fish seed for fish culture" sponsored by the Indian Council of Agricultural Research was held at the Central Inland Fisheries Research Institute, Barrackpore, on November 1 and 2, 1968. The scientific deliberations of the seminar were conducted in four sessions, each with a different chairman. Altogether 22 papers were presented at the seminar. The proceedings of the seminar are proposed to be published by the Indian Council of Agricultural Research.

Of the 20 priority laid projects, while work on 16 projects was started in 1967, work on two more projects viz. 'Murrel and air-breathing fish culture' (Project No. 7) and 'Sewage fed fisheries' (Project No. 18) was initiated during 1968.

An Experimental Brackish water Fish Farm comprising 11 ponds has been constructed on Henry's Island in lower Sunderbans (West Bengal) during May-July, 1968, to study the behaviour of dykes (with and without puddle core), salinity in impounded waters and types of fish culture possible.

Research collaboration with Institutes, Universities, Colleges and other Institutions at national level :

Spawn prospecting investigations conducted by the Institute on the Ganga, the Yamuna, and the Banas rivers were conducted in close collaboration of the Fisheries departments of Uttar Pradesh and Rajasthan States respectively. The substations and units of the Institute worked in close contact with the fisheries departments of the state of their location.

Advisory services received and provided :

Advices on a wide variety of topics, like suitability and utilization of ponds for fish culture, fish poisons, fertilizers, fish feeds, effect of chemicals on fish, keeping of aquarium fishes, control of fish diseases and reclamation of derelict swamps ; informations on availability of spawn collecting nets and pituitary glands, weed utilization and publications on aquatic weeds ; and comments on water and soil analysis data of Dandakaranya Project area and proposed fish breeding and seed rearing farm at Bhadra, Mysore, were supplied to private individuals, institutions or bodies, and Government departments.

Advice was also given to the Irrigation Research Institute, Roorkee, on methods of aquatic weed control, to the staff of the Central Rice Research Institute, Cuttack on methods of clearing lily and lotus infestations, to Bihar State Fishery Department on clearance of floating dead weed masses, to Indian Standards Institution on live fish transport and to several local private parties faced with the problem of aquatic weeds infestation.

Information on prospects of frog rearing, commercial species of frogs, their identification, availability and methods of transport was furnished to a large number of interested parties as also on frog leg processing and export from Calcutta port. Identified preserved adult specimens of commercially important species of frogs and their developmental stages and 400 live *R. hexadactyla* were supplied to the Maharashtra and Orissa Fisheries Departments respectively. Identification of some frog tadpoles was done at the request of the State Fisheries Department, Rajasthan. In order to give both theoretical and practical training in methods of survey of frog resources of various states. a survey cum training programme has been prepared.

Fish farmers have been advised on the control of monogenetic trematodes and ciliate protozoan parasites in carp nurseries and stock ponds in Midnapore and 24 Parganas districts (West Bengal).

On receipt of a request from the Managing Director, Central Fisheries Corporation, to help them lay down a policy for stocking the Konar, the Tilaiya, the Panchet and the Maithon reservoirs, a comprehensive report, entitled "An Assessment of Fisheries of the Damodar Valley Corporation Reservoirs in Relation to Stocking" was prepared and given over to the Managing Director.

Extension and any nation-building activity :

Laboratory and field demonstrations and training in various aspects of fish and frog culture were given to the students of St. Joseph's Convent,

Cuttack ; to the trainees of the Regional Training Centres for Inland Fishery Operatives, Agra and Hyderabad and those of the Central Institute of Fishery Education, Bombay and Inland Fisheries Training Unit, Barrackpore, at the Pond Culture Substation of the Institute at Cuttack, Estuarine Substation at Barrackpore and Riverine Substation at Allahabad.

In order to help boost composite culture and control of aquatic weeds in fish ponds by grass carp, fry of both grass and silver carps has been supplied to various parties as per details given below.

Sl. No.	Name of the State/ Organisation/Private parties	Silver carp	Grass carp
1.	Director of Fisheries, West Bengal	800	3,000
2.	Director of Fisheries, Madras	—	828
3.	Director of Fisheries, Mysore	500	—
4.	Director of Fisheries, Gujarat	—	200
5.	Bhutan Raj Family, Bhutan	500	—
6.	Botanical Garden, Calcutta, West Bengal	—	250
7.	Military Supply Department, Barrackpore	25	25
8.	Bachai Fish Farm, Hazaribagh, Bihar	1000	—
9.	Jute Research Institute, Barrackpore	100	100
10.	Kharibari Co-operative, Kharibari, West Bengal	50	50
11.	Dr. D. N. Roy, Nabadwip, West Bengal	—	250
12.	Shri Nitai Saha, Barrackpore	25	25
13.	Shri J. L. Bose, Barrackpore	25	50
14.	Shri M. Burman, Barrackpore	10	10

Besides, 50.8 lakhs spawn of Indian major carps, produced during the course of induced breeding experiments, was supplied to the Fisheries Department of Orissa State and Central Fisheries Corporation. In addition, 1.5

lakhs spawn of common carp was also made over to the Department of Fisheries, Orissa.

Bulk of the spawn collected during the spawn prospecting investigations was handed over to the respective states *viz.* Rajasthan and Uttar Pradesh.

Finance (Research funds and expenditure) :

The provision of funds for the Institute for the financial year April, 1968 to March, 1969 was as under.

Non-Plan	— Revenue	Rs.	18,80,000
Plan	— Revenue	Rs.	2,00,000
Plan	— Capital	Rs.	4,00,000
	Total	Rs.	24,80,000

Against the above provision the expenditure from 1.4.68 to 31.12.68 was as follows :

Non-Plan	— Revenue	Rs.	15,97,421
Plan	— Revenue	Rs.	1,85,091
Plan	— Capital	Rs.	1,82,816
	Total	Rs.	19,65,328

2. Progress of Research

In addition to 16 of the 20 research projects, work on which has been continuing since 1967, two more research projects *viz.* 'Murrel and other air-breathing fish culture' (Project No. 7) and 'Sewage fed fisheries' (Project No. 18) were taken up during 1968. Work on Project Nos. 10 and 11 *viz.* 'Research on designing fish farms' and 'Study of economics in fishery investigations and development projects' respectively could not be initiated for want of personnel. A brief account of the progress made under each project during 1968 is outlined in the following pages.

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

Problem : 1.1 Composite culture of Indian and exotic species for maximum production of fingerlings and large fish.

Duration : One year.

Personnel : Dr. M. T. Philipose, Sarvashri S. B. Singh, R. D. Chakraborty, P. R. Sen, K. Raman, K. K. Sukumaran (till September), A. C. Nandy, D. S. Murthy, P. C. Chakrabarty, M. M. Bagchi, D. P. Chakrabarty and G. V. Kowtal (from August, '68).

Composite culture of fingerlings (stocking rate : 5,000/ha) of catla, rohu, mrigal, silver carp, grass carp, common carp and calbasu in the ratio 2.5:5:2.5:5:2:2.5:0.5 gave a net production of 2,345 kg/ha (gross production 2,575 kg/ha), form a 0.14 ha pond in one year. The fish produced were table sized, their sizes and weights being catla : 303 mm and 338 gm ; rohu : 351 mm and 459 gm ; mrigal : 401 mm and 631 gm ; silver carp : 427 mm and 734 gm ; grass carp : 499 mm and 1,308 gm ; common carp : 304 mm and 488 gm ; and calbasu : 335 mm and 407 gm.

In another experiment, replicated in two 0.16 ha ponds, net productions of 2,760 and 2,548 kg/ha/annum (gross productions 3,041 and 2,830 kg/ha/annum) were obtained, when the same species were stocked in the ratio of 3:4:2.5:6:1.5:2.5:0.5 at 6,250 fingerlings/ha. The sizes and weights of fish attained in these two experiments were : Pond 1 (production 2,760 kg/ha/annum), catla : 285 mm and 200 gm ; rohu : 361 mm and 508 gm ; mrigal : 411 mm and 623 gm ; silver carp : 402 mm and 648 gm ; grass carp: 438 mm and 913 gm ; common carp : 278 mm and 362 gm ; and calbasu : 353 mm and 467 gm ; Pond 2 (production 2,548 kg/ha/annum), catla : 277 mm and 267 gm ; rohu : 345 mm and 429 gm ; mrigal : 407 mm and 623 gm ; silver carp : 409 mm and 654 gm ; grass carp : 487 mm and 1,215 gm ; common carp : 294 mm and 438 gm ; and calbasu : 333 mm and 383 gm respectively. In the experiments the population density was kept constant but feed and fertilizer was applied according to the need of the fish.

A fresh experiment with three species combinations, each at 5,000 fingerlings/ha, with two replications, has been initiated in six ponds in August, '68. In the seventh pond, some prawns and frogs have also been stocked besides seven species of fishes.

A six months' fry rearing experiment with catla: rohu: mrigal: : 2:4:4 ; silver carp: grass carp: common carp: : 4:3:3 and catla: rohu: mrigal:

grass carp: : 3:3:2.5:1.5 with 2 replicates has been initiated in September in 0.08 ha ponds.

While the utility of silkworm pupae as fish feed in far eastern countries is well known, preliminary yard experiments on the usefulness of silkworm pupae as artificial feed for the fingerlings of Indian carp indicated an average increase of 19, 21, 27.7 and 17.1% respectively with 11-15 days feeding of catla, rohu, mrigal and common carp as against 9.2, 5.4, 23.3 and 9.5% respectively with mustard oilcake and rice bran mixture, a feed which is being commonly used at present.

Problem : 1.2 Studies on the use of growth promoting substances for enhanced growth of carp fry and fingerlings.

Duration : One year.

Personnel : Dr. M. T. Philipose and Shri P. R. Sen.

Based on previous year's experiments, yeast, starch and cobalt chloride were selected from 7 screened growth promoting substances for determining their influence on the survival and growth of rohu spawn. Cobalt chloride was found to give the highest over-all average survival (77.7%) and starch the highest over-all increment in length and weight (7.00 mm/0.023 gm), when fed to 4 day old spawn in the form of pellets at 0.01 mg/fish/day and 3.4 mg/fish/day respectively. The experiment was performed in 10 litre glass jars with a density of 100, 150 and 200 spawn per jar. Yeast was fed at 1 mg/fish/day. Mustard oilcake and rice bran was fed regularly in all treatments.

In a field experiment in four 0.04 ha ponds, observations have indicated that while catla has attained the maximum increase in weight (73.3 gm) with cobalt chloride, both cobalt chloride and starch have resulted in equal increase in weight (22 gm) in rohu in one month. Mrigal recorded a greater growth increment (30.8 gm) with starch followed by cobalt chloride (18.8 gm). The ponds are stocked with catla, rohu and mrigal in the ratio of 1:1:1 at 6,000/ha.

Both laboratory and field experiments are envisaged during 1969.

Problem : 1.3 Relative efficiency of different nitrogenous fertilizers in pond fertilization using production of plankton and fry as indices of response.

Duration : Two years.

Personnel : Sarvashri G. N. Saha, K. Raman and S. R. Ghosh.

Statistically designed field experiments on the efficacy of different nitrogenous fertilizers *viz.* ammonium sulphate, urea and calcium ammonium nitrate on primary productivity and spawn survival showed that of the three rates (20, 50 and 80 kg N/ha) of application, 80 kg N/ha was most effective as it gave a uniformly high primary productivity of 2.23, 1.94 and 2.23 mg C/day and a survival of 57, 47 and 73% respectively. Yard experiments with these three fertilizers at 80 kg N/ha with slightly acid, nutrient deficient soil have given a survival of 55 and 50% with calcium ammonium nitrate and urea respectively as against 39 and 31% for ammonium sulphate and control respectively. The maximum primary productivity (2.25 mg C/day) and maximum growth rate of spawn were, however, obtained with urea. Experiments with different soil types are in progress.

Problem : 1.4 Exploratory investigations on the fixation of nitrogen by blue-green algae in pond soils with special reference to the productivity of pond water.

Duration : Two years.

Personnel : Sarvashri G. N. Saha and S. R. Ghosh.

Sterilized and unsterilized soil of near neutral reaction, treated with phosphorus, and phosphorus + calcium and maintained against a control, showed greater increase in total nitrogen content (13-86 mg N/100 gm of soil) in the sterilised set. Higher plankton density and percentage survival (62%) of spawn was obtained in yard experiments in plastic pools when inoculated with *Gleotrichia* as against the uninoculated control with a survival of only 30%. The study is in progress.

Problem : 1.5 Culture and utilization of fish food organisms.

1.5.1 Experimental culture of fish food organisms—Crude cultures.

Duration : Two years.

Personnel : Dr. M. T. Philipose, Sarvashri S. C. Banerjee (till August), D. P. Chakraborty (from August), A. C. Nandy and G. V. Kowtal.

Crude cultures of *Nitzschia* and *Navicula* were obtained in the laboratory experiments in jars with N-P-K fertilizers (urea + double superphosphate + potassium nitrate) at 230 ppm with varying phosphate ratios (5:12.5:3 ; 5:15:3 and 5:17.5:3), their greatest abundance being in the 5:15:3 series. Maximum growth of diatoms was obtained in 5:15:3 set when urea was replaced with ammonium chloride, ammonium sulphate or ammonium phosphate, of which three different ratios were tried (5:15:3 ; 5:5:3 ; 15:5:3).

Further experiments gave the highest growth of diatoms in the 5:15:3 set using ammonium sulphate, bone meal and potassium nitrate combination, the superphosphate having been replaced by bone meal. Confirmatory experiments are being taken up in plastic pools.

Crude culture of common zooplankters (*Brachionus, Moina, Cyclops, Diaptomus* and *Cypris*) was attempted in laboratory experiments in 10 litre glass jars using a number of organic (cow-dung, mahua oilcake, poultry droppings and mustard oilcake rice bran mixture) and inorganic (urea, triple superphosphate and calcium ammonium nitrate) manures. Results obtained so far indicate that mahua oilcake, poultry droppings, cow-dung and calcium ammonium nitrate, in the order given, at concentrations of 300-600 ppm, are favourable media for the culture of these organisms.

Detailed yard and field experiments are planned for the next year.

1.5.2 Experimental culture of fish food organisms in the laboratory and field for feeding fish.

Duration : Three years.

Personnel : Dr. C. S. Singh and Smt. K. K. Bhanot.

Preparatory cultures of *Chlorella* sp., *Nitzschia* sp., *Gomphonema* sp., *Closterium* sp. and *Selenastrum* sp. have been made on agar plates in Chu No. 10, Bristol's solution with 0.1% urea. Desmid agar and soil extract solutions under controlled temperature ($25°C \pm 1$) and illumination conditions (100, 200 and 500 lux).

While stock cultures of *Chlorella* and *Navicula* have been achieved in Bristol's solution with 0.1% urea, that of *Gomphonema* has been obtained in Chu No. 10. *Closterium* and *Selenastrum* have been isolated and put in Chu No. 17 and Chu No. 10 respectively for achieving stock culture. Sub-cultures of the aforesaid plankters are being regularly done to maintain them in stock.

Specimens of *Moina* and *Cyclops,* kept separately in four flasks with *Chlorella* as food, though multiplied, survived for 7 days in one experiment. In another set, they survived for 45 days. Further, work is in progress.

Observations were made on the natural occurrence of plankton in artificially manured cisterns, where the atmosphere served as a source of inoculum, by setting up an experiment in six cement cisterns ($86 \times 56 \times 48$ cm) with necessary replications. While cistern Nos. 1-5 were manured with 5% soil extract solution, 0.25% dry cow-dung, 0.05% Knop's solution, Bristol's solution and Chu No. 16 respectively, cistern No. 6 served as a control and was

filled with tap water only. Temperature, pH, DO, phosphates, and total alkalinity (as $CaCO_3$) during the period of study were found to range from 16-26°C, 8.0-9.1, 5.4-10.6 ppm (except in cistern No. 2 where it was only 1.4 ppm), 0.01-1.5 ppm and 152-500 mg/l respectively. *Chlamydomonas* sp., *Chlorella pyrenoidosa, Navicula angustisma, Nitzschia palea* and *Gleocapsa decorticans* appeared on the 7th day of the start of the experiment in all the cisterns including the control. Plankton estimation was done after an interval of 10 days for a period of one month and the increase in cell numbers/litre of *Chamydomonas* in cistern Nos. 1-6 was observed to be from 10-80, 10-250, 10-40, 10-125, 5-300 and 2-60 ; of *Chlorella* from 25-150, 20-425, 15-160, 15-450, 10-300 and 50-100 ; of *Navicula* from 5-200, 20-30, 10-2,000, 6-3,000, 20-7,000 and 5-40 ; of *Nitzschia* from 25-1,000, 50-100, 20-3,200, 12-2,000, 10-8,000 and 25-210 ; and of *Gleocapsa* from 20-250, 20-250, 20-250, 2-10, 2-20 and 5-100 respectively. This brings out the efficiency of Bristol's solution for *Chlorella* and Chu. soln. No. 16 for *Navicula* and *Nitzschia.*

1.5.3 Algae as a nutritive source of food to fishes.

Duration : Three years.

Personnel : Dr. C. S. Singh and Smt. K. K. Bhanot.

Three types of feed were prepared with *Sirogonium* sp. as the basic ingredient. The composition of one of the feeds was algae (25 gm) + fish meal (25 gm) + wheat flour (25 gm) + starch (25 gm) + yeast (16.6 gm) + cobalt chloride (2.5 gm). In the other two feeds, cobalt chloride was replaced by cobalt nitrate in one and terramycin in the other. 15 specimens of *C. mrigala* were kept on these feeds, the control being fed on plankton. The experiment had to be abandoned after 20 days owing to death of fish.

Problem : 1.6 Response of typically unproductive pond soils to different inorganic manurial combinations using primary productivity as index of response.

Duration : Three years.

Personnel : Sarvashri S. M. Banerjea and R. K. Banerjee.

Observations in plastic cisterns, with four differently productive pond soils (known for year's for high and low yields of fish) from Tripura and Orissa, showed that the average primary production was much higher (256.3 mg $C/m^3/hr$) in case of the productive soil of Rajdharnagar (Tripura) as against the medium and poorly productive soils of Kausalyaganga (Orissa), Lingipur (Orissa) and Lembuchara (Tripura), for which the values of primary productivity were 44.2, 58.2 and 71.2 mg $C/m^3/hr$ respectively. Dissolved inorganic

phosphate was found to have a direct correlation with primary production, the respective values for the four soil types being 0.18, 0.03, 0.02 and 0.03 mg P/l. The same trend in primary production and correlation between primary production and dissolved inorganic phosphate was found to continue for the next two months. Carbon assimilation, however, appeared to be influenced by NO_3-N/PO_4-P ratio as primary production was found to decrease from 256.3 to 180.6 mg C/m^3/hr with the decrease in N/P ratio from the optimal value of 3.7 to 1.3 in case of Rajdharnagar soil. Kausalyaganga and Lembuchara soils showed an increase in primary production when the N/P ratio was in the optimal range of 4.3 and 4.9 as against the abnormally low and high value of 0.03 and 69.3.

Based on the above findings that primary production could be used as an index of general biological productivity, a yard experiment has been set up with two unproductive pond soils from Tripura and Orissa to study their response to different N-P combinations. Representatively collected bulk soil samples, dried, powdered and sieved through a 2 mm sieve, have been used as a 5 cm (20 kg) deep substratum in plastic cisterns, with six replicates for each soil type, the soil water ratio being kept at 1:20. As the initial inoculation with phytoplankton, collected from natural ponds, has failed to give good growth due to extremely low concentration of dissolved nutrients in water, further seeding with plankton is being continued for the establishment and growth of plankton so as to have at least a measurable quantity of positive primary production.

Problem : 1.7 Studies on the factors responsible for low and high productivities of fish ponds in acid soil zones of Tripura.

Duration : Three years.

Personnel : Sarvashri S. M. Banerjea, R. K. Banerjee, N. C. Ghosh and M. Bhattacharjee.

With a view to elucidating the factors responsible for low and high productivity of fish ponds in acid soil zones of Tripura, a field experiment was taken up in two acid soil fish farms (one highly productive and the other extremely unproductive). Three ponds of identical morphometric features in respect of water area, slope, light conditions, etc. were selected in each farm. These ponds were completely dewatered, about 10 cm of bottom soil removed to expose the basic soil and then refilled with the same water. After allowing sufficient time for the establishment of the soil-water nutrient equilibrium, the ponds were stocked with advanced fingerlings of catla, rohu and mrigal from the same stock and regular periodic observations on chemical quality of water, plankton, primary production and growth of fish were made. Both the types of ponds were found to be very low in alkalinity and while the hydroxide component therein was entirely absent, the carbonate component was present

only in a few samples. pH of water was near-neutral or slightly alkaline (6.9-8.1) in all cases. The differentiating characters of the two types of waters were observed in their soluble organic content and different forms of dissolved nitrogen and phosphorus. The water of the productive farm had a markedly higher organic content, dissolved phosphorus (both organic and inorganic), and organic and ammoniacal nitrogen. Nitrate-nitrogen, however, showed an inverse relationship, being higher in the water of the unproductive farm. Further work is in progress.

Problem : 1.8 Studies on the prevention of seepage in fish ponds by physico-chemical treatment of soil.

Duration : Two years.

Personnel : Sarvashri S. M. Banerjea, P. Ray and B. B. Ghosh.

With a view to studying the effect of replacing the exchangeable bases by Na^+ ions on the rate of percolation through pond soils, a laboratory experiment was conducted in glass jars using the highly percolative soil of the ponds located in the Institute's campus at Barrackpore. By using a soil substratum (2.5 cm deep), supported on a bed of gravel and sand (6 cm deep), and leaching it with 1, 2 and 3% salt solutions, it was observed that after six leachings (total vertical column of water allowed to permeate through being 114 cm under an average water head of 19.5 cm), the rates of percolation were 4.1, 0.4 and 4.4 cm/hr respectively for the three concentrations as against 63 cm/hr for the control (no treatment). More exchanges, however, did not bring about further reduction in the percolation rate.

Based on these results, an *in situ* experiment in the pond bottom was taken up. But due to high water table and due to high level of water in the river, the experiment had to be deferred till the fall in the subsurface water level.

A standard seepage testing apparatus has been designed and its model fabricated to allow a 20 cm column of test soil to be used as a substratum with a water column of 10 cm for precise measurement of the percolation rate.

Problem : 1.9 Studies on indigenous plant fish poisons.

Duration : Two years.

Personnel : Dr. M. T. Philipose, A. C. Nandy and D. P. Chakraborty.

Laboratory experiments indicated that raw and decomposed coconut husk at 500 ppm and tobacco leaf powder at 10 ppm do not act as fish poisons as

tilapia so treated were not killed even in 15 days' time. In laboratory trials, the lowest effective rate of mahua (*Bassia latifolia*) oilcake was 75 ppm. Laboratory experiments with the seed powder of *Barringtonia acutangula* (20 ppm) and the unripe fruit powder of *Randia dumetorum* (12 ppm) showed that tilapia could be killed within 4-6 hours. With higher doses of the latter, the fish was killed within 3 hours at 15 ppm and within 1½-2 hours at 20 ppm. Detoxification of the water treated with *Barringtonia* seed powder was observed 48 hours after poisoning. Seed powder of *Barringtonia* at 15-20 ppm killed tilapia within 4-6 hours without any apparent adverse effect on plankton and other biota present in the plastic pools.

Samples of the stem bark and root powder of *B. acutangula* are being analysed by the Regional Research Laboratory, Bhubaneswar, with a view to determining the toxic principle.

Field experiments are proposed to be taken up during the 1969 summer.

Problem : 1.10 Estimation of fish population in small ponds by mark recovery method.

Duration : One year.

Personnel : Sarvashri M. Rout and D. S. Murthy.

Estimation of numbers in changing and constant fish populations was done by repeated sampling in three ponds (0.7, 0.12 and 0.14 ha in area). Anal/pectoral fins of the fishes were clipped and released in the pond. The experiment in the first pond was repeated thrice by varying the number of hauls and the number of clipped fish with the change of population in the pond. The error observed ranged from 8 to 18%, with minimum for catla and maximum for rohu.

In the second and the third ponds with constant population, the variation in the population was 17 to 21% for catla, 4 to 33% for rohu and 3 to 12% for silver carp by increasing the number of hauls from 1 to 3. Number of clippings were reduced from 30 to 15% in the population. Results were verified by harvesting the fish alive and then poisoning the pond. Population estimates were tested against the enumeration of total fish and found to remain always at 5% probability level.

Problem : 1.11 Life history of Indian major carps—catla, rohu and mrigal.

Duration : One year.

Personnel : Sarvashri R. D. Chakrabarty and D. S. Murthy.

Studies on the development of fertilized eggs of catla, rohu and mrigal, obtained by induced breeding, were made. In one instance, the three species bred within a few minutes of each other and the eggs could be reared almost under identical conditions.

The first cleavage commenced within about half an hour after fertilization in all the three species. Incubation period was found to vary even in the same species. In spite of general similarity in the developing stages of the three species morphological differences could be noted. Based on these characters, it appears possible to distinguish 4-5 days' old spawn of one species from those of others. These differences pertain to colouration in the anal region (rohu), chromatophores in the dorsal fin (mrigal), demarcation of the caudal fin (catla), pattern of distribution of chromatophores below notochord (in rows in rohu), branching of rays in caudal fin (catla), rows of chromatophores on the body (mrigal), etc. A number of differences have been noticed amongst the species in later stages.

Review of Project 1 :

1. A gross production of 2,575-3,041 kg/ha/year was obtained for the fifth time in successive years from stock ponds of the Cuttack Substation by composite culture of Indian and exotic carps. In these experiments population density was kept constant but fertilizer and feed were applied according to the need of the fish to safeguard their proper growth. 2. There are indications that silkworm pupae are better feed for carps than the commonly used rice bran and mustard oilcake mixture. 3. Studies on pond fertilizers have shown encouraging results, calcium ammonium nitrate and urea giving a higher survival (5.55%) than ammonium sulphate. 4. While crude cultures of both phyto- and zooplankters were achieved in the laboratory, unialgal preparatory and stock cultures of *Navicula* sp., *Gomphonema* sp. and *Chlorella* sp. have been successfully made. 5. Studies on determination of low and high productivities of fish ponds in acid soil zones of Tripura have indicated the presence of markedly higher organic content, dissolved phosphorus (organic and inorganic) and organic and ammoniacal nitrogen in the productive ponds. 6. Leaching with 2% sodium chloride solution has been found to check seepage to a great extent in laboratory experiments in that it reduced the rate of percolation to 0.4 cm/hr after six leachings as against 63 cm/hr in the control. 7. A search for indigenous and economic fish poisons has indicated that both the seed powder of *Barringtonia acutangula* and the unripe fruit powder of *Randia dumetorum* are highly effective.

Project 2 : *Induced fish breeding.*

Problem : 2.1 Fish breeding experiments under control tempeature.

Duration : Four years.

Personnel : Sarvashri K. H. Ibrahim, R. M. Bhowmick, G. C. Panicker and M. M. Bagchi.

While all the six sets of rohu, injected with pituitary extract and kept in the air-conditioned laboratory bred successfully, only four of the six sets (control) spawned in ponds. Water temperature in the laboratory and the pond ranged from 28-31° and 30-34°C respectively.

Problem : 2.3 Inducing early maturity in fishes by pituitary injection and other methods.

Duration : Two years.

Personnel : Sarvashri G. C. Panicker, R. M. Bhowmick, M. M. Bagchi and S. K. Mukhopadhyaya.

Weekly injections were given to 25 specimens of rohu at 5 mg of pituitary extract/kg of body weight and to another 25 specimens at 0.5 mg HCG/kg of body weight. Appreciable gonadial development was observed after ten injections in both the cases.

Problem : 2.4 Use of synthetic and mammalian hormones in inducing spawning of carps.

Duration : Two years.

Personnel : Shri R. M. Bhowmick.

While HCG alone did not give successful results, when injected to rohu, it gave successful results in 4 out of 79 sets in combination with pituitary extract (3-6 mg pituitary extract + 1 mg HCG). Copper sulphate solution gave negative results. Synahorin (15-100 RU/kg body weight), when injected alone to 7 rohu females gave negative results, but in combination with pituitary extract (25 RU of Synahorin + 4-6 mg of pituitary extract per kg body weight), successful results were obtained in all the 4 sets. In further experiments to determine whether the administration of Synahorin could reduce the requirement of pituitary extracts, 7 sets of rohu were injected with various doses of pituitary extract ranging from 6-18 mg/kg and the other 4 sets with 25 RU of Synahorin in combination with 4-10 mg of pituitary extract. While only those sets which received 12-18 mg/kg of pituitary extract responded to these injections, all the 4 sets treated with pituitary extract in combination with Synahorin gave successful results suggesting thereby that administration of Synahorin could considerably reduce the requirement of pituitary glands.

Problem : 2.5 Extraction, preservation and ampouling of pituitary hormones.

Duration : Two years.

Personnel : Shri R. M. Bhowmick.

Pituitary extract, prepared in distilled water and preserved in propylene glycol (2 parts of the preservative + 1 part of the extract) and stored for 71 days under refrigeration, was found to give successful results, when injected to rohu suggesting thereby that the extract preserved in this way could be used for the entire breeding season.

Incidental to various induced breeding experiments, about 55.04 lakhs of spawn of Indian major carps were produced.

Review of Project 2 :

1. No remarkable achievement under this project was made during the year except the discovery of the fact that Synahorin in combination with a low dose of fish pituitary can be used for successful spawning of carps. This discovery would, however, lead to a considerable saving of the pituitary glands.

2. Propylene glycol has been found to be a good preservative at least for one spawning season.

Project 3 : Fisheries investigations in reservoirs and studies on the dynamics of their fish population.

Problem : 3.1 Investigations in big reservoirs.

Though more than 7,680 sq km of water-spread area are covered by medium and large reservoirs in India, fish production from them is anything but encouraging. The causes of poor production could be the poor productivity of the reservoirs or defective management practices including defective fishing techniques, unimaginative stocking measures, improper selection of species and poor understanding of the concepts of the dynamics of exploited fish populations. In order to examine the above factors in details, studies have been initiated on the limnology, fishery biology, fish populations and fishing techniques in the Konar and the Tilaiya reservoirs of the Damodar Valley Corporation, Bihar.

3.1.1 Physico-chemical characteristics of water and soil of reservoirs and primary productivity.

Duration : Three years.

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

Observations on the pH, DO, free CO_2, total alkalinity, phosphate, nitrate, silicate and ferric iron showed the annual average values in the Konar reservoir to be 7.61, 8.1 ppm, 6.24 ppm, 32.13 ppm, 0.027 ppm, 0.039 ppm, 4.56 ppm and 0.041 ppm respectively. Water temperature and transparency gave an annual average value of 23.5°C and 10.3 cm respectively.

Observations on the pH, DO, free CO_2, total alkalinity, phosphate, nitrate, silicate and ferric iron in the Tilaiya reservoir showed an annual average value of 7.48, 9.29 ppm, 7.1 ppm, 41.4 ppm, 0.034 ppm, 0.045 ppm, 4.35 ppm and 0.062 ppm respectively. Water temperature and water transparency showed the yearly average values of 26.3°C and 22.1 cm respectively.

3.1.2 Fish food resources in reservoirs.

Duration : Three years.

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

Phytoplankton dominated over zooplankton (5.0 : 1.0) throughout the year except during January-March, when the latter predominated over the former (4.1 : 1.0). *Microcystis* followed by *Anabaena* represented the dominant phytoplankters, the other genera being *Oedogonium, Pleodorina, Eudorina* and *Volvox* (Chlorophyceae) and *Fragilaria* and *Synedra* (Bacillariophyceae). The dominant zooplankters were *Cyclops* and *Diaptomus* (Copepoda) ; *Keratella, Brachionus, Polyarthra* and *Filinia* (Rotifera) ; *Difflugia* and *Arcella* (Protozoa) and *Chydorus* and *Diaphanosoma* (Cladocera).

Bottom biota was not present in samples taken upto a deapth of 10 metres near the dam site.

In the Tilaiya reservoir, where the observations were initiated in July, phytoplankton showed a dominance over zooplankton (2.5 : 1.0). While the phytoplankton was chiefly constituted by Myxophyceae followed by Chlorophyceae, the zooplankters comprised Copepoda followed by Protozoa, Rotifera and Cladocera.

3.1.3 Utilization of available food resources in reservoirs by fishes based on studies of gut analysis of fishes.

Duration : Three years.

Personnel : Sarvashri A. V. Natarajan and M. Ramkrishnaiyya.

In the Konar reservoir, mrigal and calbasu were found to feed extensively on organic detritus followed by green and blue-green algae. Rohu subsisted mainly on organic detritus followed by crustaceans, diatoms and blue-green algae. The food of catla comprised organic matter, crustaceans and blue-green algae in order of abundance. Crustaceans, however, dominated the diet of juvenile catla.

The food of catla, mrigal and calbasu in the Tilaiya reservoir was almost similar as those of the Konar reservoir.

3.1.4 Effect of impoundment on reproduction and survival of fishes.

Duration : Three years.

Personnel : Sarvashri A. V. Natarajan and S. Parameswaran.

The effect of impoundment on reproduction and survival of fishes, was studied by conducting spawn prospecting investigations at two centres on the Barakar river, some 8 km away from the upper reaches of the Tilaiya reservoir. 1,380 ml (1,48,088 eggs) were collected and the samples reared in the laboratory showed a very high percentage of minor carps. Fry and juveniles of major and minor carps like *Labeo calbasu, Cirrhinus reba* and *L. boggut* have, however, been encountered in the departmental fishing nets (*Khadi jal*) in the Konar reservoir.

3.1.5 Fishery biology and population dynamics of commercial fishes of reservoirs.

Duration : Three years.

Personnel : Sarvashri A. V. Natarajan and M. A. Khan.

Fish production from the Konar reservoir during January-December was estimated at 6.6 tonnes, of which mrigal constituted 45.70%, followed by calbasu 19.49%, catla 19.46%, rohu 3.10% and other fiishes 12.25%. Mrigal and catla ranged in size from 350-670 and 388-1,088 mm with modes at 450 and 630 mm, and 463 and 913 mm respectively. Calbasu (233-473 mm) and rohu (330-

690 mm) showed only one mode each, at 368 and 450 mm respectively. While mrigal was observed to be in the V stage of maturity in July and in spent stage during August and September, calbasu was in the V/VI stages during July and spent/recovering stages in August and September. The fecundity in mrigal (433-440 mm) and calbasu (410-413 mm) was found to vary from 76,177-1,06,715 and 3,11,817-4,22,103 eggs.

Studies on the fisheries biology and population dynamics of commercial fishes in the Tilaiya reservoir were initiated in July, '68. Fish production during July-December was estimated at 5.4 tonnes, of which catla formed 53.42%, mrigal 29.88%, calbasu 3.26%, rohu 2.30% and other fishes 11.14%. Catla (388-838 mm), mrigal (330-730 mm), calbasu (323-458 mm) and rohu (330-670 mm): each showed a mode at 638, 470, 383 and 430 mm respectively.

10,383 fingerlings of catla, rohu and mrigal were clipped and released in the Tilaiya reservoir with a view to studying the rate of exploitation of commercially important species of Indian major carps.

3.1.6 Fishery management and development in reservoirs.

Duration : Three years.

Personnel : Shri A. V. Natarajan.

On the basis of recommendation of the Central Inland Fisheries Research Institute, the Central Fisheries Corporation have stocked the Konar and the Tilaiya reservoirs with fingerlings of major carps, specially catla.

Problem : 3.2 Investigations in small reservoirs.

3.2.2 Evolvement of techniques for the eradication of unwanted fishes.

Duration : Three years.

Personnel : Sarvashri J. C. Malhotra, S. J. Karamchandani, R. Chandra, S. N. Mehrotra, R. K. Saxena, G. K. Bhatnagar and R. K. Dwivedi.

Besides the survey of the fish fauna and the observations on the abundance of unwanted fishes in the Govindgarh and the Kulgarhi reservoirs, the spawning potentialities of some predatory and weed fishes were studied in connection with their eradication and control for the benefit of desirable species in the reservoirs. The details of fecundity, ova diameter, etc. are given below.

Species	Month of collection	No. of specimens examined	Size range (mm)	Fecundity	Ova diameter (mm)
Garra mullya	August	10	92—130	1,520—6,628	1.10—1.20
Mystus cavasius	May	7	105—143	1,017—4,656	0.63—0.73
Clarias magur	May	6	129—155	1,239—2,423	0.15—0.17
Rasbora daniconius	May	4	115—142	3,634—7,749	—
Puntius sophore	June	5	72—100	1,044—6,134	0.60—0.70
P. ticto	June	20	75—107	1,065—7,766	0.60—0.70
P. ambassis	June	12	78—114	905—7,676	0.70—0.80

3.2.3 Assesment of productive potential of reservoirs.

Duration : Five years.

Personnel : Sarvashri H. P. C. Shetty, S. J. Karamchandani, D. V. Pahwa, S. N. Mehrotra, S. Jena, M. R. Sinha and P. K. Mathur.

Studies in the hydrology, plankton, bottom biota and primary productivity of the Govindgarh, the Kulgarhi and the Loni reservoirs have been conducted. Salient features of these studies are given below.

(i) *Govindgarh reservoir.*

(a) Hydrological studies.

Water temperature, water transparency and pH ranged from 18.67°C (December) to 30.55°C (June), 70.69 cm (November) to 102.12 cm (February) and 8.0 ppm (July to December) to 8.2 ppm (January to May) respectively. Total alkalinity exhibited an upward trend from January (25.92 ppm) to June (41.5 ppm), then a decline up to September (36.94 ppm) and again an upward trend up to December (38.84 ppm). DO content declined from January (12.1 ppm) to September (6.2 ppm), except in June and July, and showed an upward trend from October (7.53 ppm) to December (11.35 ppm). Free CO_2, however, increased regularly from January (1.47 ppm) to September (5.52 ppm) and declined thereafter up to December (1.62 ppm). Phosphates, nitrates and silicates did not show regular trends.

(b) Plankton studies.

The total plankton content ranged from 271 units/l (September) to 2,123 units/l (February), being the highest in Zone II (31%) and the least in Zone III (21%). Phytoplankton 57% dominated over zooplankton (43%). Phytoplankton varied from 89 units/l (March) to 1,264 units/l (December) and the zooplankton from 260 units/l (March) to 1,466 units/l (February). Myxophyceae (91.4%), Chlorophyceae (7.4%) and Bacillariophyceae (1.2%) constituted the phytoplankton, while the zooplankton comprised Protozoa (72%), Rotifera (14%) and Crustacea (14%).

(c) Primary productivity.

Observations on the primary productivity have revealed the gross organic production to vary from 275 mg $C/m^3/6$ hr (April) to 716 mg $C/m^3/6$ hr (February and July).

(d) Bottom fauna.

The concentrations of bottom organisms decreased irregularly from 1,867 units/sq m (January) to 242 units/sq m (August). The bottom fauna comprised chironomid larvae (60.1%), nematodes (20.1%), insect larvae and pupae (19.1%) and molluscs (0.7%).

(ii) *Kulgarhi reservoir.*

(a) Hydrological studies.

Water temperature, water transparency and pH varied from 17°C (December) to 29.7°C (August), from 49-65 cm (August to December) to 120-136 cm (February to July) and 8.1-8.2 ppm respectively. Total alkalinity increased progressively from February (65.34 ppm) to June (99.9 ppm), declining to 80.1 ppm in October and increasing again to 97.37 ppm in December. DO contents exhibited a gradual downward trend from February-April (10.9-10.07 ppm), an abrupt fall from May-August (6.85-6.51 ppm) and again an upward trend from September-December (7.55-10.83 ppm). Free CO_2, phosphates, nitrates and silicates ranged from 0.98-5.14, negligible to 0.069, negligible to 0.045 and 9.75-19.9 ppm respectively.

(b) Plankton studies.

The total plankton content declined from March (109.4 units/l) to June (57.6 units/l) with an abrupt fall in April, but showed an upward trend from July (98.9 units/l) to October (171 units/l). It increased to 590.8 units/l in

December. Zooplankton (84.6%) dominated over phytoplankton (15.4%). Phytoplankton was made of Myxophyceae (88.5%), Bacillariophyceae (8.2%) and Cholorophyceae (3.3%). Zooplankton was constituted by Protozoa (39.1%), Rotifera (22.9%), nauplii (17.3%), Copepoda (11.2%) and Cladocera (9.5%).

(c) Primary productivity.

The gross organic production varied from 232 mg C/m³/6 hr in October to 512 mg C/m³/6 hr in May.

(iii) *Loni reservoir.*

(a) Hydrological studies.

A rising trend of almost all the chemical constituents was noted from January to June as indicated by pH (8.0-8.3), carbonate (6.0-13.4 ppm), bicarbonate (95-120 ppm), hardness (90-132 ppm), nitrate (0.04-0.1 ppm), phosphate (0.07-0.9 ppm), silicate (traces—13.2 ppm), chloride (8.4-16.0 ppm) and calcium (46-62 ppm). DO, however, showed a decline from 9.6-6.0 ppm. While carbonates showed an increasing trend, bicarbonates revealed a decreasing trend from July-December. Nitrates, phosphates, silicates and chlorides showed a slight decrease during July-December, but calcium and DO maintained a rising trend.

(b) Plankton studies.

Plankton production fluctuated between 23 units/l (August) to 663 units/l (June). Rotifers dominated the zooplankton throughout the year. Phytoplankton, in general, dominated over zooplankton.

(c) Primary productivity.

Primary productivity ranged from 150 mg C/m³/6 hr (September) to 750 mg C/m³/6 hr (October).

(d) Bottom biota.

Gastropods (181-208 units/sq m), bivalves (197-233 units/sq m), insect larvae (646-1,080 units/sq m) and oligochaetes (599-1,166 units/sq m) constituted the bottom biota of the reservoir.

(e) Macro-vegetation.

Three species each of Hydrocharitaceae (*Vallisneria spiralis, Hydrilla verticillata* and *Nechamendra alternifolia*) and Naiadacae (*Potamogeton*

pectinatus, P. crispus and *Najas minor*) were encountered. Amongst others *Tridex procumbens* was the most common.

3.2.4 Investigations on exploitation techniques, fish biology and population dynamics, towards formulation of management measures.

(i) *Experimental fishing.*

Experimental fishing with gill nets of various mesh sizes, with floats and sinkers and with floats but without sinkers was conducted in the Govindgarh, the Kulgarhi and the Loni reservoirs. It was observed that gill nets with floats only gave better catches than those with floats and sinkers. Night catches were invariably greater than the day catches.

(a) Govindgarh reservoir.

361.31 kg of fish was landed at this reservoir with the experimental gear in 50 days of fishing. The catches comprised *Catla catla* (71.1%), *Tor tor* (13.6%), *Cirrhinus mrigala* (5.7%), *Labeo rohita* (4.8%), *Labeo gonius* (1.9%), *Puntius sarana* (0.2%) and *Wallago attu* (0.1%). The catch/net/day and the catch/100 sq m net area/day ranged from 0.008 (October) to 0.84 (February) and 0.011 (October) to 0.886 (February).

(b) Kulgarhi reservoir.

363.51 kg of fish, landed in 44 days of fishing by the experimental gear, comprised *Catla catla* (64.9%), *Cirrhinus mrigala* (29.9%), *Labeo rohita* (4.7%), *Ompok bimaculatus* (0.4%) and *Channa striatus* (0.1%). The catch/net/day and the catch/area of the net/day ranged from 0.11 (July) to 0.62 (March) and 0.12 (July) to 0.71 (March) respectively.

(c) Loni reservoir.

333.88 kg of fish was landed by two types of gill nets. Maximum catches were obtained during March (53.7 kg), followed by July (50.14 kg), June (45.35 kg) and May (37.36 kg).

(ii) *Biological investigations.*

(a) Govindgarh reservoir.

Studies on the biology of *T. tor* (mahseer), catla and rohu are in progress. The gut of rohu (310-810 mm) was found to comprise sand and mud (23.25%),

decayed organic matter (32.54%), diatoms (24.98%), protozoans (9.74%), green algae (8.95%) and blue green algae (0.54%).

(b) Kulgarhi reservoir.

An examination of 95 guts of mrigal (302-483 mm) showed sand and mud (57.1%), decayed organic matter (22.3%), diatoms (17.9%), green algae (1.5%), blue-green algae (0.5%), protozoans (0.6%) and rotifers (0.1%) to comprise the food of the species. Observations on the maturity of fish of known age have indicated that the fish attains first maturity at 410 mm in its second year of life. The condition factor ranged from 0.855-1.026 in female to 0.836 to 1.009 in male.

(c) Loni reservoir.

C. mrigala : Observations on the food of mrigal indicated that the fish subsisted mainly on phytoplankton, *viz. Pediastrum* sp., *Oscillatoria* sp., *Merismopedia* sp. and *Microcystis* sp. Occasionally zooplankters, mostly rotifers (*Monostyla* sp., *Notholca* sp.) were also encountered in the gut. Intensity of feeding was observed to be poor throughout the year probably either on account of the regurgitation after gilling or due to digestion of food during the period between gilling and death of fish.

L. calbasu : 34 specimens of *L. calbasu* (285-475 mm) were collected from the experimental fishing, the sex ratio being 1 M : 1.8 F. Phytoplankton (*Pediastrum* sp., *Ulothrix* sp., *Zygnema* sp., *Oscillatoria* sp., *Spirogyra* sp., *Hydrodictyon* sp., *Navicula* sp., and *Cyclotella* sp.) appeared to be the main diet of the fish. 42% of the total guts examined were found to be empty. Immature ovaries (stages I and II) were observed during February, March, September and October. Maturing and mature ovaries were noticed during March to May and June to August respectively.

L. bata : 27 specimens (322-388 mm) were examined, the sex ratio being 1F : 1.34M. 50% of the guts examined were found to be empty. Fish subsisted mainly on phytoplankton.

P. sarana : Of the 104 specimens (240-320 mm in size ; sex ratio 1M : 18.6F), collected from the catches of experimental fishing, 26% were found to be with empty guts. Those with food showed the presence of molluscan shells, insect remains and phytoplankton (*Pediastrum, Navicula, Phormidium, Merismopedia, Cyclotella, Cymbella* and *Oscillatoria*). *The* rectal contents showed presence of molluscan shells in a semidigested condition implying that they are passed out undigested. Mature ovaries were found during May, June and July while spent ones during August and September. Ova were seen to be homogeneously distributed in both the lobes of the ovary.

M. seenghala : Gut analyses of 83 specimens (350-1,052 mm) of this species revealed that the fish is predatory on almost all the catfish as the latter made up 95% of the total food consumed by the fish. Other food items, of lesser importance, were frogs and prawns.

W. attu : While 80% of the guts examined were found to be empty, the rest contained digested fish matter.

E. vacha and *O. pabda,* of which 12 and 6 specimens respectively were examined, were also found to have subsisted mainly on teleosts.

Problem 3.3 Tank fishery investigations.

Studies on the assessment of fish production potentialities of selected tanks and ponds by estimating primary organic production and gross biogenic production and the influence of environmental factors on biological productivity were continued. Efforts at managing the tank fish populations to obtain optimum catches were made by stocking the fry and fingerlings of *Chanos chanos* and *Channa marulius, C. leucopunctatus* and *C. striatus.* Surveys for the reported availability of carp seed in the Cauvery, for *Puntius pulchellus* in the Kumudvati, and for mahseer in the Cauvery and the Kabini rivers were undertaken.

3.3.1 Assessment of biological productivity in tanks.

Duration : Three years.

Personnel : Dr. A. David, Sarvashri S. L. Raghavan and N. G. S. Rao.

Primary production, assessed once a month by light and dark bottle method in the Hutchammankere, Sakalwara, Karpur and Bellandur tanks and Kadagrahara and Side-Hoskote ponds, ranged from 200.0-549.9, 112.0-1,050.0, 445.0-675.0 and 559.0-3,738.0 mg C/m^3/day in the tanks, and 200.0-687.3 and 574.9-1,612.0 mg C/m^3/day in the ponds respectively. Presence of a myxophycean bloom was responsible for higher primary production in the Bellandur tank. The disappearance of this bloom between July and August drastically brought down the productivity values. Persistent turbidity, however, affected primary production in the Hutchammankere tank.

Reappearance of aquatic vegetation in the Jigani and Bidarguppe tanks, after the inflow of rain water, resulted in an increase in the epiphytic organisms. Fortnightly assessment of settled particulate organic matter by slide submersion method indicated carbon production to range from 13.8-37.4 mg/30 sq cm slide area in the Hutchammankere tank.

Plankton density ranged from 50-1,660 units/l in tanks, registering an increase towards the last quarter of the year. Sudden disappearance of *Microcystis* bloom resulted in a sharp fall in the plankton density of Bellandur tank from 1,40,440 to 880 units/l. Influx of rain water in ponds brought about a decine in the density from 70-3,595 to 50-2,320 units/l of plankton.

Density of invertebrate organisms constituting littoral and benthic fauna ranged from 2-2,768 units/sq m in tanks and 4-188 units/sq m in ponds. Charred weights of these samples indicated carbon content to range from 2.6-42.4% per sq m in tanks and 2.35-36.6% per sq m in ponds.

3.3.2 Influence of environmental factors on biological productivity.

Duration : Three years.

Personnel.: Dr. A. David and S. L. Raghavan.

As biological productivity of water bodies is governed by the changes in the surrounding environment, observations on the physico-chemical conditions of water and soil were made with a view to studying their role in the tanks and ponds. The details are given in Table 1.

TABLE I

Physico-chemical features of the water and soil phases of tanks and ponds

	Tanks	Ponds
Water phase		
Temperature (°C)	20·5-31·5	19·8-29·2
Turbidity (mg/l)	100-1,800	120-1,500
pH	6·8-9·4	6·9-8·1
DO (mg/l)	3·4-11·86	1·2-8·4
Alkalinity (m/gl)	19·0-492·0	36·0-264·0
Hardness (mg/l)	13·0-154.0	28·0-112·0
Specific conductivity (x10^{-6}mhos	46·0-1,224·0	82-0-1,050·0
Nitratcs (mg/l)	0·23-4·05	0·272-2.0
Phosphates (mg/l)	Traces-0·808	Traces-0,008
Silicates (mg/l)	12·8-35·0	10·6-33·0
Iron (mg/l)	0·04-35·0	0·24-33·2
Soil phase		
pH	6·5-8·5	7·5-8·5
Calcium (kg/ha)	2,242-6,726	1,121-6,726
Magnesium (kg/ha)	44·8-134·5	44·8-134·5
Phosphorus (kg/ha)	Traces-28	Traces-28
Ammonia (kg/ha)	16·8-112·1	16·8-112·1

Higher values of nutrient salts, observed during April-May, showed a marked decrease during June-October with the incursion of rain water and consequent dilution. A direct relationship was noted between turbidity, silicate and iron contents. The embankment side of the tanks showed higher nutrient values, probably due to the accumulation of nutrients in this region and absence of weeds. High values of ammonia indicated organic decomposition at the pond bottom which could probably be responsible for the acidic nature of certain tanks.

3.3.3 Management of tank fish populations to obtain optimum catches.

Duration : Three years.

Personnel : Dr. A. David, Sarvashri N. G. S. Rao, S. L. Raghavan and M. F. Rahaman.

Steps to improve the habitat by manuring and artificial stocking of ponds and tanks were taken to increase fish catches.

Sakalwara tank (4 ha) was manured with cow-dung and stocked with 2,634 juveniles of the large freshwater prawn, *Macrobrachium malcolmsonii,* and common carp fingerlings. Bellandur tank was stocked with 5,600 fingerlings of fast growing murrels, like *Channa marulius, C. leucopunctatus* and *C. striatus* with a view to replenish the dwindled predatory fish population. As a preliminary step towards mixed culture of carps and murrels, about 24,000 fry and fingerlings of murrels were stocked in the seasonal Karpur tank. The tank was later stocked with 2,240 fingerlings (75-150 mm) of major carps comprising mrigal (90%) and rohu (10%). 2,000 fry (15-40 mm) of *Chanos chanos,* collected from Kodi near Coondapur, were successfully transported and stocked at Hessaraghatta Fish Farm and Bellandur tank.

Investigations to locate the centres for the collection of seed of major carps and other economic varieties were also made to meet the demand of fish seed for stocking the tanks and ponds of the area. The stretch of the Cauvery river at and above its confluence with the Arkavati river at Sangam was explored for the availability of the seed of Cauvery carps. As the floods were not of the usual intensity, indications of major carp breeding could not be collected. The shooting net collections, however, comprised only minor carps *viz. Cirrhinus reba, Chela* spp., *Barilius* spp., *Danio aequipinnatus,* etc. The stretch of the Kumudvati river at and below Chowrdi and above the Anjanapur reservoir, where *Puntius pulchellus* was reported to be ascending for breeding, was explored, but neither running nor spent females were encountered. Preliminary exploratory work for mahseer yound in Mysore district was done.

3.3.4 Conservation of fishery in Bellandur and other selected tanks and small reservoirs.

Duration : Three years

Personnel : Dr. A. David, Sarvashri S. L. Raghavan and H. N. Chandrasekhariah.

Observations on the landing data, composition of predatory fishes and their food, loss of fish by way of migration and the viability and survival of eggs in the Bellandur tank were made. The catches were dominated by *Cyprinus carpio* var. *communis* followed by yearlings of *Catla catla*. The predatory fish population comprised *Heteropneustes fossilis, Channa striatus* and *C. gachua*. The food of the predatory species comprised insects, forage fishes and zooplankton. Observations on the ingress and egress of fish at the waste-weir during the periods of discharge of surplus water indicated that only the minor carps were involved in these movements.

Fish eggs were collected in large numbers, after the bloom of *Microcystis* disappeared from the Bellandur tank in August. On rearing, these were found to belong to *Rasbora daniconius* and *Puntius ticto*. Further studies on the viability and survival of eggs and larvae revealed the presence of *Gambusia* sp., *Puntius ticto, P. sophore* and *Rasbora daniconius* in large numbers.

Review of Project 3 :

Studies on various aspects of the limnology of the Tilaiya and the Konar reservoirs (Damodar Valley Corporation) and the food of commercially important fishes were conducted. Spawn prospecting investigations, carried out on the Barakar river above Tilaiya, did not reveal that the recruitment of major carps took place. Studies on the rate of exploitation of major carps in the Tilaiya reservoir have been initiated by releasing clipped fingerlings. Based on suggestions made by the Institute, the Central Fisheries Corporation has stocked both the Konar and the Tilaiya reservoirs.

Hydrobiological investigations in the medium sized reservoirs were conduced to formulate a programme of fishery development in them.

Fish production potentialities of selected tanks and ponds in Mysore State were studied. Fry and fingerlings of chanos and murrels were stocked in some of the ponds. Spawn prospecting investigations in the Cauvery river at Sangam revealed the presence of minor carps only.

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

Comprehensive investigations on the location of spawn collection centres and assessment of their potentiality in terms of quantity and quality, initiated by the Institute in 1964, were continued through 1968. Of the 4 centres, one on the Ganga river and two on the Yamuna river in Uttar Pradesh and one on the Banas river in Rajasthan, three were found to be promising for commercial exploitation of spawn.

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

Duration : Nine months.

Personnel : Sarvashri H. P. C. Shetty, J. C. Malhotra, A. N. Ghosh, K. K. Ghosh, Dr. A. G. Jhingran and other staff of the riverine division.

With a view to locating new centres for commercial exploitation of spawn and assessing the qualitative and quantitative potentiality of such centres, a number of possible sites were surveyed during the pre-monsoon season of 1968. A 132 km stretch of the Ganga river from Kanpur to Fategarh, a 300 km stretch of the Yamuna river for Musanagar to its confluence with the Ganga at Allahabad and a 300 km stretch of the Banas river from Negria (Tonk district) to Khamnor Panchayat Samiti (Udaipur district), were surveyed. Of the 21 centres on the Ganga and 10 centres on the Banas, one centre each at Nanamau and Negria respectively was selected for detailed spawn prospecting investigations. Deolan and Mehewapatti were the two centres selected for investigations on the Yamuna river. The salient features of the observations made at each one of these four centres, are given below.

Nanamau : A 70 km stretch of the river Ganga, from Rajghat (Kannauj), Farrukhabad district, to Bithoor in Kanpur district was prospected. For detailed investigations, a site near village Nanamau (Bilhaur tehsil, Kanpur district), on the southern bank of the river, was chosen, where round-the-clock observations were conducted for a period of 58 days, from the 5th July to 31st August, 1968. The site, situated at a distance of about 10 km north of Bilhaur town, is connected with the latter by a cart-track liable to be inundated in the monsoon season.

Although an ideal place for spawn collection was not available because of irregular river terrain, the area most suited for the purpose was selected on the eastern side of the village. The main stream branches into four parts just below the investigated site, leaving in between, vast stretches of sand-dunes. The

Ramganga, the Garra and the Kali rivers meet the river at about 35 km upstream while the Isan river joins it about 5 km downstream of Nanamau. The other bank (northern) is infested with wild *Jhau* plants and during floods, due to fast current and erosion, the suitability of the place is marred.

A total of 6,000 ml of spawn were collected at this centre, of which 5,971 ml were obtained during 3 spurts, the remaining 29 ml being collected at other times when the catch concentration had fallen below the index of availability. It is remarkable that all the three spurts of spawn, yielding 5,971 ml (99.5%) of the season's catch, were experienced in a single flood in its rising phase. The second spurt yielded the bulk of the season's catch (5,648 ml, 94.1%). The peak day of collection was 14th July and this single day's catch of 4,002 ml accounted for 66.1% of season's total yield. All the catch of this spurt was of desirable quality. The first and third spurts contributed 1.7 and 3.7% respectively to the season's catch.

During the availability period, a battery of 5 standard Midnapore shooting nets (1/8″ mesh) was operated. The catch/net/hr of the standard nets was 1.2, 13.2 and 1.2 ml for spurts 1, 2 and 3 respectively and 2.3 ml for the entire season. The season's indices of spawn quantity and quality at the centre were 807.6 ml and 76.3% respectively.

Sites near Rajghat (Kannauj), Mehndipur on the upstream and Mahadevan and Bithoor situated downstream of Nanamau were prospected. The area near Rajghat is low lying and gets inundated during floods of even low magnitude. A *nala,* running near the fort of Kannauj, together with the tributaries : Ramganga, Garra and Kali, surrounding the area of operation, result in high current velocity, thereby making the place unsuitable for net operation. While the Mehndipur and Mahadevan sites have steep banks, very little space is available at Bithoor below Brahmavar Tila for operation of shooting nets. The trial nets were operated in these places but no positive results could be obtained.

Deolan : The main investigations were carried out at Deolan from the 5th July to 28th of August, 1968, while a number of sites, distributed over the selected stretch from Lalauli in the north to Ashat in the south, were prospected for spawn.

The occurrence of floods in this region is governed primarily by the discharge of river Ken and generally by the run-off of the river and its tributaries from the catchment area. The flood pattern at the site was typical of large rivers, having well marked floods with prolonged rising and receding phases.

Negria : About 200 km stretch of the river Banas from Madpia to Negria was prospected from 7.7.68 to 8.9.68. A total of 9,650 ml (*c.* 48.25 lakhs) of spawn was collected at Negria in course of major floods. 7,890 ml (*c.* 39.45 lakhs) of spawn was collected by 1-5 standard nets and the rest by 5 research nets Flood I, which touched a level of 1.6 m on 12.7.68, yielded in its receding phase, a total of 7,372 ml of spawn in five standard nets in a spurt lasting for 94 hours. This spurt made up 76.2% of the season's total catch. After a 12 hours' vacillation phase, flood I again yielded 386 ml of spawn in its receding phase.

Flood II, which recorded a rise of 0.7 m on 23.7.68, yielded in its receding phase 221 ml of spawn in a duration of 12 hours. Floods III and IV did not yield spawn. The seasonal indices of spawn quantity and quality at Negria were estimated to be 1,531.5 ml and 59.4% respectively.

In addition to spawn, 185 and 50 ml of eggs were also collected in the rising and receding phases of floods I and II respectively.

Problem : 4.2 Standardisation of spawn collection and measuring techniques.

Duration : Nine months.

Personnel : Sarvashri H. P. C. Shetty, K. K. Ghosh, K. V. Rao and Dr. A. G. Jhingran.

In addition to the standard 1/8″ meshed Midnapore shooting nets, nets made of 1/12″ and 1/16″ meshed netting were operated side by side to study their relative efficiency. At all stages, in changed positions, 1/12″ meshed net proved to be most efficient gear, yielding more spawn.

Problem : 4.3 Spawn availability and behaviour in relation to hydrographical and biotic factors.

Duration : Six months.

Personnel : Sarvashri H. P. C. Shetty, J. C. Malhotra, K. K. Ghosh, B. N. Saigal, D. V. Pahwa, K. V. Rao, K. P. Srivastava, A. G. Godbole and Dr. A. G. Jhingran.

Observations on associates as indicators of spawn availability and weather condition were conducted at Deolan.

Associates : No indicator species for predicting spawn availability could be located. The associates were never come across in large numbers throughout the season. Amongst the associates, *Puntius* spp. dominated.

Four floods were experienced at Deolan by the river, of which the first and the third did not yield spawn. The first flood was almost wholly a result of the discharge of the Ken stream and recorded a rise of 9.57 m above the summer level. The second flood registered a peak of 5.55 m on the 24th July, after rising for about 60 hours and yielded the first spawn spurt in the rising phase and the second spawn spurt in the receding phase. The third flood touched a peak level of 8.45 m on the 7th August, but failed to yield any spawn, while the fourth flood in its rising phase yielded the third and last spawn spurt of the season.

The indices of spawn quantity and quality for the Deolan site were estimated to be 239 ml and 83.7% respectively.

Prospecting for spawn by operation of a standard net for six hours duration was done at Lalauli, Goakan, Sewramau, Marka and Ashat. Attempts at Garhi and Lametha proved futile as the banks at those places were steep rendering net operation impossible. The sites listed above are suitable for operation of nets, especially those at Lalauli and Ashat, where spawn collection is or has been made by State Government. Since the availability of spawn was generally poor throughout the stretch, quantitative comparisons of different sites could not be done.

Mahewapatti : During the period of investigation from July 12 to September 5, 1968 four floods were observed in the river. The first flood occurred round about the middle of July and touched a peak level of 5.0 m above the summer level. The second, the third and the fourth floods occurred in late July, early August and late August respectively and their respective peak levels being 2.5, 4.9 and 4.5 m above summer level.

In the entire season, spawn was available for a total period of 172 hours spread over 4 spawn spurts, when 1-5 experimental nets collected 3,252 ml (*c.* 16.26 lakhs) of spawn. Spawn spurt 1, which occurred in the receding phase of flood I for a total duration of 30 hours, yielded 298 ml (*c.* 1.49 lakhs) of spawn, all of desirable quality. Spawn spurt 2, of 24 hours' duration occurred in the receding phase of flood II, yielding a total of 193 ml of undesirable spawn. Spurt 3, which exclusively yielded desirable spawn and was the major spurt of the season, occurred during flood III and lasted for 80 hours. In all, 2,546 ml (*c.* 14.73 lakhs) of spawn were collected by the experimental nets, but about 70 to 90% were received in dead condition. The cause for this mass mortality of spawn could not be detected. In the receding phase of flood IV, the spawn spurt 4 of 46 hours' duration yielded spawn of undesirable quality only. In this spurt also 90% of the spawn was received in dead condition. In addition to above, 213 ml of spawn were collected by 1-3 experimental nets in the intervening period between the floods. The seasonal indices of spawn quantity and quality at this centre were estimated to be 601.0 ml and 18.2% respectively.

Weather condition : Extremely high and strong winds were experienced in the early part of August, which made net operation impossible, when flood III was rising.

Review of Project 4 :

Spawn prospecting investigations were conducted on four centres *viz.* Nanamau on the Ganga river and Deolan and Mahewapatti on the Yamuna river in Uttar Pradesh and Negria on the Banas river in Rajasthan. Except for Mahewapatti, the other three centres proved to have commercial potentialities. The season's indices of spawn quality and quantity at Nanamau, Deolan and Negria were 807.6 ml and 76.3%, 239 ml and 83.7%, and 153.5 ml and 59.4% respectively. Nets made of 1/12″ mesh proved to be more effective in spawn collection than those of 1/8″ and 1/16″.

Project 6 : Fresh water prawn culture.

Problem : 6.1 Culture of freshwater prawns in fish ponds.

Duration : Four years.

Personnel : Dr. M. T. Philipose, Sarvashri, K. Raman and K. H. Ibrahim.

The fingerlings of *Macrobrachium malcolmsonii* (18-47 mm), collected from Jobra anicut on the Mahanadi and stocked at 1,40,000/ha in a nursery pond (0.04 ha) in December 1967, had grown to 90.8 mm/9.1 gm by July, 1968. Their survival was, however, very poor. In three 0.012 ha ponds, prawn fingerlings (17-56 mm) were stocked at approximately 2,00,000/ha. Oxygenation by growing submerged weeds, like *Ottelia* and by bubbling air with a hand blower and construction of bamboo platforms for the prawns to remain near to the surface in better oxygenated water, are being tried with a view to improving their rate of survival.

Review of Project 6 :

Survival of *M. malcolmsonii* was found to be very poor in freshwater prawn culture experiments. Efforts are being made to improve their survival.

Project 7 : Murrel and live fish culture.

Problem : 7.1 Breeding of murrels and other air-breathing fishes.

Duration : Two years.

Personnel : Sarvashri R. N. Pal and H. A. Khan.

Sixteen out of twentyone sets of *Heteropneustes fossilis* were bred successfully by administration of both homo- and heteroplastic pituitary extract and the hatchlings could be reared up to 6 months in the laboratory. While the brood fish were found to feed on the eggs, the hatchlings were cannibalistic in tendency. A specimen bred in May was made to spawn again in July, '68. Breeding of *H. fossilis* did not occur after the first week of October, 1968.

Review of Project 7 :

Heteropneustes fossilis was successfully bred in the laboratory by administration of both homo- and heteroplastic pituitary glands and the hatchlings reared in the laboratory for six months. Survival, however, was found to be very poor.

Project 8. Brackish water prawn culture in mixed farming.

Problem : 8.1 Brackish water prawn seed investigations.

Duration : Four years.

Personnel : Dr. V. Gopalakrishnan and Shri R. M. Rao.

Investigations on the location of centres for the collection of the seed of brackish water species of prawns and their rearing in laboratory were continued. It was observed that juveniles (10-30 mm) of both *Penaeus indicus* and *P. monodon* were available in large quantities in the Rupnarayan river during January and February. Quantitative estimations on the availability of the 2 species in the main river and Kolaghat *khal* are given below.

Area	Species	Catch/net/hr (No.)
(1) River	*P. monodon*	14.71
	P. indicus	1,092.67
(2) Kolaghat *khal*	*P. monodon*	244.03
	P. indicus	332.83

Acetes indicus was also, however, predominating during the same months. Attempts to increase the survival rate of the larvae of *Macrobrachium rosenbergii* by ultra-violet light treatment proved futile, as they died within 7 days of hatching in both the control as well as the experimental jars. Feeding experiments with juveniles of *P. indicus* indicated slow growth (0.06 mm/day) in case of 70-75 mm size group and faster growth (0.21-0.30 mm/day) in case of specimens in the 30-35 mm size group with plant matter as food items.

Problem : 8.2 Brackish water fish seed prospecting.

Duration : Three years.

Personnel : Dr. V. Gopalakrishnan, Sarvashri N. K. Thakur, M. V. Gupta and K. K. Bhanot.

A steady decline in the availability of brackish water fish seed in many regions of tne Hooghly estuarine system was reported. Investigations were initiated to locate suitable fish seed collection centres. Attempts to standardise fishing effort for collection of brackish water seed are being made. Seed prospecting investigations in the Hooghly, the Matlah and the Rupnarayan estuaries have revealed the availability of postlarvae and juveniles of palaemonid prawns and fishes of commercial importance. Juveniles of *Mugil* spp., *Anchoviella indica, Ilisha elongata, Harpodon nehereus, Coilia ramcarati, Pama pama, Cynoglossus* spp., *Hemiramphus* sp., *Syngnathus* spp., *Belone* spp., *Chela* sp., gobeids, eels and sciaenids were available during December, 1967—January, 1968 in the Diamond Harbour—Nurpur stretch of the Hooghly estuary. During December, 1968 the important species encountered in the stretch were *P. styliferus* and juveniles of *Mugil parsia, I. elongata* and gobeids. Presence of juveniles of *P. monodon* and *P. indicus* in considerable numbers was observed during January and February, 1968 at Kolaghat on the Rupnarayan estuary and its associted canals. No fish of commercial importance was available in the terminal stretch of the Kulti estuary ; however, postlarvae of palaemonid prawns (*P. styliferus, P. indicus, P. monodon,* and *M. brevicornis*) and juveniles of fishes (*M. parsia, M. vaigiensis, Setipinna* spp., and *Plotosus canius*) were available during October, 1967 to April, 1968 in the stretch from the Kulti lock gate to Nazathatkola village. Shooting net and tow net collections around the newly constructed fish farm at Bakkhali revealed the availability of all the commercially important species of prawns during the period April-December. Fishes were, however, represented by *Mugil* spp., *S. panijus, I. elongata, H. nehereus, E. tetradactylum* and sciaenids.

Problem : 8.3 Biological investigations in the Pulicat lake, the Ennore backwaters and the Adyar estuary.

Duration : Three years.

Personnel : Dr. M. Subrahmanyam, Sarvashri K. N. Krishnamurthy, A. V. Prabhakara Rao, R. D. Prasadam, C. P. Rangaswamy, M. Kaliyamurthy and K. Janardhana Rao.

The total landings at the Pulicat lake during the year under report were estimated to be 926.89 tonnes, showing a decrease over 1,133.81 tonnes

landed during 1967 due to low prawn and mullet landings. Details of the catches are given under problem 14.2.3.

In the Pulicat lake, the postlarval incursion of *P. indicus* was maximum in August and October. The postlarvae of *P. semisulcatus* were maximum in June, while the postlarvae of *P. monodon* were maximum in August.

Food of *Mugil cephalus* consisted of a mixture of sand particles, silt, diatoms, algae, dinoflagellates and decayed organic matter. No appreciable change in the composition of diet throughout the year was noticed. Sectoral differences in diet also were not observed. Presence of gill raker processes in the stomachs of fishes (360-470 mm) in IV and V stages of maturity, were observed during the spawning season (October-December). Sex ratio showed the dominance of males in the whole lake with sectoral differences. Average monthly growth was estimated to be 24.7 mm from the progression of length frequency modes.

Experiments on the primary productivity of the lake, initiated in June, indicated the maximum production of 7.33 gm $C/m^3/day$ in July and the minimum production of 1.02 gm $C/m^3/day$ in November.

Water temperature, salinity, dissolved oxygen, total alkalinity, phosphate and silicate were in the range of 25.58-31.19°C, 12.55-44.75‰, 5.48-14.26 ppm, 61.5-145.2 ppm, traces—0.17 mg/l and 3.6-46.5 mg/l respectively.

Plankton studies, initiated in April, revealed that at the Lake-mouth and in the Northern Sector, the maximum standing crop was in May and in the Southern Sector during April. Phytoplankton showed two peaks with a primary peak in May and a secondary one in August. Blooms of *Rhizosolenia* sp., *Hemidiscus* sp., *Streptotheca* sp., *Eucompia* sp. and *Trichodesmium* sp., were encountered in May, while that of *Trichodesmium* sp. was available in August at the Lake-mouth and Southern Sector. Zooplankton also showed similar peaks with slight sectoral differences.

The Pulicat lake could be divided into three zones, on the basis of detailed studies made on the biota and substrata, as follows :

	Substratum		*Fauna*
Zone I.	Sandy with little mud.	—	Rich in polychaetes but total fauna moderate.
Zone II.	Muddy with little sand.	—	Rich in amphipods as well as in total fauna.
Zone III.	Clayey with fine sand and shell fragments.	—	Total fauna less than zone II, with amphipods dominant.

Polychaetes and amphipods were the dominant forms in the bottom biota. Trawling was possible only in the Southern Sector. $\frac{1}{4}$" meshed net gave better catches of prawns than $\frac{1}{2}$" meshed net.

Problem : 8.5 Investigations on the seasonal fluctuations in the abundance of prawn and fish seed in tidal influx into brackish water ponds.

Duration : Three years.

Personnel : Sarvashri A. Ghosh, S. C. Thakurta and H. S. Mazumdar.

Studies on the seasonal fluctuations in the abundance of prawn and fish seed and the adjustment of the ingress of tidal water in brackish water impoundments to allow the entry of maximum quantity of economic varieties, were initiated at recently constructed Brackish Water Fish Farm at Kakdwip (West Bengal). These observations have revealed the presence of *P. indicus* (20-40 mm), *P. styliferus* (25-45 mm), *M. brevicornis* (30-40 mm) and *P. stylifera* in the canal adjoining the farm. Fry of *Mugil parsia, M. tade, E. tetradactylum, M. brevicornis* and *M. monoceros* were available in abundance till September. While quality fish fry were not available after September, fry of prawns (*P. styliferus, P. stylifera* and *M. brevicornis*) were present. Fry of *M. parsia* entered the canal in late November and subsequently increased in numbers. Maximum quantity of prawn seed was available on the 4th and the 5th day of the lunar phase, when the opening of the sluice gate was kept at 12". *M. Parsia* and *P. styliferus* fry have been found to prefer water depths ranging from 60-90 cm below the surface.

Problem : 8.7 Experimental culture of brackish water fish food organisms.

Duration : Three years.

Personnel : Dr. C. S. Singh and Shri N. K. Thakur.

With a view to maintaining a regular artificial supply of fish food organisms in brackish water ponds, the soil, water, plankton, benthic organisms and fish samples were examined from the farm ponds at Kakdwip. Isolated culture of the preferred food organisms on agar plates was not successful evidently due to unsuitability of this medium.

Problem : 8.8 Brackish water fish farming in lower Sundarbans.

Duration : One year.

Personnel : Sarvashri B. B. Pakrasi and R. K. Banerjee.

With a view to studying the behaviour of dykes and optimum condition for the growth of cultivable euryhaline brackish water fishes in combination with indigenous and exotic carps in semi-saline waters, one experimental fish farm comprising 11 ponds, 10 measuring 50′ × 50′ and one central pond of 250′ × 150′, was constructed on Henry's Island in lower Sundarbans. The depth of these ponds varies from 92-183 cm. To test the efficacy of black clay core, the dykes of six of these ponds (including the central one) were provided with black clay puddle core (137 cm below and 153 cm above the ground level), while the rest were without a core wall. The rates of permeability through dykes of different specifications have been studied. Observations on the salinity, rainfall, water level and seepage in the farm ponds revealed that provision of puddle core wall had made no significant difference to the dykes' permeability. Silt deposition has been found to be heavy in almost all the ponds due to erosion of sides.

The pond soil, just after excavation, was found to be loamy in texture with about 80% silt, but gradually the mechanical conposition of the soil changed considerably. The silt percentage came down to about 50. Again the salinity of the soil was found to be quite high (2.37-3.24%) initially but a gradual decrease was noted, giving values of less than 1% by August. The pond soil was fairly rich in available phosphorus (12.4 to 24.9 mg/100 gm) but deficient in nitrogen and organic content.

The salinity (2.35-5.60‰) of the water in the ponds was comparatively low during monsoon months excepting that of the central pond, which has a black clay subsoil. Of the two major nutrient elements, nitrogen and phosphorus, nitrate-nitrogen has been found to be conspicuously low (nil-traces). Primary productivity has also been found to be low. Based on the soil condition, water quality and primary productivity studies, a manuring programme has been worked out. A basal dose of organic manure (90-40-20: N-P-K) at 25,000 kg/ha followed by application of inorganic fertilizers (10.5-8-4: N-P-K) at 600 kg/ha in twelve divided doses in monthly instalments was proposed to be tried.

Observations on the boring on dykes, dyke subsidence, erosion, etc. along with the observations mentioned above will be continued.

Review of Project 8 :

Investigations on the location of suitable spawn and fish seed collection centres have indicated the presence of postlarvae and juveniles of prawns at Kolaghat in the Rupnarayan estuary in January-February and the juveniles of *Mugil* spp., *Harpodon nehereus, Anchoviella indica, Ilisha elongata,* etc. in the Diamond Harbour—Nurpur stretch of the Hooghly estuary during December-January. No fish of commercial importance was available in the terminal stretch of the Kulti estuary.

Hydrobiological and fishery biological studies were continued in the Pulicat lake.

Both prawn and fish fry of commercially important species were abundantly available almost throughout the year in the canal adjoining the Brackish Water Fish Farm at Kakdwip. Isolated culture of brackish water fish food organisms was not successful.

Observations on the behaviour of dykes at newly constructed Experimental Fish Farm on the Henry's Island in the lower Sunderbans revealed that the provision of a puddle core had made no significant difference in the permeability of the dykes.

Project 9 : Selective breeding and hybridisation.

Studies on the production of better strains of cultivated species by hybridisation and selective breeding were continued. A search for suitable methods for preserving fish sperms at low temperatures was also made with a view to ensuring their availability for selective breeding at any time.

Problem : 9.1 Studies on the biological and genetical features of some Indian carp hybrids.

Duration : Two years.

Personnel : Shri K. H. Ibrahim.

Of the F_1 hybrids produced in 1967, rohu × mrigal and mrigal × catla had attained 319.0 mm/368.0 gm and 264.5 mm/194.7 gm respectively in 17 months. Hybrids of the F_2 generation had attained the following sizes by the end of two years: rohu-calbasu × calbasu, 387.0 mm ; mrigal-calbasu × calbasu, 348.0 mm ; and mrigal-calbasu × mrigal, 347.0 mm. Among rohu-calbasu × calbasu, both male and female were fertile and matured by the second year, the sex ratio being 69% ♀ and 31% ♂ . Sex ratio among mrigal-calbasu × calbasu was 100 % ♂ and in mrigal-calbasu × mrigal, 66.5% ♀ and 33.5% ♂ . Fecundity, based on a study of 15 specimens of rohu-calbasu × calbasu (351.0-449.0 mm), was found to range from 40,975 to 5,08,000 and the gonadosomatic index from 3.1 to 35.0. Fat content in rohu-calbasu × calbasu ranged from 0.328 to 0.582% in females and 0.55 to 0.64% in males. F_2 hybrids were induced to breed by hypophysation and F_3 generation was obtained.

Studies on the pharyngeal teeth in catla, rohu, mrigal, calbasu and their hybrids, though indicated structural variations, did not show significant differences.

Studies on the food and feeding habits, associated structural adaptations and modification, histology of the alimentary canal, morphometry, variations in vertebral counts, development of scales and their utility in aging fish and

cytogenetics for assessing the chromosome number and their compatability are in progress in both the hybrids and the parental forms.

Problem : 9.2 Studies on the storage of fish sperms at low temperature.

Duration : Two years.

Personnel : Sarvashri R. M. Bhowmick and M. M. Bagchi.

Preliminary experiments on the preservation of fish sperms in GPC-5 solution (physiological saline) have indicated that GPC-5 solution was more effective in preserving fish sperms than the Frog Ringer's solution. The sperms of *C. carpio* survived for 3 days in Frog Ringer's solution, while they were viable for more than 6 days in GPC-5 at 2-7°C under refrigeration.

Studies on the viability of germ cells of Indian major carps revealed that the eggs of rohu remained viable for 5 minutes, when stripped in water, but up to 22 minutes in the dry condition. The sperms remained viable for $1\frac{1}{2}$ minutes in water and up to 16 minutes in dry condition.

Review of Project 9 :

Both F_1 (rohu × mrigal and mrigal × catla) and F_2 (rohu-calbasu × calbasu, mrigal-calbasu × calbasu and mrigal-calbasu × migal) hybrids were found to be growing well. F_3 generation has been obtained by breeding the F_2 generation through hypophysation.

GPC-5 solution has been found to be a more effective preservative for fish sperms than the Frog Ringer's solution. Both eggs and sperms remained viable for a longer period (22 and 16 minutes respectively) in the dry condition than in the wet condition (5 and $1\frac{1}{2}$ minutes respectively).

Project 12. Exotic fish culture.

In order to meet the shortage of seed supply of exotic carps, attempts to achieve large scale success in natural spawning of injected grass and silver carps and to improve the techniques of stripping and hatching were continued. Observations on the monoculture of silver carp and food preferences of grass carp were also made.

Problem : 12.1 Standardisation of techniques of breeding of grass and silver carps for large scale production.

Duration : Two years.

Personnel : Sarvashri S. B. Singh, K. K. Sukumaran and P. C. Chakrabarti.

Of the 64 sets of silver carp and 55 sets of grass carp, injected with fish pituitary hormones, 42 sets of the former and 11 of the latter bred successfully.

yielding 9.01 and 4.0 lakhs of spawn respectively, being the highest achieved so far. The hormone dose mostly varied between 10-14 mg/kg body weight of females and 2-4 mg/kg body weight of males. A single dose of 4 mg/kg to a grass carp female resulted in free release of eggs which could be fertilized by milt from the uninjected males. Natural spawning of injected grass and silver carps inside *hapa* was recorded in several cases. Synahorin was also tried along with pituitary (10 and 11 mg/kg/ dose), which gave successful results in both the treated and control sets in silver carp and only in the control sets of grass carp.

Hybrids between silver carp female and grass carp male have been produced and are growing satisfactorily.

Problem : 12.2 Monoculture of silver carp.

Duration : Three years.

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

An experiment is being conducted in two 0.12 ha ponds with advanced fingerlings at 5,000/ha. The growth appears to be slow at this rate of stocking.

Problem : 12.3 Food preferences of grass carp.

Duration : Three years.

Personnel : Sarvashri S. B. Singh, K. K. Sukumaran and P. C. Chakrabarti.

Observations on preliminary screening of feeds for grass carp in plastic pools have shown that the advanced fingerlings feed on cut leaves of potato, cauliflower, raddish and cabbage. Emaciated grass carp, when fed with oilcake alone or a mixture of oilcake and rice bran, showed slight improvement, but when fed with rice bran alone, the fish recorded no increase in weight whatsoever in the course of two months.

Review of Project 12 :

Natural (without stripping) spawning of both grass and silver carps through hypophysation was achieved in the *hapas*. Synahorin along with pituitary was successfully used to induce spawning in grass and silver carps. Hybrids of silver carp × grass carp have been produced. Monoculture of silver carp has not given good results at 5,000 fingerlings/ha. Grass carp fingerlings have been found to feed on cut leaves of potato, cauliflower, raddish and cabbage.

Project 13 : Coldwater fish culture.

Experiments to control various diseases of trout responsible for large scale mortality in the hatcheries of Kashmir valley were conducted. A change from raw fish diet to partially cooked fish mixed with liver and wheat middlings checked vitamin B_1 deficiency, responsible for causing whirling disease, in both the varieties of trout. Centres for the collection of the seed of commercially important species of Kashmir valley were located on various streams. Detailed investigations on the standardisation of trout culture techniques in India have been initiated.

Problem : 13.1 Investigations on the mortality of adult trout due to whirling disease.

Duration : One year.

Personnel : Shri K. L. Sehgal.

Artificial feeding of trout on raw fish, partially boiled fish and partially boiled fish mixed with liver and wheat middlings were continued during the year. Artificial feeding with different raw fish was also continued. Trout fed with raw Schizothoracinae species and *C. carpio,* after deviscerating and cleaning, did not show any sign of 'whirling' disease. Trout fed with partially boiled fish and partially cooked fish mixed with liver and wheat middlings also did not show any sign of 'whirling' disease. However, the incidence of the disease was considerably high in the control as well as other ponds with brown trout of 3 years age and above during July-August, when the water temperature ranged from 15.0-18.7°C indicating that temperature had some role to play in the intensity of this disease.

Intramuscular administration of thiamine chloride (Berin) at 1.5-2.0 cc to the diseased fish at every alternate day met with little success. The fish after injection did show signs of recovery, but devoloped white patches all over the body and ultimately died. But, when the frequency of injection was reduced to twice a week, cent percent recovery was noticed.

Observations on the role of temperature and standardization of doses of thiamine chloride will be continued further. Mortality of trout fry due to certain ectoparasitic ciliates was controlled by bath treatment in 3% sodium chloride solution for 1 minute and 1:2,000 formalin for 15 minutes. The percentage survival in the control, sodium chloride and formalin treated troughs was 51.0, 62.0 and 70.0 respectively.

Problem : 13.2 Studies on the food and feeding habits of trouts.

Duration : Two years.

Personnel : Shri K. L. Sehgal and K. V. Ramakrishna.

A cheap and nutritive artifical feed, comprising fish meal (55.0%), beans (5.0%), gram flour (5.0%), mustard oilcake (1.0%), egg powder (5.0%), Osteo-calcium tablet (10.0%), blood (5.0%), Rovimix (5.0%), nicotinic acid (5.0%), ascorbic acid (2.0%) and sodium chloride (2.0%), was prepared in the labora-tory to which Terramycin TM 5 at 5 mg/kg of the feed was also added. However, the feed could not be used for feeding the fry and yearlings of brown trout on account of acute shortage of water supply at Harwan.

Studies on the standardisation of trout culture techniques were initiated. In October, breeders of brown trout were segregated and fed with artificial feed prepared in the laboratory at the rate of 2% of the body weight. Stripping of the breeders was completed at Laribal and Harwan hatcheries by the last week of November. The average number of eggs in brown trout (245-362 mm) at Laribal has been found to be 1,243 as against 1,294 obtained at Harwan where the breeders ranged between 237-355 mm. The percentage fertilization at both the farms was 96.8.

Experiments on the 'carrying capacity' of hatching troughs and trays and the role of Malachite green to check fungus infection were also initiated. At Laribal, average mortality up to eyed ova stage has been calculated as 16.5, 13.9 and 7.1% respectively in trays stocked with 3,000, 2,000 and 1,000 eggs. The use of Malachite green (1:2,00,000) for one hour reduced the average mortality to 12.3% against 14.6% in the control troughs. The aggregate percentage survival up to eyed ova stage at Laribal has been found to be 87.2, the highest so far achieved by the unit in experimental work in Himachal Pradesh and Kashmir. At Harwan, the average percentage morta-lity of green eggs in trays, stocked at the rate of 3,000, 2,000 and 1,000 was 11.8, 9.2 and 12.0 respectively. The percentage mortality in the troughs treated with Malachite green was found to be 10.7 as against 17.9 in control. The aggregate percentage survival up to eyed ova stage has been found to be 86.9.

Problem : 13.3 Location of spawn collection centres and assessment of their potentiality of Kashmir fishes.

Duration : One year.

Personnel : Sarvashri K. L. Sehgal and K. V. Ramakrishna.

Observations on the ecological conditions of the breeding grounds of *Schizothorax* spp. in the Erin, the Madhumati, the Lidder and the Bringhi streams of Kashmir were carried out. Fertilized eggs (2.7-3.8 mm) were found attached to the gravel in shallow water (depth: 10-18 cm) areas with a moderate current. The eggs were transparent, glossy and with a light yellow to orange coloured yolk. The larger eggs from each stream, on rearing were found to belong to *Schizothorax* spp. The physico-chemical conditions of the water of the spawning grounds were as follows : temperature, 10.0-16.5°C : turbidity, 7.0-11.0 cm ; pH, 7.1-7.7 ; and DO, 8.8-9.5 ppm.

Fry and fingerlings were found to be concentrated in the side channel. Large quantities of fry were found to perish in the diversion channels to the paddy fields, due to the rapid drying of streams during September. In the Lidder and the Bringhi systems, fry of *S. esocinus* and *S. longipinnis* comprised 28.6 and 13.0% respectively, the rest being *Nemacheilus* spp. In the Madhumati and the Erin streams, *S. esocinus* and *S. longipinnis* fry contributed to 59.2 and 21.2% respectively, the remaining being that of *Nemacheilus* spp. In the Sind river, the percentage of fry of *S. esocinus* and *S. longipinnis* was only 5.7 and 6.2 respectively.

Review of Project 13 :

Investigations on the control of diseases responsible for large scale mortalities in trout hatcheries, have led to improvement in the rate of survival.

Investigations on the carrying capacity of hatching troughs and trays and the use of Malachite green to check fungus infection have led to considerable improvement in the rate of survival, the aggregate percentage survival up to eyed ova stage being 86.9-87.2. Some breeding grounds and the centres for the collection of the seed of commercially important fishes (*Schizothorax* spp.) have been located.

Project 14 : Riverine and estuarine fish catch statistics.

Problem : 14.1 Riverine fish catch statistics.
14.1.1 Riverine fish catch statistics of the Ganga river system.

Duration : Four years.

Personnel : Sarvashri A. N. Ghosh, K. K. Ghosh, B. N. Saigal, J. K. Verma, S. P. Singh, M. J. Bhagat, K. P. Srivastava, S. N. Sar, R. K. Saxena, S. K. Wishard, G. N. Srivastava and R. K. Bhattacharya.

(i) *Upper stretch of the Ganga river* :

The estimated fish landings at the seven fish assembly centres totalled 766.18 tonnes, of which 460.91 tonnes were landed at the five centres on the Ganga river and 305.27 tonnes at two centres on the Yamuna river. Hilsa, with a landing of 239.23 tonnes was the most dominant species followed by *C. mrigala* (82.47 tonnes), *M. aor* (66.47 tonnes), *M. seenghala* (53.87 tonnes), *W. attu* (31.76 tonnes), *C. catla* (29.28 tonnes), *L. calbasu* (28.65 tonnes), *R. rita* (27.45 tonnes) and *L. rohita* (24.75 tonnes). Species wise landings at different assembly centres on the Ganga and the Yamuna rivers are given in Table 2.

TABLE 2.

Species wise total landings (in tonnes) at various fish assembly centres on the Ganga and the Yamuna rivers during 1968.

Centres	*C. mrigala*	*C. catla*	*L. rohita*	*L. calbasu*	*M. aor*	*M. seenghala*	*W. attu*	*R. rita*	*H. ilisha*	Miscellaneous fishes	Total
On the Ganga river :											
Ballia	2.13	1.26	0.77	0.09	2.04	2.32	1.25	0.07	20.21	6.70	36.84
Buxar	0.11	0.77	0.56	0.16	2.19	0.39	0.06	0.17	113.36	10.25	128.02
Kanpur	3.52	1.70	3.07	0.71	3.30	2.87	10.46	0.55	—	11.28	37.46
Varanasi	0.40	0.80	0.44	0.42	15.30	8.90	0.90	5.80	72.40	48.35	153.71
Patna	3.69	3.80	3.63	0.02	11.88	12.25	0.64	—	4.45	64.52	104.88
Total	9.85	8.33	8.47	1.40	34.71	26.73	13.31	6.59	210.42	141.10	460.91
On the Yamuna river :											
Agra	23.95	1.52	4.83	14.76	8.22	7.30	7.29	5.92	0.53	5.55	79.87
Sadiapur	48.67	9.43	11.45	12.49	23.54	19.84	11.16	14.94	28.28	45.60	225.40
Total	72.62	10.95	16.28	27.25	31.76	27.14	18.45	20.86	28.81	51.15	305.27
Grand Total	82.47	19.28	24.75	28·65	66.47	53.87	31.76	27.45	239.23	192.25	766.18

(ii) *Lower stretch of the Ganga river* :

On the basis of market sampling, the total fish landing from riverine resources at Bhagalpur fisn assembly centre during January to December, 1968, was estimated to be 155.72 tonnes against 114.03 tonnes during 1967. The landings of the different species were estimated as : *C. mrigala* (6.91 tonnes), *C. catla* (15.99 tonnes), *L. rohita* (6.91 tonnes), *L. calbasu* (1.59 tonnes), *M. aor* (6.64 tonnes), *M. seenghala* (6.50 tonnes), *W. attu* (17.77 tonnes), *H. ilisha* (9.79 tonnes) and miscellaneous species (83.95 tonnes).

The estimated landings at Lalgola on the Padma river from January to November, 1968 were 11.75 tonnes. Out of the eight species, only *H. ilisha* (6.46 tonnes) was represented in the landings, the remaining 5.29 tonnes being the landings of miscellaneous species of fish.

14.1.2 Investigation on the reported depletion of fisheries in the Godavari river.

Duration : Seven years.

Personnel : Shrimati T. Rajyalakshmi, Sarvashri Y. Rama Rao, G. Ramamohana Rao, L. Hanumantha Rao, P. L. Narayana Rao, M. Ranadhir, T. S. Ramaraju and K. S. Rao.

Studies on the reported depletion of fisheries in the Godavari river continued. Estimation of total landings, catch/unit effort, age composition of the fish landed was continued to be done as in the previous years.

The total landings from the river during January to December were 233.4 tonnes, the landings in Zone I being 175.2 tonnes, in Zone II 30.1 tonnes, and in Zone III 28.1 tonnes. The total yield was lower by 30 tonnes over that of the year 1967, the reduction being mainly due to the poor catches of prawn and miscellaneous groups of fish. The total yield of major carp was 43.6 tonnes (18.6%), catfish 14.9 tonnes (6.3%), H. ilisha 21.6 tonnes (9.3%), prawn 82.6 tonnes (35.3%) and miscellaneous fishes 70.7 tonnes (30.3%). Despite a slight rise in the landings of hilsa, the over-all abundance of the species continued to be low since 1965. Prawn, major carp and catfish also showed a decline in catches.

Studies on the age composition of the main species in the fishery indicated, in general, an abundance of higher age groups. In *H. ilisha*, the abundance of the III and the IV age groups was of equal magnitude, while the V group showed much reduction over that of 1967.

Higher age groups *viz.* the V (620 mm) and the VI (700 mm and 740 mm) constituted the fishery of *C. mrigala* followed by the I and the VI groups (700-

740 mm). As this period represents the period of breeding and recruitment of juveniles of *C. mrigala* to the fishery, the I group dominated the fishery during November and December. Introduction of small meshed (6-8.5 mm) nylon gill nets increased the capture of small sized fish of this species.

In *L. fimbriatus* the trend in age groups composition was similar to those of *C. mrigala,* the III and the I group being predominant over the IV and the II group.

Landings of *M. seenghala* showed a further decline over the corresponding period of 1967. Recruitment of the I year group (at modal lengths 100, 180, 210 and 260 mm) occurred over all the months from January to October. Age groups : the III (420 and 460 mm), the IV (540 and 580 mm), the V (600 and 620 mm), the VI (700 mm) and the VII (740 and 780 mm) were also present throughout the year.

The total landings of *M. malcolmsonii* during 1968 were 82.8 tonnes, showing a decline of about 15.0 tonnes over that of the year 1967. The size composition of females during the main prawn fishing season (January-June) was 13.0-17.5 mm (carapace length) and of males 17.5-27.5 mm at Rajahmundry. However, the size group increased to 23.5 mm in females and 28-47.5 mm in males at the upstream centres. The breeding was found to commence a little early during this year as compared to the year 1967. While 0.3% of the females were in the berried condition during April, the percentage increased to 12.23 in May. 19.09 in June and 50 in July-September. During July-December, about 50% were found to be in the mature or spent condition.

Studies on the migratory behaviour of the species were conducted by staining and tagging various size groups of the prawn in the river at two centres, *viz.* Rajahmundry and Dummagudem. A total of about 2,164 prawns were stained by Trypan blue and Fast green. The recaptures occurred within about a month, 1.8% being at Dummagudam and 2.2% at Rajahmundry. These observations indicated a localised movement of prawns, the maximum distance travelled being 35 km.

Experiments on tagging in laboratory were also conducted.

In order to estimate the abundance of migrating juvenile prawns at Dowleiswaram anicut, a sampling design has been implemented during November and December. The indices of abundance are being calculated with a view to correlating this with index of abundance of the breeding population at the beginning of the breeding season of the same year.

14.1.3 Estimation of primary productivity in the Ganga river system around Allahabad and Bhagalpur and in the Godavari river at Rajahmundry.

Duration : Four years.

Personnel : Shrimati T. Rajyalakshmi and Shri T. V. Prem Swaroop

Studies on primary productivity in Godavari river were conducted at one centre near Rajahmundry during January-June and at two centres during November-December. The primary productivity showed a progressive increase from January to May, being 127.68, 182.90, 198.01, 223.80 and 383.33 mg C/m^3/day respectively, but in June it declined to 274.48 mg C/m^3/day Station I showed a primary production of 255.86 mg C/m^3/day and station II 172.93 mg C/m^3/day in November. During December, however, the values declined to 160.75 and 150.11 mg C/m^3/day at stations I and II respectively. This decline followed a corresponding decline in temperature from November to December.

Problem : 14.2 Estuarine fish catch statistics.

14.2.1 Estuarine fish catch statistics by total enumeration at lower zone and sample survey at other zones of the Hooghly estuary.

Duration : Four years.

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

Seven important assembly centres, receiving catches of fish from the lower Sundarbans, were totally enumerated regarding gear wise and species wise landings. On the upper part of the Hooghly, the Rupnaryan, the upper part of the Matlah and the Ichamati rivers 13, 9, 1 and 1 fishing villages respectively, were observed on sampling basis regarding number of units in operation, catch/unit effort, species composition and number of operating days, gear wise. The total landing of fish from the estuarine system for December, '67 to October, '68 has been estimated to be 6,290.0 tonnes, Zone III contributing 67.1% of the catch. The species which predominated in quantity were *H. nehereus* (26.6%) prawns (15.7%), *H. ilisha* (8.2%), *S. phasa* and *S. taty* (5.6%), and *T. savala* and *T. haumela* (4.4%). Bag nets and drift nets contributed 63.7 and 9.6% respectively to the catches landed (Tables 3-5).

Table 3. Zone wise catches (in tonnes) in the Hooghly-Matlah estuary during December, '67 to October, '68.

Zone	December, '67 to May, '68	June, '68 to October, '68	Total	%
I. Nabadwip—Calcutta	511.7	241.6	753.3	12.0
II. Calcutta—Diamond Harbour	141.2	167.5	308.7	4.9
III. Lower Sunderbans	3,493.0	728.9	4,221.9	67.1
IV. Rupnarayan	636.6	261.8	898.4	14.3
V. Port Canning	61.7	46.9	108.6	1.7
Total	4,844.2	1,446.7	6,290.9	100.0

Table 4. Gear wise composition of catches (in kg) in the Hooghly-Matlah estuary during December, '67 to October, '68.

Gears	December, '67 to May, '68	June '68 to October, '68	Total	%
Trawl	1,12,061	10,407	1,22,468	1.9
Large seine	2,97,163	1,805	2,98,968	4.8
Small seine	3,43,452	1,01,806	4,45,258	7.1
Purse	3,407	7,389	10,796	0.2
Drift	1,55,978	4,49,254	6,05,232	9.6
Lift	42,581	46,657	89,238	1.4
Cast	12,581	13,181	25,762	0.4
Bag	34,25,261	5,82,511	40,07,772	63.7
Set gill	2,50,985	45,371	2,96,356	4.7
Set barrier	55,791	62,211	1,18,002	1.9
Traps	1,390	25,015	26,405	0.4
Hooks and lines	1,01,044	86,726	1,87,770	3.0
Unknown and unclassified	42,546	14,366	56,912	0.9
Total	48,44,240	14,46,699	62,90,939	100.0

Table 5. Species wise composition of catches (in kg) in the Hooghly-Matlah estuary during December, '67 to October, '68.

Species	December, '67 to May, '68	June, '68 to October, '68	Total	%
M. tade	5,137	4,575	9,471	0.2
M. parsia	27,676	24,193	51,869	0.8
L. calcarifer	10,111	7,975	18,086	0.3
S. panijus	26,447	13,266	39,713	0.6
P. paradiseus	16,385	14,143	30,528	0.5
P. indicus	2,18,135	5,995	2,24,130	3.6
E. tetradactylum	15,360	7,927	23,287	0.4
S. biauritus	88,336	1,517	89,853	1.4
S. miles	9,728	239	9,967	0.2
P. pama	1,08,492	36,201	1,44,693	2.3
H. ilisha	80,313	4,34,629	5,14,942	8.2
H. toli	15,432	5,464	20,896	0.3
I. elongata	37,586	20,380	57,966	0.9
C. ramcarati	42,381	22,156	64,537	1.0
C. borneensis	507	458	965	†
S. phasa and S. taty	3,06,760*	46,767*	3,53,527*	5.6*
P. pangasius	53,965	46,539	1,00,504	1.6
T. jella	41,664	52,852	94,516	1.5
O. militaris	5,126	2,076	7,202	0.1
P. canius	2,996	3,657	6,653	0.1
T. savala and T. haumela	2,61,601*	15,033*	2,76,634*	4.4*
H. nehereus	14,62,213	2,09,686	16,71,899	26.6
S. cinereus	91,746	9,749	1,01,495	1.6
Prawns	7,65,271	2,21,618	9,86,889	15.7
Miscellaneous	11,50,872	2,39,604	13,90,476	22.1
Total	48,44,240	14,46,699	62,90,939	100.0

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

† Indicates less than 0.05%.

14.2.2 Simple random sampling and systematic sampling as alternative to total enumeration in lower zone of the Hooghly estuary.

Duration : Two years.

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

Data from one fish assembly centre have been arranged and samples were drawn according to linear systematic sampling. Estimation of mean of catches of all important species and also of total catch is being made on the basis of linear systematic sampling. The total estimated landings of different species, studied according to random and systematic samplings, and the variances of the estimated means according to random sampling are given below.

Species	Random sampling	Systematic sampling	Variances of the means (random sampling)
P. indicus	342.60	208.35	10.81
P. pama	350.40	230.55	6.05
H. ilisha	1,068.30	706.80	55.59
S. phasa and S. taty	428.70	267.00	6.79
T. savala and T. haumela	26.10	16.95	0.04
Prawns	527.70	341.85	11.20
Total catch	9,282.90	6,003.75	3,594.76

14.2.3 Estimation of total fish landings at the Pulicat lake.

Duration : Three years.

Personnel : Dr. M. Subrahmanyam, Sarvashri H. Srikant, K. Janardhan Rao and S. Ganesan.

The total landings were estimated to be 926.89 tonnes, showing a decrease over 1,133.81 tonnes landed during 1967 due to low prawn and mullet landings (Table 6). Southern Sector contributed to 66.3% of the catch. Prawns dominated in the Southern Sector and mullets in Northern Sector of the lake. The size range that contributed maximum to the catches of important species, was as follows : *P. indicus,* 81-115 mm ; *P. monodon,* 121-185 mm ; *P. semisulcatus,* 46-80 mm ; *M. monoceros,* 51-75 mm ; *M. dobsoni,* 48-60 mm ; *M. burkenroadi,* 61-80 mm ; *M. cephalus,* 226-405 mm ; *M. macrolepis,* 151-280 mm ; *M. parsia,* 131-170 mm ; *S. sihama,* 121-140 mm ; *G. oyena,* 126-200 mm ; *G. filamentosus,* 91-135 mm ; *G. limbatus,* 76-105 mm ; *N. nasus,* 91-230 mm ; *C. chanos,* 76-210 mm & 256-315 mm ; and *E. saurus,* 136-270 mm.

Table 6. Species wise landing of fishes, prawns and crabs during 1968 in the Pulicat lake.

Species	Southern Sector		Northern Sector		Total 1968		Total 1967	Fall (—) or rise (+) over the year 1967
	kg	%	kg	%	kg	%	kg	%
PRAWNS								
P. indicus	1,21,026	19.70	34,094	10.90	1,55,120	16.74	3,88,024	— 60.02
P. monodon	26,021	4.24	3,982	1.27	30,003	3.24	64,572	— 53.54
P. semisulcatus	27,112	4.41	4,509	1.44	31,621	3.41	30,702	+ 2.99
M. monoceros	74,899	12.19	2,727	0.87	77,626	8.37	80,094	— 3.08
M. burkenroadi	8,862	1,44	5	—	8,867	0.96	5,823	+ 52.28
M. dobsonii	70,127	11.42	1,458	0.48	71,585	7.72	55,368	+ 29.29
M. affinis	2,586	0.42	—	—	2,586	0.28	560	+361.79
Other prawns	1,244	0.21	—	—	1,244	0.13	9,410	— 86.78
Total	3,31,877	54.03	46,775	14.96	3,78,652	40.85	6,34,553	— 40.33
MULLETS								
M. cephalus	48,257	7.86	81,488	26.06	1,29,745	14.00	1,41,273	— 8.16
M. macrolepis	16,231	2.64	6,979	2.23	23,210	2.50	23,372	— 0.69
M. parsia	1,162	0.19	381	0.12	1,543	0.18	947	+ 62.94
M. tade	2,794	0.45	18,658	5.97	21,452	2.31	13,200	+ 62.52
M. cunnesius	6,554	1.07	11,449	3.66	18,003	1.94	23,447	— 23.22
Total	74,998	12.21	1,18,955	38.04	1,93,953	20.93	2,02,239	— 4.10

TABLE 6—(*Contd.*).

Species	Southern Sector kg	%	Northern Sector kg	%	Total 1968 kg	%	Total 1967 kg	Fall(—) or rise (+) over the year 1967 %
PERCHES								
S. sihama	33,691	5.49	2,033	0.65	35,724	3.85	33,706	+ 5.99
G. oyena	6,770	1.10	5,809	1.86	12,579	1.36	5,586	+125.19
G. filamentosus	2,046	0.33	3,629	1.16	5,675	0.61	3,624	+ 56.59
G. limbatus	2,008	0.33	4,647	1.49	6,655	0.72	3,162	+110.47
Sparus sp.	2,979	0.49	9,308	2.98	12,287	1.33	17,796	− 30.96
Tuethis sp.	7,221	1.18	1,897	0.61	9,118	0.98	952	+857.77
E. suratensis	67	—	76	0.01	143	0.02	215	− 33.49
L. calcarifer	12,870	2.10	12,183	3.90	25,053	2.70	16,753	+ 49.54
Other perches	11,935	1.94	1,867	0.60	13,802	1.49	2,534	+444.67
Total	79,587	12.96	41,449	13.26	1,21,036	13.06	84,328	+ 43.53
CLUPEIDS								
N. nasus	19,104	3.11	16,680	5.33	35,784	3.86	42,255	− 15.31
C. chanos	1,088	0.18	6,407	2.05	7,495	0.81	6,534	+ 14.71
E. saurus	2,248	0.37	2,967	0.95	5,215	0.56	2,793	+ 86.72
Thrissocles spp.	1,662	0.27	6,706	2.14	8,368	0.90	7,044	+ 18.80
Other clupeids	379	0.06	2,134	0.69	2,513	0.28	4,911	− 48.83
Total	24,481	3.99	34,894	11.16	59,375	6.41	63,537	− 6.55

TABLE 6—(*Contd.*).

Species	Southern Sector		Northern Sector		Total 1968		Total 1967	Fall(—) or rise (+)over the year 1967
	kg	%	kg	%	kg	%	kg	%
CATFISHES								
P. canius	2,189	0.37	5,108	1.64	7,297	0.79	5,007	+ 45.74
Tachysurus spp.	16,413	2.67	23,677	7.57	40,090	4.33	50,692	— 20.91
Other catfishes	51	—	—	—	51	—	914	— 94.42
Total	18,653	3.04	28,785	9.21	47,438	5.12	56,613	— 16.21
Polydactylus indicus	13,262	2.16	852	0.27	14,114	1.50	13,637	+ 3.50
Sciaenids	10,559	1.72	10,105	3.23	20,664	2.23	21,239	— 2.71
Beloniforms	4,538	0.73	14,143	4.52	18,681	2.02	14,266	+ 30.95
CRABS								
S. serrata	30,313	4.94	4,727	1.51	35,040	3.78	16,274	+115.31
N. pelagicus	12,758	2.07	4,268	1.37	17,026	1.84	7,154	+137.99
Total	43,071	7.01	8,995	2.88	52,066	5.62	23,428	+122.24
Miscellaneous	13,183	2.15	7,725	2.47	20,908	2.26	19,970	+ 4.70
GRAND TOTAL	6,14,209		3,12,678		9,26,887		11,33,810	— 18.25

TABLE 6—(*Contd.*).

Species	Southern Sector		Northern Sector		Total 1968		Total 1967	Fall(—) or rise (+) over the year 1967
	kg	%	kg	%	kg	%	kg	%
PERCHES								
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Total	24,481	3.99	34,894	11.16	59,375	6.41	63,537	− 6.55

Review of Project 14 :

Estimation of total landings, catch/unit effort, age composition of commercially important species of fish and prawn of the Ganga river system, the Godavari river and the Hooghly-Matlah estuarine system was done. A sampling design has been implemented to estimate the abundance of migrating juvenile prawns at Dowleiswaram anicut. Studies on systematic sampling and random sampling as an alternative to total enumeration in the lower zone of the Hooghly estuary have been made.

Project 15 : Fish pathology.

Investigations on the parasitic and epidemical diseases of fish and fresh water prawn, responsible for large scale mortality or reduction in the market value, were continued.

Problem : 15.1 Fish pathology investigations.

Duration : Four years.

Personnel : Dr. V. Gopalakrishnan, Sarvashri R. N. Pal and A. K. Ghosh.

15.1.1 Investigations on the parasitic diseases of cultivated fishes.

39% of 644 fry of Indian major carps from Hooghly and Midnapore districts of West Bengal were found to be infected with *Trichodina, Cyclochaeta, Myxobolus, Thelohanellus, Gyrodactylus* and *Dactylogyrus.*

LC_{50} values for four therapeutic compounds, *viz.* sodium chloride, potassium dichromate, potassium permanganate and Acriflavine were found to be within the ranges of 5,500-7,500, 92.5-125, 37.5-48 and 47.5-80 ppm respectively.

Dip treatment in 3% NaCl solution was found to check the infection of ciliate protozoan and monogenetic trematode parasites in three stocking ponds. Field application of potassium permanganate at a dose of 0.3 ppm/day for a period of one week could control the infection of *Argulus* sp. in a local fish pond.

15.1.2 Studies on epidemical diseases.

Bacterial organisms responsible for eye disease, dropsy and tail and fin rot in the Indian major carps were identified and *Pseudomonas* sp., *Escherichia* sp. and gram positive cocci (? *Sarcina*) respectively were found to be causing the above diseases.

15.1.3 Studies on parasites of fresh water prawns.

Though species of *Macrobrachium mirabile* and *M. villosimanus* were not found to be infected with parasites during July to December, 1.8% *M. lammerrei*, 4% *M. malcolmsonii* and 71% *M. dayanum* were found to be infected with bopyrid parasites, belonging to the genus *Palaegyge*, during January to December, '68. *M. rude, M. femnicola* and *M. scabriculum* were free from parasitic infection.

Review of Project 15 :

About 40% of the fry of Indian major carps, examined from the Hooghly and Midnapore districts (West Bengal), were found to be infected with protozoan and trematode parasites. Dip treatment (in 3% NaCl soln.) was found to be effective in controlling the infection due to these parasites in stocking ponds. Bacterial organisms responsible for eye disease, dropsy and tail and fin rot have been studied. Of the various species of freshwater prawns, *M. lammerrei, M. malcolmsonii* and *M. dayanum* were found to be infected with bopyrid parasites (*Palaegyge*).

Project 16 : Weed control.

The problem of menacing aquatic weeds in fishery waters is of common occurrence throughout the eastern region of the country. Precise effective doses of the commonly used 2,4-D acid salt or other formulations are yet as unknown as the techniques for effective treatment of larger areas. Investigations on these problems together with methods of control of various types of aquatic weeds with hormone weedicides, ammonia or coppersulphate mud pellets were conducted. Efforts were also made to test new weedicides for their efficacy against common aquatic weeds.

Problem : 16.1 Standardisation of method of control of water hyacinth with 2,4-D acid, 80% sodium salt or other formulations.

Duration : Three years.

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

Work on the standardisation of control of water hyacinth with 2,4-D sodium salt, initiated in 1967 with the object of working out precise minimum doses of the weedicide, has revealed that the response of the plants to the weedicide depends upon the plant weight. It is, therefore, obvious that doses must be prescribed on the basis of infestation density rather than on infestation

area. Studies on the categorisation of plants have indicated three broad categories of infestation in and around Cuttack.

Problem : 16.2 Standardization of method of control of aquatic sedges and grasses with hormone weedicides.

Duration : Three years.

Personnel : Sarvashri V. Ramachandran, S. Patnaik, T. Ramaprabhu, P. V. G. K. Reddy, A. C. Banerjee and Dr. (Miss) E. Mitra.

Studies on the categorization of growth stages of *Panicum* sp. have indicated a minimum density of 2.9 kg/sq m in September and a maximum of 6.4 kg/sq m in November.

In yard trials, *Cyperus* sp. in young stages (below 100 cm height) required about 2 mg of 2,4-D acid salt/plant for complete kill. Mature plants, in post-flowering stage, though affected at this dose at the top, regenerated very soon.

Problem : 16.3 Evolution and evaluation of new weedicide formulations.

Duration : Two years.

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

Studies on the evaluation of new weedicides have shown that dense *Pistia* sp. (6.4 kg/sq m) infestations could be quickly destroyed (97% kill) with the paraquat weedicide Gramoxone-20 at a dose of about 0.4 kg a.i./ha. The cost of the entire operation was about Rs. 197/ha including about Rs. 70.00 for the weedicide. In laboratory trials, the weedicide seemed to be non-lethal to carp fingerlings up to about 5 ppm.

An infestation of lilies was effectively cleared with 2,4-D sodium salt at 10 kg/ha and 0.16% detergent (surf).

Problem : 16.4 Standardization and evaluation of the use of ammonia as an aquatic weedicide fertilizer.

Duration : Three years.

Personnel : Sarvashri V. Ramachandran, T. Ramaprabhu, G. V. Kowtal, P. V. G. K. Reddy and K. M. Das.

Promising results have been obtained in attempts to use aqueous ammonia as an alternative substitute for the control of water hyacinth. In the laboratory and yard trials, 2% aqueous solution of ammonia in contact with fresh leaves of water hyacinth for 30 minutes was found to cause considerable damage to the leaves. When applied in water at about 60-80 ppm N, it showed translocated toxicity and checked the growth rate of water hyacinth. In the field trial, aqueous ammonia at 14 kg ammonia/ha, applied as foliar spray on water hyacinth infestation, caused considerable damage to the leaves, but the plants were not killed. Ammonia at 17-30 ppm N eliminated about 90% bulk of *Hydrilla* sp.

Problem : 16.5 Use of copper sulphate as a weedicide in fishery waters.

16.5.1 Eradication of weeds by treatment of bottom soil with copper sulphate in mud pellets.

Duration : Two years for each pond.

Personnel : Dr. (Miss) E. Mitra, Sarvashri A. C. Banerjee, M. K. Banerjee and B. R. Dutta.

Observations on the ponds treated with copper sulphate mud pellets have shown either no growth or slight growth of weeds. Two fresh field experiments with 4-6 intermittent doses of copper sulphate mud pellets (3.6-35 kg/ha) have controlled the growth of both submerged and floating weeds at a cost of Rs. 700-900/ha.

In a laboratory experiment, the treatment of bottom soil with commercial superphosphate (50 kg/ha) was found to act as a fertilizer, but at a higher dose (900 kg/ha) it affected the health of the rooted plants.

16.5.2 Autecological aspects of study of higher aquatic plants.

Duration : One year.

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

Minute plants of *Vallisneria spiralis,* developing at the apices of runners, have been found to survive in a floating state on detachment from the mother plant, but they behave as normal plants on contact with the substratum. The flowers of the plants are being studied.

16.5.3 The use of eradicated weeds, in the form of compost, for manuring fish ponds.

Duration : Four years.

area. Studies on the categorisation of plants have indicated three broad categories of infestation in and around Cuttack.

Problem : 16.2 Standardization of method of control of aquatic sedges and grasses with hormone weedicides.

Duration : Three years.

Personnel : Sarvashri V. Ramachandran, S. Patnaik, T. Ramaprabhu, P. V. G. K. Reddy, A. C. Banerjee and Dr. (Miss) E. Mitra.

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In yard trials, *Cyperus* sp. in young stages (below 100 cm height) required about 2 mg of 2,4-D acid salt/plant for complete kill. Mature plants, in post-flowering stage, though affected at this dose at the top, regenerated very soon.

Problem : 16.3 Evolution and evaluation of new weedicide formulations.

Duration : Two years.

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

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An infestation of lilies was effectively cleared with 2,4-D sodium salt at 10 kg/ha and 0.16% detergent (surf).

Problem : 16.4 Standardization and evaluation of the use of ammonia as an aquatic weedicide fertilizer.

Duration : Three years.

Personnel : Sarvashri V. Ramachandran, T. Ramaprabhu, G. V. Kowtal, P. V. G. K. Reddy and K. M. Das.

Personnel : Dr. (Miss) E. Mitra, Sarvashri A. C. Banerjee and M. K. Banerjee.

Three sets of laboratory experiments, two with *Spirodela* sp. and one with *Eichhornia* sp. compost, have been completed. A very high concentration of plankton was found in the compost jars as compared to the control.

Review of Project 16 :

Attempts on the standardisation of control of water hyacinth with 2,4-D sodium salt have revealed that doses should be prescribed on the basis of infestation density rather than area. *Cyperus* sp. (below 100 cm) could be completely killed in yard trials at 2 mg of 2,4-D acid salt/plant. 2,4-D sodium salt at 10 kg/ha in combination with a detergent (0.16% surf) effectively cleared an infestation of lilies. Gramoxone-20 was evaluated as an effective weedicide against *Pistia* sp. infestations. Aqueous ammonia has given promising results as an alternative substitute for control of water hyacinth. Copper sulphate mud pellets have continued to give good results in controlling both submerged and floating weeds.

Project 17 : Frog farming.

The boom in frog leg export in recent years has drawn the attention of both the Government and the traders. While the Government is primarily interested in the conservation of frog resources, the industry is ever seeking for new resources. Frog farming has, therefore, been initiated at this Institute on an experimental basis and the results achieved so far both in raising the frogs alone or in combination with fish, have been encouraging. The American bull frog, *Rana catesbeiana,* has now been found to acclimatise to the Indian conditions obtaining at Cuttack (Orissa).

Problem : 17.1 Tadpole rearing and raising small frogs.

Duration : Five years.

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

Studies on developing suitable culture methods for fertilized eggs of *Rana tigrina* and *R. hexadactyla,* for raising and rearing their tadpoles, with a view to obtaining an optimum rate of survival, were continued. Laboratory and field observations on tadpole raising from fertilized eggs of *R. tigrina* and *R. hexadactyla* and their rearing up to early and small frog stages, have revealed that while metamorphosis in *R. hexadactyla* was completed in 5-6 weeks,

in *R. tigrina* it took about 20 days to a month. In contrast to comparatively low survival of various life-history stages of *R. tigrina, R. hexadactyla* tadpoles were easily reared up to early frog stages in plastic pools with cent percent survival. In all, about 25,000 and 7,000 tadpoles of *R. tigrina* and *R. hexadactyla* respectively were produced.

Pond water was found to be a suitable substitute for Haltfreter solution in culture operations.

Problem : 17.2 Culture of frogs and study of productivity in frog farming.

Duration : Five years.

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

An experiment on productivity study in frog farming with early frogs of *R. tigrina/R. hexadactyla* stocked in nursery ponds at 2,000/ha, was concluded and the production of *R. tigrina* after 11 months of rearing was found to be 259 kg/ha, as against 236.6 kg/ha of *R. hexadactyla* after $8\frac{1}{2}$ months' rearing The growth rates of both the species in farming and in nature were found to be similar.

Problem : 17.3 Investigations on fish cum frog culture.

Duration : Five years.

Personnel : Dr. A. K. Modal, Sarvashri P. Gopalakrishna, R. K. Jana and D. P. Chakraborty.

Frog cum fish culture experiments in five 0.04 ha nursery ponds at the Killa Farm, where early/small frogs of *R. hexadactyla/R. tigrina* were stocked at 2,000/ha along with early fingerlings of catla, rohu and mrigal at 3,705/ha in the ratio of 3:4:3 against suitable controls, were concluded. The production of *R. tigrina* and major carps and *R. hexadactyla* and major carps after $8\frac{1}{2}$ months' rearing was 234.8 and 1,611 kg/ha and 218.3 and 1,093.1 kg/ha respectively, as against the individual production of 259.0, 236.6 and 886.1 kg/ha respectively of *R. tigrina, R. hexadactyla* and fish in the control ponds. These findings indicate that extra frog raising is possible in fishery waters.

Problem : 17.4 Induced breeding of commercially important species of Indian frogs.

Duration : Four years.

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

Of the 19 sets of induced breeding experiments with *Rana tigrina,* using homoplastic pituitary gland extracts, complete ovulation was achieved in 12 sets, while partial ovulation was recorded in another two. Seven sets of breeding experiments conducted with *R. hexadactyla,* using both homo- and heteroplastic pituitary gland extracts, revealed that high doses were required in case of heteroplastic gland extracts. In cases where the experiments failed, the females were found to have either already bred in nature or lost their reproductive potency due to senility. Artificial fertilisation of eggs was resorted to with cent percent success. Preliminary studies on fecundity revealed that egg counts in ovaries vary between 5,000-8,000 depending on body size and weight.

Specimens of *Rana catesbeiana,* the American bull frog, received from Texas (U.S.A.) in April and September, 1967 have bred in July, 1968 under the changed environmental and climatological conditions obtaining at Cuttack. Metamorphosis was over in $1\frac{1}{2}$ months, and small frogs have been raised.

Problem : 17.5 Report on survey of frog resources, development, maintenance and extension work of frog leg industry, etc.

Duratoin : Two years.

Personnel : Dr. A. K. Mondal.

A preliminary survey of frog resources of Cuttack, Puri and Balasore districts of Orissa was completed. Prospective resources of *R. tigrina* for commercial exploitation were located in these three districts.

Informations on prospects of frog rearing, their identification, availability and methods of transport have been supplied to interested parties. Further information has been supplied to a firm interested to start frog leg processing and export from Calcutta port. Identification of some frog tadpoles of Rajasthan was done at the request of State Fisheries Department, Rajasthan. Besides, 400 early frogs of *R. hexadactyla* were supplied to Orissa Fisheries Department

Review of Project 17 :

The two indigenous species of frog, *viz. R. tigrina* and *R. hexadactyla* have been induced to breed through hypophysation in the laboratory. Observations on the rearing of early and small frog stages of *R. tigrina* and *R. hexadactyla* have revealed poor survival of various life-history stages in cases of the

former as aginst cent percent survival in the latter. Metamorphosis was completed in 3-4 weeks in *R. tigrina* and 5-6 weeks in *R. hexadactyla*. Frog culture and frog cum fish culture have been found to yield encouraging results.

The exotic American bull frog, *R. catesbeiana*, has been acclimatized to Indian conditions obtaining at Cuttack.

A survey of frog resources of various districts of Orissa was done. Early frog stages of *R. hexadactyla* were supplied to the Fisheries Department, Orissa, to establish this species in the state.

Project 18 : Sewage fed fisheries.

Problem : 18.1 Ecological studies in sewage fed fisheries.

Duration : Two years.

Personnel : Sarvashri S. D. Tripathi, P. Ray, R. R. Khan and P. K. Chakrabarti.

About 4,000 ha of fish ponds aorund Calcutta are irrigated by raw sewage, but no scientific investigations have been conducted so far to determine the factors responsible for high or low fish production from these ponds.

Ecological investigations in six sewage fed ponds, two each, belonging to the highly productive, medium productive and poorly productive categories, were, therefore, envisaged. Investigations were initiated in two highly productive ponds in August ; but due to heavy rains and overflooding of the area, it was not only found difficult to approach the site, but also that the ponds belonging to the other two categories were not available in the near vicinity. Routine collections were stopped and a fresh bid through various agencies was made to have the ponds of the three categories in one single area. As ponds of the three types were not found in one area, investigations were started in December in Pagladanga sewage fed fisheries, near Calcutta, in one poorly and one highly productive pond both of which are adjacently located and directly fed by sewage from the same canal.

On an average, the sewage is taken in the ponds for 4 hours a day. The water qualities of the highly productive and poorly productive ponds are given below.

Factors	Highly productive ponds	Poorly productive ponds
pH	8.0	8.1
DO	16.30 ppm	8.40 ppm
OC	28.40 ppm	22.90 ppm
Turbidity	23.0 cm	25.0 cm
Total alkalinity	276.00 ppm	264.00 ppm
Phosphates	0.12 ppm	0.08 ppm
Chlorides	176.00 ppm	330.00 ppm

Primary productivity, as estimated by light and dark bottle method, was found to be 915 and 373 mg $C/m^3/hr$ in the highly productive and poorly productive ponds respectively.

While the plankton density in the highly productive pond was 3 cc/50 l, it measured only 1 cc/50 l in the poorly productive pond.

Review of Project 18:

As systematic work in the project started only in December, 1968, no progress can be recorded.

Project 19: Hilsa investigations.

Problem : 19.1 Riverine hilsa investigations.

19.1.1 Delimitation of spawning grounds and studies on the spawning of *Hilsa ilisha* (Ham.).

Duration : Four years.

Personnel : Sarvashri J. C. Malhotra, Ravish Chandra, P. K. Mathur, S. C. Pathak, A. N. Ghosh, K. V. Rao, S. N. Sar, T. D. Nangpal, P. L. Narayana Rao, G. Ramamohana Rao, L. Hanumantha Rao and Shrimati T. Rajyalakshmi.

Studies on the delimitation of hilsa spawning grounds in selected stretches of the Ganga river system and the Godavari river and quantitative estimation of spawning success to forecast the fluctuation in hilsa fishery were continued.

Investigations undertaken at Bhagalpur on the Ganga river since January, '68 have established for the first time that hilsa spawns during the post-winter months from late February to late April. It is observed that spawning during these months is distinctly separate from the monsoon spawning. Fluctuation of water temperature appear to be responsible for the intensity of spawning. The spawning ground has been broadly delimited to be between Sultanganj and Bhagalpur. The younger size group of the slender sub-population of hilsa was ascertained to be responsible for breeding during this period.

Observations on the delimitation of spawning grounds of hilsa in the middle stretch, initiated during the monsoon of 1967, were extended further downstream covering a stretch of about 60 km, from Narayanpurghat/Agiabir-

ghat to Saraswatighat on the Ganga river during the monsoon season of 1968. During the winter breeding season, investigations were, however, continued in the Allahabad-Saraswatighat stretch. Four centres, *viz.* Narayanpurghat Samneyghat, Sujabad (Bhadurpur) and Saraswatighat (Sarsowal) were selected for weekly observations during September-November. Necessary morphometric measurements of hilsa were recorded to assign breeding grounds to different subpopulations of hilsa. In the stretch represented by Saraswatighat, the breeding season of hilsa was found to extend from middle of August to about the middle of October with a peak during the second and third weeks of September. In the Sujabad and Samneyghat stretches, it lasted during September only, the peak breeding period in case of the former stretch being in the first and third weeks of September and in case of the latter stretch during the third week of September. In the Narayanpur stretch, the upper most region in the middle sector of the Ganga river, though the breeding extends from September till about the middle of October, the peak breeding period was from the end of September to about the middle of October. Further, the magnitude of breeding was maximum in the Samneyghat stretch followed by Sujabad, Narayanpur and Saraswatighat stretches.

Investigation on the delimitation of spawning grounds of hilsa were carried out in the Goutami and the Vasishta distributaries of the Godavari river, about 8 km downstream of the Dowleishwaram anicut. During July and August, no larvae were encountered at any of the centres in both the branches of the river. In second half of September, a collection with 467 yolked larvae was made just at the anicut. Further trials up to October gave negative results.

In order to investigate the probable reasons for lack of larvae, the maturity stages of gonads in males and females and percentage ratios of males and females in the fishery were studied and it was found that during July, when migration had just commenced, the males constituted 90% and females 10% of the catches. The percentage of the III group males (with modal length at 382.5 mm) was much higher (60%) than that of the IV group. In August, the males to females percentage ratio was 60.7 to 39.3, the III group males continuing to dominate. While in females the IV group (with modal length at 438.5 mm) was predominant, the III group being absent. In September, the ratio of females further increased to 71.1% in the second fortnight. The III group males continued to be predominant while the V group predominated amongst females. In October and November, the migration had practically ceased, but the negligible catch was composed of a few oozing females and the III group males. Month wise studies on the maturity of gonads by size group showed that while in males the gonads were in the V and the VI stages of maturity from the beginning of the migration in July, very few females were in the V stage of maturity. By the middle of September, however, several females were fully mature and a few were observed to be oozing.

19.1.2 Induced breeding of *Hilsa ilisha* (Ham.).

Duration : Three years.

Personnel : Sarvashri J. C. Malhotra, Ravish Chandra, P. K. Mathur, M. Y. Kamal, L. Hanumantha Rao and Shrimati T. Rajyalakshmi.

Investigations to induce breed *Hilsa ilisha* through the administration of pituitary hormones as well as by stripping were undertaken in the river Ganga at Sirsa, about 50 km downstream of Allahabad during October and November, 1968. Live hilsa were procured from the catches made by commercial fishermen with clap type of net locally known as *Kamel.*

Towards artificial fecundation by stripping, the gonadial contents of the male and female hilsa were simultaneously stripped into enamel trays containing 22 mm deep fresh river water, deviating from the technique followed by earlier workers. It was observed that most of the fertilised eggs turned transparent in about 15 minutes after stripping.

All the seven strippings, attempted during the investigations, were successful (Table 7). More than one male was used when the quantity of milt was not found to be sufficient to fertilise all the eggs. In experiment No. II, the development of the embryo progressed normally for about 2 hours after fertilisation, but ceased thereafter. Microscopic examination revealed fungal attack as the cause of mass mortality. In experiment No. III, the female was stripped partially and the eggs treated with the milt of a male which had died about 30 minutes earlier. In the same experiment, the female, 30 minutes after its death, was stripped of all the remaining eggs and treated with the milt of two (one oozing and other partly spent) males. The rate of fertilisation in both the cases was 85 to 95%. It was observed that the development of the embryo proceeded normally for about eight hours and thereafter the eggs started dying in large numbers. The cause of this mass mortality could be attributed, probably, to decrease in the temperature of the water in the trays from 28°C, at the time of stripping, to 16°C, when mortality occurred. Only about 2% of the eggs hatched out after 25 hours. As all the hilsa eggs invariably passed through the mesh of the inner *hapa,* the round meshed mosquito netting *hapa* used for hatching carp eggs was found to be of no use. As an alternative, an inner *hapa* made out of 1/16″ meshed netting cloth was tried on experimental basis but with no results. Thereafter, ordinary markin *hapas* were used and hatchlings were segregated mechanically, taking advantage of the direction of the flow.

TABLE 7.
Details of stripping experiments on *H. ilisha*.

Exp. No.	Date	Time (hr)	Female		Male		Number of eggs stripped (lakh)	Percentage of fertilisation	Percentage of hatching
			Total length mm	Maturity stage	Total length (mm)	Maturity stage			
I.	20.10.68	18.00	477	VI	333	VI	5.0	90	2.0
II.	22.10.68	18.50	480	VII	380	oozing	1·5	85	0.0
III.	23.10.68	17.00	450	VI	324	oozing	8.0	95	60.0
					326	—			
					316	—			
IV.	23.10.68	18.20	458	VI	400	oozing	10.0	90	30.0
V.	25.10.68	16.45	466	VI	453	oozing	4.0	80	0.0
					333	oozing			
					317	—			
					475	—			
VI.	1.11.68	17.45	465	VI	321	oozing	3.0	70	50.0
					448	oozing			
					458	—			
VII.	3.11.68	17.30	380	VI	320	oozing	1.0	80	40.0

The resultant hatchlings were successfully reared in markin cloth *hapas*, fixed adjacent to the hatching *hapas*, for periods ranging from 7 to 20 days and thereafter two samples, one of 50,000 and the other of 75,000 hatchlings, transferred to two (90′ × 70′) fresh water nursery ponds for further rearing. In 20 days of rearing in river, the first batch of hatchlings (2.5 to 3.0 mm) grew to 10 mm size, while the second batch of hatchlings attained 7.5 to 8.0 mm size in 7 days. In nursery ponds, 7-8 mm long postlarvae attained a size of 20 mm in a period of 30 days, while 7.5 to 10.0 mm long postlarvae grew to 22.0 mm size in 45 days.

To adjudge the possibilities of transporting hilsa spawn under oxygen in sealed containers, two preliminary experiments were conducted. In the first experiment, 152 yolked larvae were packed in a 20 l alkathene bag containing 4 l of river water and the rest oxygen. The mouth was then sealed and reopened after a lapse of 48 hours, the mortality was calculated to be 37%. In the second trial, 100 hatchlings were kept packed for a period of 36 hours. During this period, the sealed bag was transported by road to a distance of 43 km in one hour, and the mortality was calculated to be 15%.

Experiments to induce-breed hilsa through the administration of pituitary hormones using pituitary glands of *Hilsa ilisha, Cirrhinus mrigala* and *Wallago attu,* preserved in absolute alcohol or acetone at temperatures ranging from 7 to 8°C, were carried out. As the injected fish could not be kept alive beyond $4\frac{1}{2}$ hours in captivity, no tangible results could be achieved.

To keep hilsa alive under captivity, and to circumvent situations, when fish of one sex is procured and the procurement of the other sex takes sometime, *hapas* of different dimensions and materials were tried. It was found that the fish remained alive and active for a period of $4\frac{1}{2}$ hours in a *hapa* fabricated from bamboo splits of dimensions : length, 185 cm ; width, 105 cm and height, 135 cm. The *hapa* was fixed in the river bed, close to the bank at a place where the depth of water was about 1.05 m and a mild current was available all the time.

Attempts were made to induce-breed hilsa of the Godavari river by pituitary injections but the main hurdle appeared to be the problem of keeping the fish alive for more than an hour. While males lived for an hour or two, females died quickly. The second problem was poor occurrence of females in the population during July and August in early stages of maturity.

During September, when females were fully mature and available in great numbers, stripping was adopted as a better means of conducting artificial breeding. In two trials, eggs which were found loose in the ovary were removed and fertilized by collecting milt from males. Although fertilization had taken place, no further development occurred.

19.1.3 Appraisal of hilsa fishery of the lower sector of the Ganga river system, in relation to stock patterns.

Duration : Three years.

Personnel : Sarvashri A. N. Ghosh, K. V. Rao, T. D. Nangpal, S. N. Sar and R. K. Bhattacharya.

Compared to the month wise pattern of landing in 1967, it was observed that while the fishery showed a sharp decline in October and November, it increased considerably from July to September. The estimated annual landings of hilsa at Bhagalpur on the Ganga river were 9.79 tonnes, registering a rise of 114.69% over that of the year 1967. A study of the monthly pattern of intermingling of the three sub-populations of hilsa at Bhagalpur segregated with the aid of the discriminant scores, indicated that the "slender" variety was predominated over by the "broad" and the "broader" varieties during the winter months.

Hilsa landings at Lalgola on the Padma river from January to November, 1968, were estimated to be 6.45 tonnes as against 3.46 tonnes in the corresponding period of 1967, thus recording an increase of 86.71%, which was found to be due to higher yields during the post-winter and monsoon months, especially during the latter. A considerable decline was noted in the magnitude of the fishery during the winter months. It was further observed that while the "broad" variety maintained itself consistently during all the months more or less at a constant level, slight fluctuations were observed in the relative representation of the sub-population, the "broader" variety being at its maximum during post-winter and monsoon months. The "slender" variety, which contributed poorly to the total fishery was observed to be at the minimum and maximum during the monsoon and post-monsoon months respectively.

Review of Project 19 :

Post-winter spawning of hilsa between Sultanganj and Bhagalpur in the Ganga river from late February to late April has been established for the first time, the sub-population of the "slender" form constituting the breeding stock during this period. Delimitation of spawning grounds of hilsa in the Gautami and the Vasishta distributaries of the Godavari river was not possible due to the failure of spawning. Absence of mature females in July, absence of similar age groups in the spawning run and incompatible sex ratio seem to be the probable reasons for this failure.

Artificial fecundation by stripping of hilsa was successfully done. The germ cells of even dead hilsa could be used for fecundation within $\frac{1}{2}$ hr of the parents' death. Hilsa larvae in nursery ponds attained a length of 20 mm in 30 days in one pond and 22 mm in 45 days in another. Induced breeding of hilsa through hypophysation was not successful as the injected fish could not be kept alive for more than four hours and a half.

Project 20. Water pollution investigations.

Problem : 20.1 Water pollution investigations in the Hooghly estuary.

Duration : Three years.

Personnel : Dr. V. Gopalakrishnan, Sarvashri P. Ray, S. B. Saha and B. B. Ghosh.

Observations on the effect of industrial pollution on the fisheries of the Hooghly estuary were continued. Work on the inventory of polluted waters and characterisation of major industrial wastes was undertaken with a view to measuring the pollutional load in the estuary.

The physico-chemical characteristics of various industrial wastes discharged into the Hooghly estuary are given below.

(i) *Paper and pulp mill wastes.*

The effluent was an offensively smelling and coloured liquid, with turbidity ranging as 85-1,000 ppm, pH as 5.5-10.5, BOD as 8.6-1,490 mg/l, total solids as 290-7,450 mg/l and dissolved solids as 59-3,228 mg/l. The wastes from the sulphite process had a greater pollutional load than that from the sulphate process.

(ii) *Paint factory wastes.*

The effluent was almost a colourless to pinkish liquid with pH varying as 6.7-9.7, BOD as 8-692 mg/l, OC as 28-376 mg/l, DO as 0.0-4.4 mg/l, suspended solids as 20-692 mg/l, total solids as 498-3,912 mg/l, dissolved solids as 372-3,220 mg/l, free and saline ammonia as 0.04-6.0 mg/l and the maximum value of chloride (as Cl) as 1,607 mg/l.

(iii) *Match industry wastes.*

The waste was a pinkish and slightly smelling liquid with pH ranging as 7.1-7.6, BOD as 16.0-24.0 mg/l, OC as 75.0-82.6 mg/l, DO as 3.7 mg/l, suspended solids as 94.0-372.0 mg/l, turbidity as 120 ppm, alkalinity (as $CaCO_3$) as 290-345 mg/l, chloride (as Cl) as 820 mg/l, free and saline ammonia as 2.4-6.2 mg/l and albuminoid ammonia (as N) as 0.8-1.5 mg/l.

(iv) *Yeast manufacturing company wastes.*

The waste was a colourless to deep brown, sweet smelling and turbid liquid with turbidity as 580 ppm, pH as 5.8-8.1, carbonate alkalinity (as $CaCO_3$) as 380-600 mg/l, total solids as 5,822 mg/l, dissolved solids as 5,650 mg/l, BOD as 1,000-4,400 mg/l, OC as 61.0-1,793 mg/l, free and saline ammonia (as N) as 19.2 mg/l and albuminoid ammonia as 4.5 mg/l.

(v) *Rayon factory wastes.*

The waste was a colourless to slightly coloured and sulphide smelling liquid with pH ranging as 5.8-9.7, carbonate alkalinity (as $CaCO_3$) as 30-1,165 mg/l, DO as 0.0-4.0 mg/l, BOD as 12.2-320.0 mg/l, OC as 32-438 mg/l, suspended solids as 335-2,428 mg/l, total solids as 1,264-4,072 mg/l and dissolved solids as 882-1,730 mg/l.

(vi) *Textile (cotton) factory wastes.*

The waste was a coloured liquid, smelling of bleaching powder, with pH ranging as 8.2-10.5, turbidity as 360-834 ppm, suspended solids as 422-4,428 mg/l, hydroxide alkalinity as 0-550 mg/l, carbonate alkalinity as 0-1,300 mg/l and bicarbonate alkalinity as 0-470 mg/l.

(vii) *Dunlop rubber company wastes combined with Estate sewage.*

The waste was almost a clear and colourless liquid with pH ranging as 7.1-7.6, BOD as 24-106 mg/l, OC as 8.5-70.0 mg/l, DO as 2.6-5.1 mg/l, turbidity as 85-130 ppm, alkalinity (as $CaCO_3$) as 250-310 mg/l, total solids as 446-478 mg/l and dissolved solids as 340-370 mg/l. Presence of nitrite-nitrogen and high amount of free and saline ammonia in relation to albuminoid ammonia indicate sewage pollution.

(viii) *Domestic sewage effluents.*

The effluent was a slightly blackish and offensive smelling liquid with pH varying as 6.9-8.1, BOD as 24-216 mg/l, OC as 31.51-244.0 mg/l, DO as 0-1.2 mg/l, turbidity as 85-900 ppm. suspended solids as 12-6,780 mg/l, alkalinity (as $CaCO_3$) as 250-660 mg/l and total solids as 962-3,728 mg/l and dissolved solids as 722-768 mg/l. Free and saline ammonia was nearly ten times higher than albuminoid ammonia.

(ix) *Tannery wastes.*

The waste was a clear and colourless to light brown liquid, having a faint smell with pH 6.0-8.0, BOD as 26.0-240.0 mg/l, OC as 158.0-480.0 mg/l, DO as 1.0 mg/l, alkalinity (as $CaCO_3$) as 190 mg/l and suspended solids as 362-1,552 mg/l. While free and saline ammonia was much higher than albuminoid ammonia, chloride (as Cl) was 5,520 mg/l.

(x) *Jute industry wastes.*

The waste containing only machine and floor washings and sewage was faint yellow in colour and had an offensive smell with pH ranging as 7.2-8.1, DO as 2.2-6.2 mg/l, BOD as 27-30 mg/l, OC as 18-64 mg/l, suspended solids as 48-806 mg/l and carbonate alkalinity as 220-396 mg/l.

(xi) *Municipality and chemical factory wastes.*

The waste was a faintly coloured liquid with pH varying as 8.0, DO as 2.1 mg/l, BOD as 126 mg/l, OC as 118 mg/l, suspended solids as 922 mg/l and $CaCO_3$ alkalinity as 430 mg/l. Free and saline ammonia were nearly ten times higher than albuminoid ammonia.

(xii) *Metal, steel and rifle factory, and estate wastes.*

Wastes were faint yellow in colour with turbidity as 450 ppm, suspended solids as 3,550 mg/l, DO as 2.8 mg/l and BOD as 10.0 mg/l.

Review of Project 20 :

Characterization of industrial wastes from paper and pulp mill, paints, match, rayon, textile, rubber, chemical, and metal and steel factories, and tannery, jute and yeast industries was done to measure the pollutional load in the Hooghly estuary.

3. Papers Published

A list of papers published during the year by members of the staff is given below :

Babu, N. 1963
Observations on the biology of *Caridina propinqua* De Man. *Indian J. Fish.* (A), **10** (1) : 107-117.

Banerjee, S. C. and S. M. Banerjea 1963
Observations on the manganese status of pond soils in Cuttack and Puri districts of Orissa. *Ibid,* **10** (1) : 190-196.

Barrackpore, Central Inland Fisheries Research Institute. 1967 and 1968.
Bibliography of Indian Fisheries (*Mimeo.*), **6** (4) and **7** (1-3).

Basu, A. K. 1967
Treatment of effluents from the manufacture of soap and hydrogenated vegetable oil. *J. Wat. Poll. Contr. Fed.,* **39** (10) : Part 1 : 1653-1658.

Bhatnagar, G. K. 1964
Observations on the spawning frequency and fecundity of certain Bhakra reservoir fishes. *Indian J. Fish.* (A), **11** (1) : 485-502.

Bhattacharya, C. G. 1967
A simple method of resolution of a distribution into Gaussian components. *Biometrics,* **23** (1) : 115-135.

Bhimachar, B. S. 1967
Chandrakala Hora Lecture, 1966 : Organization of development-oriented fisheries research in India. *Proc. natn Inst. Sci. India* (B), **33** (5 & 6) : 211-218.

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(xi) *Municipality and chemical factory wastes.*

The waste was a faintly coloured liquid with pH varying as 8.0, DO as 2.1 mg/l, BOD as 126 mg/l, QC as 118 mg/l, suspended solids as 922 mg/l and $CaCO_3$ alkalinity as 430 mg/l. Free and saline ammonia were nearly ten times higher than albuminoid ammonia.

(xii) *Metal, steel and rifle factory, and estate wastes.*

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Review of Project 20 :

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4. Extension

(a) *Results of immediate practical application.*

Average fish production in fish culture operations in India is said to be about 600 kg/ha/year. Observations on the composite culture of Indian and exotic fishes have revealed that fish production/ha can be increased considerably by adopting scientific techniques. Now, an average production of 3,000 kg/ha/ year of table size fish is not difficult to achieve by judicious combination of species, adequate stocking, population manipulation, intensive feeding and timely manuring. In experimental culture in small 0.14 to 0.4 ha ponds high production of the magnitude of 2,575 to 4,210 kg/ha/year has consistently been achieved for the fifth year in succession at Cuttack. A hand-out on the methodology adopted to obtain the high yields has been sent to members of the Scientific Panel for Fisheries Research of the Indian Council of Agricultural Research and a Coordinated Research Programme has been proposed on the subject so as to cover six main soil types of the country.

Another hand-out on rearing of carp fry into fingerlings has also been prepared and sent to members of the Scientific Panel for Fisheries Research of the Indian Council of Agricultural Research. This is of special significance, since the average survival rate in rearing of carp fry to fingerlings is said to be only

about 25% in the country. In experimental rearings of carp fry a survival range of 53.5-97.4% (average 76.6%) and production range of 1,505-3,486 kg/ha average 2,204 kg/ha) per three months has been obtained during 1965-1967 at Cuttack.

Three new spawn collection centres have been located during the year for commercial exploitation of spawn at Nanamau (R. Ganga) and Deolan (R. Yamuna) in Uttar Pradesh and Negria (R. Banas) in Rajasthan.

(b) *Results likely to be useful to the farmers, but needing further trials.*

The use of the seed or bark of indigenous plants, *Barringtonia acutangula* and *Randia dumetorum,* as fish poisons for clearing fish ponds is likely to be highly economical to fish culturists. However, further work is required to develop optimum dose etc.

Observations on the increase in the rate of survival and growth, obtained in experiments on feeding carp spawn and fry with starch and cobalt chloride, have given encouraging results but need further experimentation.

Further trials with copper sulphate mud pellets for rooted vegetation and with 2,4-D and ammonia for the control of floating and submerged vegetation, are required to be carried out for their large scale application.

(c) *Publicity activities.*

An exhibition of posters showing the techniques of nursery preparation and induced breeding, economics of carp culture and composite culture, sites of spawn prospecting investigations and economics of spawn collection, was arranged at the headquarters of the Institute on November 1 and 2, 1968. during the seminar on 'Production of quality fish seed for fish culture'.

5. Conferences and Symposia

A seminar on the "Production of quality fish seed for fish culture" was held under the auspices of the Indian Council of Agricultural Research at the Central Inland Fisheries Research Institute at Barrackpore on November 1 and 2, 1968. The seminar was inaugurated by Prof. Satyendra Nath Bose who referred to the need for paying attention to further development of indigenous varieties of cultivable fish in addition to the exotic carps recently introduced in the country.

6. Summary of the Report

In addition to 16 out of 20 research projects continuing since 1967, two more research projects, *viz.* 'Murrel and air-breathing fish culture' (Project No. 7) and 'Sewage fed fisheries' (Project No. 18) were taken up during 1968.

Project 1.

Composite culture of Indian and exotic carps at 5,000 fingerlings/ha gave a gross production of 2,575 kg/ha. However, the same species, when stocked in a different ratio at 6,250 fingerlings/ha, gave a gross production of 2,830-3,041 kg/ha/annum.

Utility of silkworm pupae as fish feed indicated an increase of 17.1-21.0% in 15 days in case of catla, rohu and common carp as against 5.4-9.5% with mustard oilcake and rice bran mixture.

Laboratory experiments with growth promoting substances have indicated the highest rate of percentage survival in case of cobalt chloride and the highest increment in length and weight with starch, when fed to 4 days' old spawn.

Field experiments on the efficacy of different nitrogenous fertilizers, *viz.* ammonium sulphate, urea and calcium ammonium nitrate in pond fertilization, have indicated 80 kg N/ha as the most effective dose for obtaining a high primary productivity (1.94-2.23 mg C/m^3/day) and a high survival (47-73%). Urea, however, gave the maximum primary productivity and the highest growth rate of spawn.

Sterilized and unsterilized soil, when treated with phosphorus and phosphorus + calcium, showed a greater increase in total nitrogen content in the sterilized set. Inoculation with *Gleotrichia* and *Anabaena* resulted in a higher survival (62%) of rohu spawn than in the uninoculated control sets (30%).

Crude cultures of *Nitzschia* and *Navicula* have been obtained in the laboratory with N-P-K at 230 ppm in 5:15:3 ratio with urea as the source of nitrogen. Further experiments have shown ammonium chloride and ammonium sulphate also to be as effective as urea. However, bone meal was found to be superior to superphosphate as a phosphate source. Mahua oilcake, poultry droppings, cow-dung and calcium ammonium nitrate appeared to be favourable media for the culture of zooplankters.

Preparatory cultures of *Chlorella* sp., *Nitzschia* sp., *Gomphonema* sp., *Closterium* sp. and *Selenastrum* sp. have been made in the laboratory. While stock cultures of *Chlorella* sp., *Navicula* sp. and *Gomphonema* sp. have also been obtained, *Closterium* sp. and *selenastrum* sp. have been put in Chu solu-

tions for achieving stock cultures. Observations on the natural occurrence of plankton in artificially manured cisterns revealed the efficiency of Bristol's solution for *Chlorella* sp. and Chu No. 16 for *Navicula* sp. and *Nitzschia* sp.

Three types of feed were prepared with *Sirogonium* sp. as the basic ingredient and tried on mrigal.

Laboratory experiments with highly and poorly productive pond soils have indicated that primary production could be used as an index of general biological productivity.

Studies on the factors responsible for low and high productivities of fish ponds in acid soil zones of Tripura have revealed that, while both types are very poor in alkalinity (the hydroxide component being entirely absent), they differed in their soluble organic content and different forms of dissolved nitrogen and phosphorus. The water of the productive farm had a markedly high organic content, dissolved phosphorus (organic and inorganic) and nitrogen (organic and ammoniacal). Nitrate-nitrogen, however, was inversely related, being high in the unproductive farm.

Six leachings with 1, 2 and 3% sodium chloride solutions in the laboratory through the porous soils of the Institute's ponds at Barrackpore, reduced the rate of percolation to 4.1, 0.4 and 4.4 cm/hr as against 63 cm/hr for the control. A standard seepage testing apparatus has been designed and its model fabricated.

Laboratory and yard experiments have indicated that the seed powder of *Barringtonia acutangula* at 15-20 ppm kills tilapia in 4-6 hours, without adversely affecting the plankton and other biota. Unripe fruit of *Randia dumetorum* (12 ppm) killed tilapia in 4-6 hours in the laboratory, but an increase in dose to 15 and 20 ppm reduced the effective time to 3 and $1\frac{1}{2}$ hours respectively.

Estimation of numbers in changing and constant fish populations was done by repeated samplings of clipped fishes. Error in the population estimates was observed to range from 8-18%, with minium for catla and maximum for rohu. Estimated population of fishes were observed to remain within upper and lower confidence limits at 5% probability.

Morphological differences in 4-5 days' old spawn of catla, rohu, mrigal have been noted. This will be found useful in distinguishing the spawn of one species from the other.

Project 2.

Appreciable gonadial development was observed in two sets of rohu, after ten weekly injections of pituitary extract (5 mg/kg) to one set and HCG (0.5 mg/kg) to another set.

While HCG and Synahorin alone could not induce spawing in rohu, they gave successful results with combinations of 3-6 mg pituitary extract + 1 mg HCG and 4-6 mg pituitary extract + 25 RU Synahorin, thereby suggesting that they could be effectively used to reduce the requirement of pituitary glands.

Pituitary extract, preserved in propylene glycol and stored under refrigeration, was found to retain its potency. 55.04 lakhs spawn of Indian major carps was produced, of which 50.8 lakhs were supplied to the Fisheries Department, Orissa, and the Central Fisheries Corporation.

Project 3.

Hydrobiological investigations in the Konar and the Tilaiya reservoirs have indicated the waters of the former to be more turbid than that of the latter. The waters of the two reservoirs can be said to be medium hard to hard. The nutrient level in the two reservoirs is more or less the same. While organic detritus was found to constitute the chief food item of mrigal and calbasu, both zoo- and phytoplankters comprised the food of catla. Spawn prospecting investigations carried out some 8 km upstream of the reservoir on the Barakar river revealed the presence of minor carps only in the spawn.

Both the Konar and the Tilaiya reservoirs are poor in fish production, mrigal forming the chief fishery of the Konar reservoir and catla that of the Tilaiya reservoir. Rohu does not seem to adapt to the conditions prevailing in these reservoirs. 10,383 major carp fingerlings have been clipped and released in the reservoir with a view to studying their rate of exploitation. Both the reservoirs have been stocked with major carp fingerlings on the basis of the recommendations of the Central Inland Fisheries Research Institute.

Fecundity and ova diameter studies of predatory and weed fishes, abounding in small reservoirs, were done. Hydrobiological studies in the Govindgarh, the Loni and the Kulgarhi reservoirs were continued. Experimental fishing with nets of varying mesh sizes, with floats and sinkers, and with floats but without sinkers, have revealed the latter to be more effective. Observations on the commercially important species of the reservoirs were made.

Observations on the hydrobiology of selected tanks and ponds in Mysore State have revealed them to be sufficiently productive. Steps were taken to

improve the habitat by manuring and artificially stocking these water bodies with prawns, major carps, murrels and milk fish to increase the yield.

Surveys for the location of seed collection centres on the Cauvery river above Sangam and on the Kumudvati river above the Anjanapur reservoir showed the presence of minor carps only in the spawn.

The fishery of Bellandur tank comprised mainly of *C. carpio* var. *communis* followed by young catla. Minor carps alone were observed to be involved in the ingress and egress of fishes through the waste weir during the periods of discharge of surplus water.

Project 4.

Spawn prospecting investigation were conducted at four centres, *viz.* Nanamau on the Ganga river, and Deolan and Mahewapatti on the Yamuna river in Uttar Pradesh and Negria on the Banas river in Rajasthan. Except for Mahewapatti, the other three centres have been found to bear commercial potentialities. The season's indices of spawn quantity and quality have been respectively estimated to be 807.6 ml and 76.3% at Nanamau, 239.0 ml and 83.7% at Deolan and 1,531.5 ml and 59.4% at Negria. Nets made of 1/12″ mesh proved to be more effective in spawn collection than those of 1/8″ and 1/16″ meshes. Bulk of the spawn collected was handed over to the respective state fisheries departments.

Project 6.

While the growth of prawn fingerlings was found to be quite satisfactory in fresh water ponds, their survival was very poor possibly due to low oxygen concentration. Attempts to increase the rate of survival are being made by artificially bubbling air in the ponds, erecting slightly submerged bamboo platforms and planting *Ottelia.*

Project 7.

Heteropneustes fossilis was bred in the laboratory by administration of both homo- and heteroplastic pituitary injections. Though the survival was extremely poor, the young could be reared for six months in glass aquaria.

Project 8.

Seed prospecting investigations in the Hooghly-Matlah estuarine system and the Rupnarayan estuary have indicated the availability of fish and prawn

seed of commercial varieties. The peak seasons of availability of the post-larvae of *P. monodon, P. indicus* and *P. semisulcatus* were determined to be August, August-October and June respectively.

Hydrobiology of the Pulicat lake and the growth, maturity and food habits of *M. cephalus* were studied. Fluctuations in the adundance of fish and prawn seed in the canal adjoining the Brackish Water Fish Farm at Kakdwip (West Bengal) revealed the presence of quality prawn seed almost throughout the year, fish seed being available till September.

The provision of a puddle core was not found to make any significant difference in the permeability of the dykes of the newly constructed Experimental Fish Farm in the lower Sunderbans.

Project 9.

Hybridisation experiments were continued and F_3 generation was produced. Bionomics of the F_1 hybrids in relation to parental forms are being studied. GPC-5 was found to be more effective as a fish sperm preservative than Frog Ringer's solution. The viability of both fish eggs and sperms increased by 5½ and 10 times respectively in the dry condition as against the wet condition.

Project 12.

9.01 lakhs spawn of silver carp and 4.0 lakhs of grass carp was produced through hypophysation. Natural spawning, without stripping, was observed on several occasions. Synahorin, along with fish pituitary extract, induced spawning in silver carp but not in grass carp. Hybrids between silver carp and grass carp were produced.

8.1 lakhs spawn of silver carp and 2.95 lakhs of grass carp were made over to the Fisheries Department, Orissa. 8,750 fry and 400 fingerlings of silver carp and 6,828 fry and 2,540 fingerlings of grass carp were supplied to the various state fisheries departments, Damodar Valley Corporation and certain other parties. Of the 3.4 lakhs of common carp spawn produced during the year 1968, 1.5 lakhs was supplied to the Orissa Fisheries Department.

Monoculture of silver carp did not yield encouraging results. Fingerlings of grass carp were observed to consume cut leaves of potato, raddish, cauliflower and cabbage.

Project 13.

A diet of partially cooked fish mixed with liver and wheat middlings checked the incidence of whirling disease in adult trout. Feeding with raw fish, particularly in the temperature range of 15.0-18.7°C, led to high mortality in adult brown trout due to the same disease. Intramuscular administration of thiamine chloride was found to check the disease effectively. Mortality of trout fry due to certain ectoparasitic ciliates was controlled by bath treatment in 3% salt solution or 1:2,000 formalin.

Standardisation of trout culture techniques resulted in a high percentage of fertilization (97%) and a remarkably high rate of survival (87.2% at Laribal and 86.9% at Harwan) from the green egg to the eyed ova stage in the trout hatcheries of Kashmir.

Breeding grounds of *Schizothorax* spp. have been located in the Erin, the Madhumati, the Lidder and the Bringhi streams of Kashmir. The centres for their fry and fingerling collection in these rivers have also been located.

Project 14.

The total estimated landings of fish at selected assembly centres in the upper and the lower stretches of the Ganga river were 766.18 and 167.47 tonnes respectively. The total landing from the selected stretch of the Godavari river was estimated at 233.4 tonnes. Higher age groups were, in general, predominant in the fishery of the Godavari river. Observations on the migratory behaviour of prawns, as studied by staining, revealed their localised movement, the maximum distance covered being 35 km.

The total landing of fish from the Hooghly estuarine system was estimated at 6,290 tonnes, 67.1% being constituted by the lower Zone (Zone III) alone. The total catch from the Pulicat lake was estimated at 926.9 tonnes, the Southern Sector contributing about 66.27% was mainly dominated by prawns.

Studies on developing new designs of sampling in the lower Zone of the Hooghly estuary have been made.

Project 15.

40% fry of Indian major carps in Hooghly and Midnapore districts (West Bengal) were found to be infected with protozoan and trematode parasites. These parasites in stock ponds were controlled by dip treatment in 3% NaCl

solution. *Argulus* infection in a pond was controlled by a field application of 0.3 ppm/day of potassium permanganate for a period of a week.

Bacterial organisms responsible for eye disease, dropsy, and tail and fin rot have been identified to be *Pseudomonas* sp., *Escherichia* sp. and gram positive cocci (? *Sarcina*) respectively. Incidence of infection in fresh water prawns due to bopyrid parasites (*Palaegyge*) was studied.

Project 16.

Infestation density rather than area has been found to be a better criteria for estimating the dose of 2,4-D sodium salt for effective clearance of water hyacinth. *Cyperus* (below 100 cm) could be completely killed in yard trials at 2 mg of 2,4-D acid salt/plant.

Ammonia has given encouraging results as an alternative for imported weedicides for the control of both floating and submerged weeds. Copper sulphate mud pellets have continued to give good results in controlling both submerged and floating leaves.

Project 17.

Rearing of the indigenous frogs, *Rana tigrina* and *R. hexadactyla* in the laboratory gave a very poor survival in the former as against cent percent in the latter. Metamorphosis was completed in about 3 weeks to a month in case of *R. tigrina* as compared to 5-6 weeks required by *R. hexadactyla.*

A production of 259 kg/ha of *R. tigrina* and 236 kg/ha of *R. hexadactyla* was obtained after 11 and $8\frac{1}{2}$ months' rearing respectively, when the early frogs were stocked at 2,000/ha. Frog cum fish culture experiments have indicated that extra frog raising is possible in fish ponds.

R. hexadactyla has been found to be phytophagous in habit.

Both *R. tigrina* and *R. hexadactyla* were induced to breed by the administration of homo- and heteroplastic pituitary gland extracts in the laboratory. Early frogs of *R. hexadactyla* were supplied to the Fisheries Department, Orissa, with a view to extending its range of distribution. Survey of frog resources of Puri, Cuttack and Balasore districts (Orissa) has indicated the possibilities of commercial exploitation of *R. tigrina.*

Project 18.

Investigations in sewage fed fisheries have indicated a high total alkalinity (264-274 ppm), phosphates (0.08-0.12 ppm) and chloride contents (176.0-330.0 ppm) in sewage fed ponds.

Project 19.

Studies on the delimitation of spawning grounds in the middle sector of the Ganga river were conducted between Narayanpurghat and Saraswatighat where the spawning was observed to last from August to mid-October. Delimitation of hilsa spawning grounds in the Godavari river was not possible due to the failure of spawning, similar mature age groups in the spawning run being absent.

While success in inducing the hilsa to breed through pituitary injections was not achieved, artificial fecundation through stripping was possible. A remarkable feature was the utilization of the germ cells of both male and female hilsa within $\frac{1}{2}$ hr of the parent's death. The larvae were found to grow to about 20 mm in 30 days in one nursery pond and 22 mm in 45 days in another.

Project 20.

Physico-chemical characteristics of the effluents from paper and pulp mill, paint factory, match industry, yeast company, rayon factory, textile factory, Dunlop rubber factory, tannery and jute industries, chemical, and metal, steel and rifle factories, besides domestic sewage, were studied.

7. Personnel

(A) Retirements, promotions, transfers.

Shri K. H. Sujansingani, Research Assistant (Selection Grade), and Shri R. B. Deb Roy, Fieldman, retired from service on attaining the age of superannuation. Shri Jhak Bahadur, Watchman, however, retired on grounds of invalidation.

Shri J. C. Malhotra and Dr. V. Gopalakrishnan, Junior Fishery Scientists were promoted to the posts of Fishery Scientists. Shri M. A. Vijayalakshmanan, Assistant Fishery Scientist, was promoted to the post of Junior Fishery Scientist.

The following research workers were transferred during 1968 :

Dr. A. David, Fishery Scientist.	:	From Bangalore to Cuttack.
Shri A. N. Ghosh, Junior Fishery Scientist.	:	From Bhagalpur to Kakdwip.
Shri A. V. Natarajan, Junior Fishery Scientist.	:	From Konar Dam to Hazaribagh.
Shri S. P. Ayyar, Assistant Fishery Scientist.	:	From Panna to Hazaribagh.
Shri Ch. Gopalakrishnayya, Assistant Fishery Scientist.	:	From Barrackpore to Ponneri.
Shri A. Ghosh, Assistant Fishery Scientist.	:	From Kakdwip to Barrackpore
Dr. M. Subramanyam, Assistant Fishery Scientist.	:	From Ponneri to Barrackpore.

(B) Honours and Awards.

Shri V. R. Pantulu, Fishery Scientist, was awarded the degree of Doctor of Philosophy by the University of Calcutta on his thesis entitled "Contributions to the study of the biology and fishery of some estuarine fishes".

(C) Staff.

Director	:	Dr. V. G. Jhingran.
Deputy Director	:	Vacant.

(i) Pond Culture Division.

(a) Central Inland Fisheries Research Substation, Cuttack (Orissa).

Fishery Scientists	:	Dr. A. David and Dr. M. T. Philipose.
Frog Scientist	:	Dr. A. K. Mondal.
Junior Fishery Scientists	:	Sarvashri V. Ramachandran, S. B. Singh and R. D. Chakraborty.

Assistant Fishery Scientists	:	Sarvashri R. M. Bhowmick, S. P. Ayyar, K. Raman, K. H. Ibrahim, G. N. Saha, P. R. Sen, S. Patnaik and Y. Ramaprabhu.
Research Assistants (Sel. Grade)	:	Shri A. K. Banerjee.
Research Assistants	:	Sarvashri D. P. Chakraborty, D. S. Murthy, S. R. Ghosh, M. M. Bagchi, P. C. Chakrabarty, A. C. Nandy, P. Gopalakrishnan, G. C. Panickar, M. D. Rout, R. K. Jena, D. K. Chatterjee, G. V. Kowtal, K. V. Rajagopal and K. K. Sukumaran.
Survey Assistant	:	Shri P. V. G. K. Reddy.

(b) Central Experimental Fish Farm, Panna (Madhya Pradesh).

Junior Fishery Scientist	:	Shri M. A. V. Lakshmanan.
Research Assistants	:	Sarvashri S. Radhakrishnan, and C. Selvaraj.

(c) Pond Culture Unit, Calcutta (West Bengal).

Junior Fishery Scientists	:	Shri S. M. Banerjea and Dr. (Miss) E. Mitra.
Research Assistant (Sel. Grade)	:	Shri A. C. Banerjee.
Research Assistant	:	Shri M. K. Banerjee.

(ii) Riverine and Lacustrine Division.

(a) Central Inland Fisheries Research Substation, Allahabad (Uttar Pradesh).

Fishery Scientists	:	Sarvashri H. P. C. Shetty and J. C. Malhotra.
Assistant Fishery Scientists	:	Sarvashri K. K. Ghosh, Ravish Chandra, D. V. Pahwa and Dr. A. G. Jhingran.
Research Assistants	:	Sarvashri S. N. Mehrotra, M. Y. Kamal, A. G. Godbole, P. K. Mathur, M. R. Sinha, S. D. Gupta, S. C. Pathak, J. K. Verma, V. R. Desai, P. L. N. Rao, G. R. M. Rao, L. H. Rao and T. V. Premswarup.

Survey Assistants (Sel. Grade)	:	Sarvashri S. Jena, S. P. Singh, K. P. Srivastava and M. J. Bhagat.
Survey Assistants	:	Sarvashri R. K. Saxena, G. N. Srivastava, K. S. Rao, S. K. Wishard, R. C. Singh, Y. S. Rama Raju and M. Ranadhir.

(b) Ganga Survey Unit, Bhagalpur (Bihar).

Assistant Fishery Scientist	:	Shri B. N. Saigal.
Research Assistant (Sel. Grade)	:	Shri K. V. Rao.
Research Assistant	:	Shri T. D. Nangpal.
Survey Assistant	:	Shri R. K. Bhattacharjee.

(c) Small Reservoirs Unit, Rewa (Madhya Pradesh).

Junior Fishery Scientist	:	Shri S. J. Karamchandani.
Research Assistants	:	Sarvashri G. K. Bhatnagar, Balbir Singh and D. N. Misra.
Survey Assistants	:	Sarvashri M. D. Pisolkar, R. K. Dwivedi and S. N. Sar.

(d) Krishna Godavari Unit, Rajahmundry (Andhra Pradesh).

Junior Fishery Scientist	:	Smt. T. Rajyalakshmi.
Assistant Fishery Scientist	:	Shri Y. Rama Rao.

(iii) Estuarine Division.

(a) Estuarine Fisheries Research Substation, Barrackpore (West Bengal).

Fishery Scientist	:	Dr. V. Gopalakrishnan.
Junior Fishery Scientist	:	Shri P. Dutta.
Assistant Fishery Scientists	:	Dr. M. Subramaniam, Dr. C. S. Singh, Sarvashri R. N. Pal, A. Ghosh, H. A. Khan and P. Ray.
Research Assistants (Sel. Grade)	:	Sarvashri S. B. Saha, S. C. Banerjee and B. B. Ghosh.
Survey Assistants (Sel. Grade)	:	Sarvashri S. N. Dutta and A. Chaudhury.

Research Assistants	:	Sarvashri M. V. Gupta, R. M. Rao, K. K. Bhanot, N. K. Thakur, G. C. Laha, A. K. Ghosh, S. Mukhopadhyaya and Smt. K. K. Bhanot.
Computor	:	Shri P. M. Mitra.
Survey Assistants	:	Sarvashri R. K. Chakraborty, D. D. Haldar, R. N. De, A. R. Chaudhury, B. K. Saha and P. B. Das.

(b) Brackish Water Fish Farm, Kakdwip (West Bengal).

Junior Fishery Scientist	:	Shri A. N. Ghosh.
Research Assistant (Sel. Grade)	:	Shri S. C. Thakurta.
Research Assistant	:	Shri P. R. Das.
Survey Assistants	:	Sarvashri P. K. Pandit and H. S. Majumdar.

(c) Pulicat Unit, Ponneri (Tamil Nadu).

Assistant Fishery Scientist	:	Shri Ch. Gopalakrishnayya.
Research Assistant (Sel. Grade)	:	Shri K. N. Krishnamurthy.
Research Assistants	:	Sarvashri A. V. P. Rao, R. D. Prasadan and P. Rangaswamy.
Survey Assistants	:	Sarvashri H. Srikant, M. Kaliyamurthy, K. G. Rao and S. Srinivasagam.

(iv) Tank Fisheries Research Unit, Bangalore (Mysore State).

Research Assistants	:	Sarvashri N. G. S. Rao and S. Lakshmiraghavan.

(v) Cold Water Fisheries Research Unit, Srinagar (Jammu and Kashmir).

Junior Fishery Scientist	:	Shri K. L. Sehgal.
Research Assistant (Sel. Grade)	:	Shri K. V. Ramakrishna.
Research Assistants	:	Sarvashri C. B. Joshi and K. L. Shah.
Survey Assistant	:	Shri Shyam Sundar.

(vi) Sunderbans Survey Unit, 24-Parganas (West Bengal).

Junior Fishery Scientist	:	Shri B. B. Pakrasi.
Research Assistant	:	Shri R. K. Banerjee.

(vii) Reservoir Fisheries Substation, Hazaribagh (Bihar).

Junior Fishery Scientist	:	Shri A. V. Natarajan.
Assistant Fishery Scientist	:	Shri B. V. Govind.
Research Assistants	:	Sarvashri M. Ramkrishna, S. K. Sarkar and M. A. Khan.
Survey Assistant	:	Sarvashri B. Ray and B. K. Banerjee.

(viii) Library and Documentation Unit, Barrackpore (West Bengal).

Junior Fishery Scientist	:	Shri S. D. Tripathi.
Research Assistant	:	Shri R. R. Khan.
Reference Collection Assistant	:	Shri P. K. Chakraborti.
Librarian	:	Miss A. Ghosh.

Critical Appraisal of the Progress made during 1968.

The year 1968 was an year of satisfactory progress. A gross production of 2,575-3,041 kg/ha/annum of fish by mixed farming of Indian and exotic carps was obtained in the experimental farm ponds at Cuttack for the fifth time in successive years, as against reported average of 600 kg/ha/year. This has great fishery developmental significance as it evolves a high yielding cultivation of several species of Indian and exotic fishes. Progress in evolving effective doses of indigenous and economic fish poisons for clearing fish nurseries has been made. Efforts in mass culture of natural fish food organisms of both plant and animal origin have given encouraging results. Studies on the prevention of seepage from porous soils of fish ponds have indicated the possibility of checking it by replacing the exchangeable bases by sodium ions.

While the demand for fish pituitary is increasing day by day, no alternatives have been discovered. However, the successful use of Synahorin in reducing this demand is a great leap forwards.

Hydrobiological observations in the large (the Konar and the Tilaiya in Bihar) and medium sized (the Kulgarhi, the Loni and the Govindgarh in

Madhya Pradesh) reservoirs and in the selected tanks and ponds of Mysore State have been made with a view to undertaking and improving their fisheries. The Central Fisheries Corporation has stocked the Damodar Valley Corporation reservoir with major carp fingerlings on the basis of the recommendations of this Institute for which a detailed report was submitted.

Three new centres with commercial potentialities for spawn collection have been located, one each on the Ganga and the Yamuna rivers in Uttar Pradesh and the third on the Banas river in Rajasthan. Similar centres for brackish water fish and prawn seed have been discovered in the Rupnarayan and the Hooghly estuaries in West Bengal. These will help in meeting requirements of fish seed for fish culture both in fresh and brackish waters.

Some experience has been gained in the construction of brackish water fish farms. Observations on the provision of a puddle core in the dykes of brackish water ponds on the Henry's Island in lower Sunderbans (West Bengal) have been significant in that they have revealed almost no difference in the dykes' permeability.

Hybridisation of major carps to produce better strains has been carried out successfully in that the F_3 generation was produced this year. An effective preservative (GPC-5) for fish sperm was found and at the same time idea about a five to ten fold increase in the viability period of the male and female germ cells in the dry condition as against the wet condition was gained. Hybrids of silver carp and grass carp were also obtained. Natural spawning (without stripping) of both grass and silver carp through hypophysation in *hapas* was another additional successful feature.

Considerable improvement has been made in the rate of survival in trout hatcheries by control of diseases in the green to eyed ova stage and amongst the adult trout. With a view to giving a fillip to the culture of indigenous commercially important species (*Schizothorax* spp.), some breeding grounds and centres for the collection of their fry have been located.

Investigations have been conducted on the common parasitic infections of fish fry in nurseries to help improve the rate of survival by devising suitable control methods against them. Parasites of fresh water prawns have also been studied.

Further improvements have been effected in the standardization of control techniques of water hyacinth by 2,4-D sodium salt in that it has been discovered that the doses should be prescribed on the basis of infestation density rather than area. The same weedicide at 10 kg/ha (in combination with a detergent) has also been effective in eradicating lily infestation. Gramoxone-20, aqueous ammonia and copper sulphate mud pellets have also given successful results.

Frog and frog cum fish culture, initiated at this Institute only in 1967, has given encouraging results. While the two indigenous species of frogs, *viz. Rana tigrina* and *R. hexadactyla* can be bred in the laboratory through hypophysation, survival was found to be considerably poor in the former species. Early frog stages of *R. hexadactyla* have been supplied to Orissa State with a view to establishing the species in that state.

Post-winter spawning of hilsa in the Ganga river around Bhagalpur has been established for the first time. Artificial fecundation of hilsa was successfully done even by stripping the germ cells of dead fishes within $\frac{1}{2}$ hr of the parents' death. However, attempts at inducing the fish to breed through hypophysation have failed mainly due to the difficulty experienced in keeping the fish alive after injection. Attempts at delimiting the spawning grounds of hilsa in the Godavari river did not yield any results due to the failure of successful spawning.

More than a dozen industrial effluents were studied with a view to characterizing them and measuring the pollutional load due to them in the Hooghly estuary.

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