1971

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE BARRACKPORE

ANNUAL REPORT

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CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

BARRACKPORE

ANNUAL REPORT

for the year

1971

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

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ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES RESEARCH INSTITUTE, 1971

1. Director's Introduction

History : 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 on the left bank of the river Hooghly.

Objects : The main object of the Institute is to study and elucidate the scientific principles which can be applied for full utilization of all available inland waters of the country for the maximum production of fish for food. Such an objective requires evolving of suitable fish culture techniques, investigations on the biology of important food fishes, studies on hydrology and ecology of different types of waters, research on the fish populations in natural waters ; like, rivers, lakes, estuaries etc. and fishery management problems concerning both fresh and brackish water environments. With a view to achieving this, three divisions ; *viz.,* Freshwater Fish Culture Division, Riverine and Lacustrine Division and Estuarine Division, at Cuttack, Allahabad and Barrackpore were established to deal with the problems of pond culture, riverine and lacustrine, and estuarine fisheries respectively.

Organisational structure : The above stated divisions with their units and survey centres : the Reservoir Fisheries Unit at Hazaribagh, Small Reservoirs Unit at Rewa, Tank Fisheries Unit at Bangalore, Lower Ganga Unit at Bhagalpur, Cold Water Fisheries Unit at Srinagar, Krishna-Godavari Unit at Rajahmundry, Sunderbans Survey and Brackish Water Fish Farm Units at Kakdwip and Pulicat Lake Fisheries Research Unit at Madras continued to function as in the previous year. Soil Chemistry and Weed Control Units in Calcutta, and Documentation and Fisheries Economics Units at Barrackpore functioned under the direct control of the Director. In mid-1971, four coordinated research projects ; *viz.,* (i) Ecology and Fisheries of Freshwater Reservoirs (with main centre at Nagarjunasagar and subcentres at Bhavanisagar, Nagarjunasagar and Rihand), (ii) Composite culture of Indian and Exotic Fishes (with main centre at Barrackpore and subcentres at Kurnool, Bhavanisagar, Barrackpore, Jaunpur, Karnal and Poona), (iii) Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps (with

main centre at Darbhanga, and subcentres at Bhadra and Gauhati) and (iv) the Investigations on Riverine Carp Spawn Prospecting (with main centre at Allahabad and subcentres at Barrackpore, Gauhati and Patna) were initiated at the Institute.

Library and Documentation : During the year under report, 134 books, 280 reprints, 103 miscellaneous publications and 1,090 issues of periodicals were added to the library. The Institute subscribed 34 Indian and 42 foreign journals. It obtained, either as free gift or in exchange, 160 Indian and foreign journals. The present library holdings, inclusive of the year's arrivals, comprise 2,466 books, 1,508 bound periodicals, 3,007 reprints and 1,330 miscellaneous publications, excluding the stock of loose issues of journals, pamphlets, maps, departmental publications etc. Besides maintaining exchange relationship with 215 institutions and organizations, excluding 24 institutes and departments under the Indian Council of Agricultural Research, 25 new exchange relationships were established during the year. Accession list for July-December, 1970 and January-June, 1971 were brought out and circulated for the benefit of the staff of the Institute.

A total of 61 technical and non-technical enquiries from India and abroad were attended to by the Documentation Unit. The Institute supplied a number of publications to Andhra University Post-Graduate Centre (Guntur), Institute of Basic Medical Sciences (Calcutta), Uttar Pradesh Fisheries Department (Lucknow), Central Institute of Fisheries Technology Substation (Burla), and Institute of Library Information Service (Calcutta) on interlibrary loan basis.

During the year, 127 reports on progress of research were compiled and sent to Indian Council of Agricultural Research. "Bibliography of Indian Fisheries" Vol. 9 (3 & 4), 1970 and 10 (1), 1971 were brought out. The annual report of the Institute for the year 1970 was also brought out in printed form. Besides the above, 216 sketches/diagrams, 12 posters/charts and 760 photographs on research findings were prepared.

Honours, Awards etc. : As per exchange programme of scientists between the Royal Society (London) and the Indian National Science Academy (New Delhi), Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, attended a discussion meeting on "Freshwater and Estuarine Studies of the Effect of Industry" held on June 3 and 4, 1971 under the auspices of the Royal Society at 6, Carlton House Terrace, London S.W. 1.

Dr. H. Chaudhuri, Fishery Scientist, after completing 4 years' assignment in Burma as FAO/TA Inland Fishery Biologist, joined the post of Senior Fishery Scientist at this Institute.

Dr. V. R. Pantulu, Fishery Scientist has completed his 5th year of assignment under Economic Commission for Asia and the Far East as Freshwater Fisheries Expert in Bangkok.

Shri S. B. Singh, Junior Fishery Scientist and Shri M. A. V. Lakshmanan, Junior Fishery Scientist were awarded merit increments by the Indian Council of Agricultural Research

Shri P. U. Verghese, Senior Research Assistant and Shri K. L. Sehgal, Junior Fishery Scientist were awarded Ph.D. degrees during the year.

Shri S. B. Saha, Senior Research Assistant and K. Janardhana Rao, Research Assistant, have been awarded Junior fellowships of the Indian Council of Agricultural Research for in-service training at the Central Institute of Fisheries Education, Bombay.

Distinguished visitors : The following scientists and distinguished persons visited the Institute and its various establishments during the year under report : Dr. T. G. Anderson of UNICEF, Calcutta ; Dr. Yasutiko Taki, Tokyo University of Agriculture ; Dr. John R. Oppenheimer & Mrs. Eliyabett C. Oppenheimer, John Hopkins University, presently attached to CMRT, 4-A Orient Row, Calcutta-17 ; Mr. C. W. Perchard, the British Council, Calcutta ; Miss Maluthin and Mr. Vertitskaya from Moscow ; Mrs. G. Popova from USSR ; Mr. A. Hakim, Ministry of Agriculture, Government of India ; Mr. Annasahib P. Shinde, Minister of State Agriculture, Government of India ; Dr. B. P. Pal, Director-General, Dr. B. K. Soni, Deputy Director-General, Shri K. P. A. Menon, Secretary and Dr. R. Raghu Prasad, Assistant Director-General, Indian Council of Agricultural Research, New Delhi ; Gen. J. Hopkins, Director, Water Pollution Control Department, Kansas City, Missouri, U.S.A., and Dr. A. J. P. Mzumara, Fisheries Training Officer (Principal), Fisheries Training College MPWEPWE, Mangochi, Malawi.

Important events of the year : Maturation and breeding through hypophysation of catla, rohu and mrigal for the second time in the same season have been achieved on several occasions The results confirmed the observations made during 1970 when specimens of Indian major carps were, for the first time, induced to breed twice in the same season. Indian major carps hitherto, were known to breed ordinarily only once while in captivity either through hypophysation or naturally in the riverine habitat. By this achievement, it has been possible to obtain almost double the production of spawn from the same specimen. The result achieved is outstanding and further research in this line may lead to prolongation of the breeding season and domestication of the Indian major carps.

Four workshops were held during the year 1971 on the co-ordinated projects on (i) Composite Culture of Indian and Exotic Fishes, (ii) Ecology and Fisheries of Freshwater Reservoirs, (iii) Investigations on Riverine Carp Spawn Prospecting and Collection Techniques and (iv) Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps, at this Institute.

Staff Councils have been set at the Headquarters at Barrackpore, at the

Pond Culture Division at Cuttack and at the Riverine and Lacustrine Division at Allahabad.

The Audit Inspection Party of the Indian Council of Agricultural Research visited the Institute during the year for inspection of accounts.

The Indian Council of Agricultural Research took a decision in the year under review to return the site and the buildings thereon of the once proposed Experimental Fish Farm of the Institute at Panna (M.P.) to the Government of Madhya Pradesh since tests had conclusively shown that the site was unsuitable for a fish farm.

Shri V. Ramachandran, Fishery Scientist and Shri S. B. Singh, Junior Fishery Scientist went to Canada under Colombo Plan for advance training in the field of pond nutrition using radio active isotopes during July, 9 to November 26, 1971 and in fish pond organism culture during July, 8 to November 29, 1971.

Research collaboration with institutes, universities, colleges and other institutions at national level : To meet the increasing demand of fish seed for fish culture, this institute has been helping the State Governments in locating new spawn collection centres on the rivers of the country for the last seven years. During the year under report, work was taken up, through a co-ordinated project on Riverine Carp Spawn Prospecting and Collection Techniques, at Silghat in Assam on the river Brahmaputra, Daryapur in Bihar on the river Ganga, Benadihi in West Bengal on the river Kangsabati and Mahewapatti in Uttar Pradesh on the river Yamuna. Silghat appeared to be a promising centre.

To assist the State Governments in standardising breeding, rearing and cultural techniques of air-breathing fishes in hitherto unutilised swampy areas and other derelict water masses, work has been taken up through a co-ordinated project entitled Propogation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps, at Balbhadrapur (Bihar), Bhadra reservoir (Mysore) and Gauhati (Assam). In *Anabas* sp. culture, cannibalism has been a serious problem. The fry at 8 mm stage show 88% survival but between 8 and 22 mm stages, cannibalism, which is prominent, could be checked considerably by restricting the stocking rate to 3 fry/1 of ambient water and providing abundant zooplankton to serve as food. As many as 300 specimens of *Clarias* sp., 300 specimens of *Heteropneustes* sp. and 400 specimens of *Anabas* sp. could be cultured in cages (1.83 m × 0.91 m × 0.91 m) made from phragmites-stem mats, split bamboo mats, palm leaf mats, deal wood strips, galvanised wire mesh, synthetic fibre mesh etc., keeping the growth rate of fishes comparable to that obtaining in nature. Limnological studies and investigations on the biology of the air-breathing fishes were continued.

The Institute has been helping the State Governments to develop formulae of species combinations of fishes whereby fishes feeding in different zones are cultured together to increase the production in culture operations. For implementation of the scheme in different soil and climatic zones, through

a co-ordinated project entitled Composite Culture of Indian and Exotic Fishes, the ponds at Poona have been manured and stocked with fingerlings of Indian and exotic carps, one pond at Sunkesula with Indian carps only and another pond there with both Indian and exotic carps. Ponds at Jaunpur, Bhavanisagar and Kulia have been prepared for stocking, while to obtain suitable ponds in Hariyana, the centre had to be shifted from Faridabad to Karnal.

Through the co-ordinated project on Ecology and Fisheries of Freshwater Reservoirs, assistance is being rendered to State Governments by this Institute for the development of reservoir fisheries. Data on limnology, quantitative biology and methods of exploitation with a view to formulating suitable development and management measures for fish stocks in order to obtain sustained optimum yiend in reservoirs under different geographic conditions and climatic locations and with distinctive eco-morphological features, such as the Nagarjunasagar, Bhavanisagar and Rihand reservoirs, were continued to be collected.

Eighty four ampoules of fish pituitary extract were supplied to various State Governments and fish breeding agencies to facilitate induced breeding programmes.

A meeting for interorganizational collaboration between Zoological Survey of India, Botanical Survey of India and the Central Inland Fisheries Research Institute was held on November 3, 1971 and the procedure for undertaking co-operative researches were outlined. Further action on this matter is in progress.

The Indian Council of Agricultural Research has constituted a group in order to discuss the problems of water pollution in the country and assign areas of responsibility. For this, co-operation among the Central Inland Fisheries Research Institute, Central Public Health Engineering Research Institute, Indian Institute of Technology, All-Indian Institute of Hygiene and Public Health, Port Authorities and State Research Organisations was felt necessary.

Since, there is need for co-operative programmes between the Central Marine Fisheries Research Institute, Central Inland Fisheries Research Institute, National Institute of Oceanography and Bhaba Atomic Research Centre, the matter relating to interorganisational co-operation in primary production studies has been referred to the Director, National Institute of Oceanography.

Research collaboration at international level with FAO, Ford Foundation etc. : Information on important researches were regularly sent for publication in the FAO Newsletter.

At the request of the Department of Agriculture, Papua and New Guinea, a note on the information on bionomics and breeding of mahseer and details of frog culture were compiled and sent. The probable source for obtaining parasite-free carps was also conveyed.

Details about the literature on hypophysation and artificial breeding of

warmwater fishes have been communicated to the Documental Centre, Argentina.

The published results on artificial fecundation of *Hilsa ilisha* have been forwarded to Songkhla Marine Fisheries Station, Thailand for conducting similar trials for breeding *Lates calcarifer*.

Photographs of catla, rohu, mrigal and spawn collection net were sent to Professor John Bardach of Michigan University to be included in his book on aquaculture.

Steps were taken to establish exchange relationships with Experimental Fish Processing Station (Tanzania) and Marine Fisheries Laboratory (Thailand) for exchange of literature on fisheries.

Fellowships and Studentships : (Nothing to report).

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

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

Indian :

(i) The Asiatic Society, Calcutta.
(ii) Marine Biological Association of India, Mandapam Camp.
(iii) Indian Association of Water and Water Pollution Control. Nagpur.
(iv) Indian Science Congress Association, Calcutta.
(v) Inland Fisheries Society of India, Barrackpore.

Foreign :

(i) Societas Internationalis Limnologiae, Westmoreland, England.
(ii) The Fisheries Society of the British Isles, Humtingdon, England.

Advisory services received and provided : Technical advice on ecology of aquatic and marsh vegetation, equipment for fisheries training, supply of tilapia larvae, socio-economics in fisheries, effect of insecticides on fish biology, microbiological research, fish and fisheries and aquatic weed control were supplied to universities, colleges and research institutes. Detailed information about this institute and its publications and comments on the scheme for studies on the maturity of gonads of *Lates calcarifer* were furnished to Indian Institute of Management, Ahmedabad and the University of Calcutta.

The main topics of information supplied to various Government Departments were : Write-ups on 'induced breeding' and 'weed control' for Television Programme ; 'fish food and control of fish diseases' ; 'catfish culture' ; 'fast growing fishes' ; 'supply of exotic carps' ; 'cyclops identification & biological control of guineaworms' ; 'ammonia tolerance of Indian fishes' ; 'general guideline for collection of statistics of inland fishes' ; 'inventry of fishermen and fishing villages' ; 'nets and crafts' ; 'induced breeding of fish'

and 'weed control'. Suitable suggestions were given to the Department of Fisheries, Goa, Daman and Diu for eradication and detection of crocodiles in a lake.

Informations on the following items were provided to different organizations and enterprises in India : proper guidance and suitable literature required for fish culture to 'Fisheries and Builders International Ltd., Bombay' ; unsuitability of 'Sinbar Terbacil Weed Killer' for pisciculture to 'Development and Service, Bangalore' ; supply of exotic carps for abroad to 'Fish Seed Syndicate, Howrah' ; extraction of shark liver oil to 'R. Akoojee Jadwet & Co., Calcutta' and management of fish farm to 'Nav Yuvak Machindra Machhli Sahakari Samiti Ltd., Bhandra'.

Information supplied to foreigners were : illustrations of catla, rohu, mrigal, spawn-net and *hapa* to Dr. John Bardach, School of Natural Resources, University of Michigan ; details of artificial fecundation of *Hilsa* sp. to Mr. Swasdi Wongsomnuk, Songkhla Marine Fisheries Station, Thailand ; culture of *Mugil cephalus* to Estacion de Biologia Pesquera, Mexico ; culture of frogs, fish seed supply, and details about breeding and life history of mahaseer to Dr. W. L. Conroy, Department of Agriculture, Papua and New Guinea ; distribution of *Micropterus dolomieui* in India to Dr. H. Robbins, University of Guelph, Canada ; and treatment of effluents of a vegetable oil factory to Dr. Donald R. Whitfill, 707 Montego Road, East Jachsonville, Florida.

Extension and nation building activity : Laboratory and field demonstrations and training in various aspects of fish and frog culture were given to (i) 47 trainees of the Regional Training Centre of Inland Fishery Operatives, Agra ; (ii) 43 trainees of the Inland Fisheries Training Unit, Barrackpore and (iii) 25 trainees of the Central Institute of Fisheries Education, Bombay.

With a view to promote composite culture and control of aquatic weeds by grass carp, the details about supply and sale of spawn, fry, fingerlings and adults of various cultivable fish species are presented in the table 1.

Finance : The provision of funds for the Institute for the financial year April, 1971 to March, 1972 was :

Non-Plan	Rs.	26,50,000
Plan	Rs.	6,25,000
Total	Rs.	32,75,000

Against the above provision the expenditure from 1.4.71 to 31.12.71 was as follows :

Non-Plan	Rs.	20,32,427
Plan	Rs.	1,86,305
Total	Rs.	22,18,732

Table 1. Distribution/Sales of spawn, fry, fingerlings and adult fish to various agencies during the calendar year 1971

Items	Agencies							
	To whom distributed							To whom sold
	Orissa Fisheries Department	Co-ordinated Project	Bhilai Steel Plant	Tamil Nadu Government	Jabalpur University	Kakdip Fish Farm	Sunderbans Survey Unit of CIFRI	Private Parties/public
Spawn (lakh)								
Indian major carp	103·25	—	—	—	—	—	—	—
Common carp	20·70	—	—	—	—	—	—	0·80
Silver carp	1·00	—	—	—	—	—	—	—
Fry & Fingerlings (lakh)								
Indian major carp	4·85	—	—	—	—	—	—	0·49
Common carp	—	0·01	—	—	—	—	—	0·02
Silver carp	—	0·05	—	0·01	0·01	0·005	—	0·07
Grass carp	—	0·02	0·003	—	—	—	—	—
Mugil tade	—	—	—	—	—	—	0·007	—
Large fish & prawn (Kg)								
Indian major & exotic carps	—	—	—	—	—	—	—	1,242·95
Mullets	—	—	—	—	—	—	—	13·73
S. argus	—	—	—	—	—	—	—	1·75
E. tetradactylum	—	—	—	—	—	—	—	3·60
Sciaenids	—	—	—	—	—	—	—	8·50
M. gulio	—	—	—	—	—	—	—	6·00
W. attu	—	—	—	—	—	—	—	0·70
Miscellaneous	—	—	—	—	—	—	—	25·00
Prawn	—	—	—	—	—	—	—	17·60

N.B. Total amount realised through sale proceeds is Rs. 4,599·24

Harvesting of marketable fish was continuous during the year (June, 1970-May, 1971), the harvested fish being replaced with equal number of fingerlings of the species removed. Average percentage survival/weight (Kg) attained by initial stock were: silver carp, 94.0/1.245; catla, 88.7/1.136; rohu, 100.0/0.535; grass carp, 82.0/0.400; mrigal, 92.3/0.488 and common carp, 73.0/0.600 in 5-12 months. Replacements for harvested silver carp, catla and rohu recorded only figures of 8.3/0.100; 90.7/0.315 and 100.0/0.116 respectively in 4-7 months. A fresh experiment for raising large fish, using the species combination—silver carp 2: catla 1: rohu 3: grass carp 3: mrigal 1.5: common carp 1.5 @ 55,000/ha, has been initiated in three 0.15 ha and one 0.4 ha ponds. Another experiment on large fish culture has also been initiated in four (0.23-0.26 ha) ponds at Kausalyaganga using 6 major carp and 2 minor carp species at a total stocking density of 5,750/ha.

Problem : 1.2 Artificial feeding

1.2.1 Evolving a balanced fish diet and to improve feeding technique

Duration : Four years

Personnel: M. A. V. Lakshmanan, D. P. Chakraborty (upto 8.4. 1971) and D. S. Murty

In a series of yard experiments using oilcakes (ground-nut, sesame and mustard), pulses (blackgram, Bengal gram and horse gram), cereals (Italian millet) and animal proteins (prawn waste and fish meal), ground-nut oilcake proved to be the most superior. Fish meal proved superior to prawn waste among animal proteins. A diet composed of 65% plant material and 35% fish meal or prawn waste powder was found quite acceptable by all the cultivated species of fish; but percentage survival and growth increaments were different, depending on the composition of the feed. With fish meal as one of the constituents of the feed, 100% survival and 18.0% growth increment were obtained, while with prawn waste powder as the main constituent of the feed, 93% survival and 19.5% growth increment were achieved.

1.2.2 Conversion ratio of selected carp feed into fish flesh

Duration : Two years

Personnel: R. D. Chakrabarty, P. R. Sen, G. V. Kowtal (upto 22.6.1971) and D. K. Chatterjee

Live zooplankters, silkworm pupae, prawn waste, soyabean and ground-nut oilcake-wheat bran mixture (1:1) were tested as feeds for the spawn and fry of catla, rohu and mrigal. The living zooplankton given consisted of cladocerans, rotifers, nauplii of copepods, copepods and ostracods. The other feeds were given as fine, dry powder sieved through organdie cloth. The rate of feed was equal to the initial weight of the spawn. In case of fry, the experiments were carried out in plastic pools for 30 days and the same feeds were

2. Progress of Research

The Institute continued its research investigations as per programmes prepared under 17 projects. Each project has several problems and sub-problems to be worked out on the basis of priority. Investigation on 2 problems were completed by the end of the year, while work on the remaining problems is being continued. Besides these a few new problems are proposed to be taken up in the year 1972.

(a) Research completed

Researches on the following two problems were completed and the final reports are under preparation.

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

Problem : 1.8 Algae in relation to fish nutrition
Personnel: K. K. Bhanot (Mrs.)

Project 13 : *Cold water fish Culture*

Problem : 13.3 Standardisation of trout culture techniques
Personnel: K. L. Sehgal, K. V. Ramakrishna, C. B. Joshi and S. Sundar

(b) Research in hand

Researches on 17 projects were continued during the year under report. The progress achieved under each project, during 1971, is outlined in the following pages.

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

Problem : 1.1 Composite culture of Indian and exetic species
Duration : Continuing
Personnel: M. T. Philipose, S. B. Singh, R. D. Chakrabarty, M. A. V. Lakshmanan, K. Raman, P. R. Sen, A. C. Nandy (upto 9.6.1971), D. S. Murty, D. P. Chakraborty (upto 8.4.1971), P. C. Chakrabarti (upto 17.5. 1971) M. M. Bagchi (upto 6.5.1971) and M. D. Rout

A fresh experiment in two 0.08 ha ponds stocked @ 1,00,000/ha in the proportion—silver carp 4 : grass carp 3 : common carp 3, is now in progress.

A net production of 2,963 Kg/ha was obtained in the year when silver carp catla, rohu, grass carp, mrigal and common carp were stocked in the ratio 1.5 : 0.75 : 3 : 1 : 1.5 : 1.5 respectively @ 4,425 fingerlings/ha.

given as tablets except for soyabean which was given as fine powder. The quantity of feed given was 6% of initial body weight of the fry. The water temperature was 27-30°C in case of spawn and 20.1-33.2°C in case of fry.

Survival of spawn, fed with zooplankton, was 86.7, 99.3 and 90.0% in catla, rohu and mrigal respectively. Among the artificial feeds, soyabean for catla (88%), ground-nut oilcake + wheat bran for rohu (82%) and ground-nut oilcake + wheat bran and soyabean for mrigal (96.7%) gave the best survival rates. Five to six-times better growth rate was recorded with zooplankton in case of spawn of all the three species than with artificial feed. Mrig-l showed 25% better growth when fed with zooplankton than with ground-nut oilcake + wheat bran mixture. Mrigal spawn appeared to be a better utilizer of artificial feed. Conversion ratio of zooplankton to fish flesh in case of the above 3 species appeared to vary from 1-2.

The highest survival of fry of rohu (84.38%) and catla (100%) was recorded with silkworm pupae and ground-nut oilcake — wheat bran mixture respectively. In terms of growth as weight, zooplankton feed was the best for catla and silkworm pupae for rohu. Rohu appeared to be a better utilizer of artificial feed than catla. The conversion ratio of zooplankton for fry of catla appeared to be about 1.5, while the values for artificial feeds varied widely.

The chemical composition of the various feeds were :

	Soyabean	Ground-nut oilcake	Wheat bran	Prawn waste	Silkworm pupae
Protein (%)	37.63	32.41	11.23	17.77	59.72
Ash (%)	5.27	16.27	4.33	49.27	15.80

Problem : 1.3 Use of growth promoting substances
Duration : Four years
Personnel: P. R. Sen

Among rohu hatchlings stocked (@ 37.5 lakh/ha in nursery ponds and fed with artificial feed containing cobalt choloride at a dose of 0.01 mg/day/fish, survival was 74.33% as against 66.00% in the control without cobalt chloride in the feed. The average growth in increment was also 16.77 mm/127.47 mg among fish fed with cobalt chloride as compared to 14.45 mm/91.76 mg in the control specimens.

In another set of field experiments, cobalt chloride, starch and manganese were administered to fingerlings of catla, rohu and mrigal stocked @ 6,000/ha in the ratio of 1:1:1. The over-all survival percentage at the end of four months was 98.8 with cobalt chloride (@ 0.01 mg/day/fish) followed by 91.7 with starch (@ 3.44 mg/day/fish) and 73.3 with manganese (@0.01 mg/day/fish) as compared to 74.58 in control. Average growth increment of 123.33 mm/117.49 gm was obtained during the same period with cobalt chloride followed by 127.8 mm/98.64 gm with starch and 121.46 mm/91.47 gm with manganese as compared to 106.17 mm/69.27 gm in the control.

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

Duration : Four years

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

The efficiency of three nitrogenous fertilizers; *viz.*, urea, ammonium sulphate and ammonium nitrate in alkaline, acidic and neutral soils, was studied in plastic pools, each stocked with fry of *Cyprinus carpio* (15.6 mm/32.6 mg) and rohu (20 mm/75 mg) @ 1.5 lakh/ha. The fertilizers were applied in split doses at two levels of N (80 and 50 Kg/ha). Ammonium sulphate in alkaline soil gave the maximum growth of *Cyprinus carpio* (37.8 mm/6.35 gm) at 80 Kg N/ha and rohu (59.9 mm/22 gm) at 50 Kg N/ha followed by urea and ammonium nitrate as compared to control. Survival of cent percent in all cases was also recorded. Primary production in alkaline soil was higher with urea (264.5 mg C/m^3/hr) at higher level of nitrogen; but at medium level, ammonium sulphate gave the maximum production 315.23 mg C/m^3/hr.

Slightly acid soil treated with nitrogenous fertilizers at 80 Kg N/ha gave the maximum growth of fry (44.08 mm/1.05 gm) with urea as compared to 32.06 mm/0.34 gm in control during one month ; but survival was cent per cent in all cases.

In the field, four nurseries (0.012 ha each) with neutral soil were treated with either urea, ammonium sulphate or calcium ammonium nitrate @ 80 Kg N/ha against suitable control. Each pond was stocked with rohu spawn @ 12.5 lakh/ha. Urea gave the maximum percentage survival (76%) followed by calcium ammonium nitrate (61%) and ammonium sulphate (45%) as compared to control (13%). The percentage of zooplankton being 89, 71, 41 and 16 respectively. The bottom fauna in the ponds increased remarkably after manuring, the maximum being for urea.

Problem : 1.5 Fixation of nitrogen by blue-green algae in pond soils (Research completed in 1970)

Problem : 1.6 Crude culture of fish food organisms (No progress)

Problem : 1.7 Culture of fish food organisms in the laboratory and field for feeding fish

Duration : Three years

Personnel: K. K. Bhanot (Mrs.)

Preparatory cultures of *Chlorella* sp., *Navicula* sp. *Nitzschia* sp., *Gomphonema* sp. and *Pinnularia* sp. were done in Bristol's solution with 0.1% urea and Chu-10 solution on agar plates, keeping at a controlled temperature of 25°C ± 1 and artificial illumination of 100, 200 and 500 lux.

Regular subcultures for maintaining the stock oultures of *Chlorella* sp., *Navicula* sp. and *Gomphonema* sp. were continued.

Attempts to culture *Chlorella* sp. in glass jars kept under natural conditions proved unsuccessful during summer (31-33°C); but in winter (20-23°C) mass culture could be achieved in plastic pools kept under natural conditions in Bristols' solution CO_2 was supplied to the cultures very week. The number of cells/l had increased from 5 to 50,000 in two months. In addition to *Chlorella* sp. and *Navicula* sp. which were inoculated for culture, other food organisms in the culture were *Scenedemus* sp., *Vorticella* sp. and *Paramecium* sp.

Cyclops sp., *Moina* sp. and *Daphnia* sp. were cultured in glass jars in cotton seed extract, paddy straw extract and boiled & filtered pond water. The cultures could be maintained for three months only.

Problem : 1.8 Algae in relation to fish nutrition
(Work completed in 1971)

Problem : 1.9 Response of unproductive pond soils to different inorganic manurial combinations

Duration : Four years

Personnel: S. M. Banerjea (upto 31.12.1971), E. Mitra (Miss) and B. R. Dutta

To study the response of unproductive pond soils to different inorganic fertilizer combinations, using primary production as index of response, a laboratory experiment was taken up in plastic cisterns with two unproductive fish pond soils, from Lingipur Farm (Orissa) and Lembuchara Farm (Tripura). Observation with $N_{40}P_{40}$ for one complete year was concluded in February, 1971. The fertilizer was added in four divided doses at an interval of three months.

The details of response by soils to the fertiliser combination ($N_{40}P_{40}$) and the nutrient levels for the concluding three months are given in table 2.

Table 2.

Average for the month	Fertilised cisterns			Unfertilised cisterns		
	Primary Productivity (mg C/m³/hr)	Dissolved NH_4/NO_3 – N (ppm)	Dissolved PO_4 – P (ppm)	Primary Productivity (mg C/m³/hr)	Dissolved NH_4/NO_3 – N (ppm)	Dissolved PO_4 – P (ppm)
Lingipur Farm						
Dec '70	272.2	0.64	2.72	50.3	0.02	0.09
Jan '71	280.8	0.46	0.82	60.7	0.03	0.07
Feb '71	218.4	0.05	0.33	53.8	0.02	0.08
Lembuchara Farm						
Dec '70	265.2	0.60	2.38	38.2	0.02	0.08
Jan '71	283.0	0.48	0.88	48.6	0.05	0.08
Feb '71	183.7	0.06	0.42	57.2	0.02	0.05

The second series of experiments with $N_{40}P_{40}$ was concluded in March, 1971 while the third and final series with $N_{40}P_{80}$ was initiated in April, 1971.

While seeding with plankton collected from natural sources, it was, however, observed that all the cisterns developed an intense bloom of *Botryococcus* sp, so much so, that it prevented the growth of any other form of chlorophyll bearing organisms. So the cisterns had to be drained out ; the soil was sterilised by acid treatment and the experiment was reset.

Problem : 1.10	Factors responsible for low and high productivities of fish ponds in acid soils of Tripura
Duration :	Four years
Personnel:	S. M. Banerjea (upto 31.12.1971) and Staff of Tripura Government

To elucidate the factors responsible for low and high productivities of fish ponds in acid soil zones of Tripura, observations were continued on two fish frams, one highly unproductive and the other highly productive. All the ponds were stocked with fingerlings of catla, rohu and mrigal at a uniform rate 5,000/ha, the ratio being 1 : 1 : 1 . The pronounced differenciating character of the two waters, was observed in their soluble organic content and different forms of soluble nitrogen and phosphorus. The productive water had a markedly higher organic content and dissolved phosphorus both, in organic and inorganic forms. While organic and ammoniacal-nitrogen was relatively higher in productive water, nitrate-nitrogen concentration was higher in unproductive water.

The results obtained during the first three months are presented in table 3.

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

	NH_4-N (ppm)	NO_3-N (ppm)	Org–N (ppm)	PO_4-P (ppm)	Org–P (ppm)	Primary Productivity (mg C/m³/hr)	Weight of fish (gm)		
							Catla	Rohu	Mrigal
College Tilla farm (unproductive) :									
Jan	0.041	0.278	0.165	0.03	0.02	160.3	14	10	10 (0m)
Feb	0.034	0.258	0.159	0.03	0.02	104.8	—	—	—
Mar	0.030	0.253	0.158	0.04	0.02	161.5	102	47	42 (3m)
Rajdharnagar farm (productive) :									
Jan	0.223	0.107	0.929	0.25	0.37	263.7	14	10	10 (0m)
Feb	0.212	0.103	0.915	0.23	0.34	152.5	—	—	—
Mar	0.174	0.095	0.852	0.19	0.29	245.7	272	211	165 (3m)

Problem : 1.11 Remedial measures for preventing seepage in fish ponds by physico-chemical treatment of soil
Duration : Four years
Personnel: S. M. Banerjea (upto 31.12.1971) and S. C. Banerjee

To study the effect of bentonite clay, sticky clay of West Bengal known as *entel mati,* the saline sticky soil and cheap alkali ; like, soap lye waste on the prevention of seepage in pond soils, laboratory experiments were conducted with two highly permeable soils — one a sandy loam type from Lingipur, Orissa and the other a loamy sand type from Barrackpore, West Bengal.

Observations under laboratory conditions showed that Lingipur soil was more percolative than Barrackpore soil, the rate of seepage being 30 and 22 cm/hr respectively. Studying the effect of (i) sticky soil, (ii) saline and sticky soil, (iii) bentonite clay and (iv) soap lye waste as covering material, the percolation rates were reduced to 0.14 and 0.12, 0.10 and 0.12, 0.10 and 0.07, and 2.0 and 2.5 cm/hr respectively in case of Lingipur and Barrackpore soils. The strength of solution in each case was 0.1% excepting for soap lye when 0.5% solution was used. The hydrostatic pressure was 110 cm water column and the percolation was continued three times.

Problem : 1.12 Evaluation of indigenous plants as fish poisons
Duration : Three years six months
Personnel: M. T. Philipose, D. P. Chakraborty (upto 8.4. 1971) and A. C. Nandy (upto 9.6.1971)

Dry alcoholic extract of *Barringtonia acutangula* was found to be much more effective than raw bark powder, but poised serious handling problems.

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

Bias in population estimation due to species-selectivity of the conventional drag-net was eliminated for short term experiments by fixing iron sinkers at a distance of 20 cm each and floats at 3 m. The efficiency of the modified net in relation to conventional one was 1.52. Modified nets, having 0.7 hanging coefficient, were suitable for collecting representative samples of each species. Differences between estimated population and actual population remained within 5% error.

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

Spawn of catla, rohu and mrigal exhibited certain dissimilarities in their responses to continuous depletion of dissolved oxygen in water overcrowded

with them. Catla died first followed by rohu. Mrigal appeared to be more tolerant. The patterns of shoaling and swimming at the surface under stress of dissolved oxygen depletion and in response to sharp taps on the container, were somewhat distinctive. However, these differences were not sharp enough to be used in segregating them.

Problem : 1.15 Selective capture of predators and unwanted fishes from carp culture ponds
Duration : Three years
Personnel: A. David, R. M. Rao (upto 7.6.1971), S. L. Raghavan and M. F. Rahman

Experimental operation of the specially designed bamboo-, metallic- and fibre-traps in tanks indicated that these can be successfully utilised in controlling predatory fishes ; like, *Channa leucopunctatus, C. striatus, C. marulius, N. notopterus* and *Mystus vittatus.*

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

Among the fish in the age groups 1, 2 and 3 studied, the marks in the scales and bony parts did not correspond to their ages. The growth pattern was irregular and no sharp period of rapid or slow growth could be made out. In scales, the growth checks were more than the age in years of the fish.

Problem : 1.17 Effect of irradiation on fish
Duration : Three years
Personnel: R. D. Chakrabarty and P. R. Sen

Developing eggs with twitching embryos and 4-day old rohu hatchlings were killed on exposure to ultraviolet light for more than 1 minute. Eggs exposed for more than 3 minutes did not hatch.

Problem : 1.18 Role of some trace elements in pond fertilization
Duration : Five years
Personnel: G. N. Saha, D. K. Chatterjee, K. Raman

Among boron, cobalt, zinc and molybdenum tested in glass jars with low nutrient acid soils, only boron and cobalt encouraged the growth of diatoms and zooplankton (*Moina* sp.) at 0.05-0.20 ppm. At higher dose (0.5 ppm), though phytoplankton was not affected, zooplankton disappeared.

Growth of rohu spawn in 15 days with 0.05 ppm of boron and cobalt alone in the water was 10.0 mm/8.5 mg and 11.2 mm/10.0 mg respectively as compared to 8.1 mm/3.6 mg in the control.

Project 2 : Induced breeding

Problem : 2.1 Induction of early maturity and breeding in major carps
(Research completed in 1970)

Problem : 2.2 Use of various hormones for inducing spawning in carps
Duration : Four years
Personnel : R. M. Bhowmick and G. V. Kowtal (upto 22.6.1971)

2,017 pituitary glands of major carps and other fishes were collected for induced breeding experiments. Extracts from the pituitaries of *Mystus seenghala* and *Bagarius bagarius* were effective in inducing spawning in carps, whereas the extracts from pituitaries of *Notopterus notopterus* were not effective.

124.25 lakh of major carp spawn were produced of which 36.25 lakh were of catla. 103.25 lakh of spawn supplied to the Orissa Fisheries Department.

Problem : 2.3 Extraction, preservation and ampouling of fish pituitary hormones and setting up of pituitary bank
Duration : Five years
Personnel : R. M. Bhowmick

182 ampoules of pituitary extract in glycerine (40 mg/ml) were prepared and 84 of these were distributed to different state departments and other fish breeding agencies. Nagaland achieved induced breeding of major carps by using ampoules supplied by the Institute. Acetone preserved pituitary material kept under room temperature for about 16 months was found effective in inducing spawning in rohu.

Problem : 2.4 Hatching of eggs of major carps in newly designed hatching jars under controlled conditions
Duration : Two years
Personnel : R. M. Bhowmick and M. M. Bagchi (upto 6.5.1971)

The battery of glass jars demonstrated better hatching and survival of spawn than in the *hapa* fixed in the pond.

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

The result of a 7-month experiment on the comparative survival and growth of fish of induced bred and riverine stocks has indicated no adverse effect due to inbreeding.

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

Duration : Three years

Personnel: R. M. Bhowmick, G. V. Kowtal (upto 22.6.1971) and M. M. Bagchi (upto 6.5.1971)

The breeding of the same catla, rohu and mrigal specimens for the second time in the same season has been achieved on several occassions during the year under report through hypophysation. The results confirmed the observations made during 1970 when specimens of Indian major carps were for the first time induced to breed twice in the same season. Indian major carps hitherto, were known to breed only once either through hypophysation under capacity or naturally in the riverine habitat. By this success, it has been possible to obtain almost double the production of spawn from the same specimen. The result achieved is outstanding and further research in the line may lead to prolongation of the breeding season and domestication of the Indian major carps.

Project 3 : Reservoir fisheries

Problem : 3.1 Fisheries of the Tilaiya reservoir

Duration : Three years eight months

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

Personnel: A. V. Natarajan (upto 8.4.1971) and S. K. Sarkar

During the period under report, transparency of water of the Tilaiya reservoir was 24.4 cm. Surface water temperature ranged as 16.0 (January)—29.0°C (June). Isothermal condition in depths was observed in January. The maximum difference in temperature (1.9°C) between surface and 12-m depth was observed in September and October. Total alkalinity values for the Tilaiya reservoirs (mean value : 51.5 ppm at surface and 54.6 ppm at 12-m depth) showed that it could be classified as a medium hard reservoir with medium to high production potential. Analysis of specific conductivity, initiated in June, 1971, showed 98.93×10^{-6} mhos at surface and 103.36×10^{-6} mhos at the bottom (12-m depth). The pooled averages of various physico-chemical determinations of the Tilaiya reservoir are presented in table 4.

Gross primary productivity for the Tilaiya reservoir for the period under report was 617.9 mg C/m³/day (12 hr). Monthwise evaluations ranged from 375 (October) to 1,066 (November) mg C/m³/day (12 hr).

3.1.2 Food resources—A. Plankton, B. Bottom biota and C. Large aquatic plants and associated faunna and flora

Personnel: A. V. Natarajan (upto 8.4.1971) and B. V. Govind (upto 30.6.1971)

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

Depth (m)	Transper-ancy (cm)	PH	DO (ppm)	Free CO_2 (ppm)	Total alkalinity (ppm)	PO_4 (ppm)	NO_3 (ppm)	Silica (ppm)	Iron (ppm)	Dissolved organic matter(ppm)	Total hardness (ppm)	Specific Conductivity ($x10^{-6}$ mhos)
0	24.4	7.7	8.20	5.8	51.5	0.021	0.235	1.63	0.020	1.74	16.12	98.73*
3	—	7.6	8.20	4.2	50.3							
6	—	7.6	8.15	5.2	51.8	0.018	0.243	1.69	0.020	1.49	17.61	105.28*
9	—	7.4	7.40	3.8	53.5							
12	—	7.3	7.40	4.3	54.6	0.021	0.142	1.37	0.018	1.86	17.60	103.96*

* Average value of the 2nd half of the year only

A. Plankton : Zooplankton showed dominance over phytoplankton in the Tilaiya reservoir, the ratio being 14.5 : 1. The dominant zooplankton constituted of *Diaptomus* spp. and *Cyclops* sp. with their larvae among copepoda (89.7%) and cladocerans, rotifers and protozoans were represented by *Diaphanosoma* sp., *Keratella* sp. and *Difflugia* sp. respectively, though relatively in meagre quantity. The phytoplankton comprised *Microcystis aeruginosa* (6.18%).

The vertical distribution of plankton revealed an increased density at 3-m depth by numbers and by volume at 6-m as indicated in table 5.

Table 5. Vertical distribution of plankton in the Tilaiya reservoir

Depth (m)	Units/m³	Volume (ml/m³)
0	2,000	0.100
3	83,133	1.311
6	44,877	1.823
9	34,839	0.396
12	27,042	0.119

B. Bottom biota : The bathymetric distribution of bottom macrofauna at 2-m intervals in the Tilaiya reservoir upto 12-m depth showed the maximum concentration at 2-m depth, followed by 10-m depth. The minimum numbers were at 12-m. The bottom macrofauna comprised insects (*Tendipes* sp., *Chaoborus* sp. and *Philopotamus* sp.), bivalve (*Corbicula* sp.) and gastropod (*Melanogaster* sp.). The bathymetric distribution of bottom fauna at different depths was as in table 6.

Table 6.

Depth (m)	Units/m²	Weight (mg/m²)
2	1,659	48,906
4	429	6,563
6	1,073	99,385
8	1,144	53,996
10	1,430	1,602
12	57	1,716

On an average bottom macrofauna were 964 u/35,312 mg/m².

3.1.3 Effect of impoundment on reproduction and survival of fishes

Personnel: A. V. Natarajan (upto 8.4.1971), S. P. Ayyar (upto 28.5.1971), M. Ramakrishnaiah and M. A. Khan

In the Tilaiya reservoir, *Ambassis nama* formed the most dominant species among the trash fishes followed by *Labuca labuca, O. bacila, O. phulo* and *E. danrica.* Other species ; like, *R. corsula, P. ticto, P. stigma, B. barna* and juveniles of *G. giuris* were also encountered in the catches. In general, trash fish populations were more abundant during post-monsoon months.

3.1.4 Biology of commercially important fishes

Personnel: A. V. Natarajan (upto 8.4.1971), M. Ramakrishnaiah and M. A. Khan

The annual fish catch was estimated as 13.457 t of which catla formed 21.18% ; mrigal, 23.26%; calbasu, 7.70% ; rohu, 3.05%; and others, 44.81%. The annual production for the Tilaiya reservoir was 3.615 Kg/ha.

Catla occurred in the size range of 275-825 mm (modal value 625 mm) ; mrigal, 300-800 mm (m.v. 500 mm) ; rohu, 360-600 mm (m.v. 420 mm) ; and calbasu, 210-495 mm (m.v. 360 mm). The average sizes (and weight) of major carps in the catch for the year were : 626 mm (3,300 gm) for catla ; 512 mm (1,500 gm) for mrigal ; 432 mm (840 gm) for rohu ; and 370 mm (560 gm) for calbasu.

The average co-efficient of condition of *C. catla, C. mrigala, L. calbasu* and *L. rohita* was 1.051, 1.037, 0.989 and 1.018 respectively.

3.1.5 Experimental fishing

Personnel: A. V. Natarajan (upto 8.4.1971), B. V. Govind (upto 30.6.1971), B. Roy and B. K. Banerjee

Two fingerlings of catla (117 mm/21.2 gm) clipped and released on 25.10.68 in the Tilaiya reservoir were recovered after 27 and 30½ months, registering a growth of 9.2 and 9.1 mm/month respectively.

C. catla, C. mrigala and *L. calbasu* showed early stages of maturity till March and were fully mature in June/July. Afterwards, spent specimens were mostly encountered in the catches. Fecundity studies revealed that total number of mature eggs in *C. mrigala* (471-542 mm) ranged as 68,302-1,89,543 ; in *L. calbasu* (355-470 mm), 89,006-4,21,900. In *C. catla* (638 mm), the number of mature eggs counted were 5,86,320.

The maturity study conducted on other fishes ; like, *L. bata, P. sarana* and *N. notopterus* revealed that they started maturing by February/March and were fully matured in May/June. However, a quite prolonged breeding period was observed in *N. notopterus,* spreading from May to September.

Experimental gill-net fishing (January-May) in the mid-zone of the Tilaiya reservoir, yielded 361 gm/10 sq m net area for 35-mm mesh bar nets. The catch was dominated mostly by *P. sarana* and *L. bata.* The mesh bars, 50-60 mm were effective for mrigal and 45-50 mm, for calbasu.

Experimental fishing conducted during the year gave an average catch of 2.811 Kg/day, the maximum catch being in May (10.960 Kg/day) and the minimum in April (0.823 Kg/day).

The total catch in departmental gill-nets was 137.770 Kg of which mrigal formed 19.39% ; calbasu, 4.86% ; and others, 75.75%.

Problem : 3.2 Fisheries of the Konar resorvior
Duration : Three years eight months

3.2.1 Physico-chemical characteristics of water and soil, and primary productivity
Personnel: A. V. Natarajan (upto 8.4.1971) and S. K. Sarkar

Physico-chemical characteristics of water and primary productivity : The pooled averages of various physico-chemical features of the Konar reservoir are presented in table 7. During the year, transparency of water of the Konar reservoir was 14.8 cm. Surface water temperature ranged from 15.7 (January) to 27.9°C (September). Isothermal condition in depths was observed in January and October with a difference of 0.1°C between surface and bottom (30-m depth). The differences in temperature increased in February and March and were 3.5 and 3.2°C respectively. Summer thermal stratification was observed in April, May and June with temperature difference of 7.3, 11.7 and 7.8°C respectively. pH, DO and free CO_2 did not show much difference in depths. Total alkalinity for the Konar reservoir (mean value: 39.7 ppm at surface and 33.2 ppm at 30-m depth) shows that it may be classified as a soft reservoir with low to medium production potential. In the riverine stretch of the reservoir, total alkalinity values were higher than that in the rest of the reservoir.

Mean gross primary productivity for the Konar reservoir during the year was 421.5 mg C/m^3/day (12 hr) and monthwise evaluations ranged from 281.3-825 mg C/m^3/day (12 hr).

3.2.2 Food resources—A. Plankton, B. Bottom biota and C. Larger aquatic plants and associated fauna and flora
Personnel: A. V. Natarajan (upto 8.4.1971) and B. V. Govind (upto 30.6.1971)

A. Plankton : The plankton of the Konar reservoir showed the dominance of phytoplankton over zooplankton in the ratio of (1.4 : 1). The phytoplankton mainly consisted of *Microcystis aeruginosa* (58.28%), while other groups were relatively meagre. Among zooplankters, copepods were in dominance, being represented by *Diaptomus* sp., *Cyclops* spp. and their larvae. They formed 37.7% of the total standing crop of plankton. Rotifers and protozoans were represented by *Keratella* sp. and *Difflugia* sp. respectively. In post-monsoon months, the zooplankton showed an increase from 13.06 to 37. 70%, and phytoplankton decreased from 86.10 to 58.28%.

Table 7. Pooled average of various hydrological observations in the Konar reservoir

Depth (m)	Transparency (cm)	pH	DO (ppm)	Free CO_2 (ppm)	Total alkalinity (ppm)	PO_4 (ppm)	NO_3 (ppm)	Silica (ppm)	Iron (ppm)	Dissolved organic matter	Total hardness (ppm)	Specific Conductivity ($\times 10^{-6}$ mhos)
0	14.8	7.3	8.95	6.45	39.7	0.016	0.291	1.62	0.026	2.05	13.30	97.82*
3	—	7.3	8.25	6.50	35.8							
6	—	7.3	8.70	8.30	35.7	0.016	0.297	1.63	0.024	1.71	14.12	84.79*
9	—	7.1	8.15	8.10	32.8							
12	—	7.2	8.45	6.00	36.2	0.017	0.306	1.58	0.030	1.55	13.29	83.49*
15	—	7.0	7.40	7.55	31.6							
18	—	7.2	8.26	7.20	34.0	0.019	0.273	1.57	0.028	1.59	13.49	81.46*
21	—	7.1	7.65	7.60	33.3							
24	—	7.2	8.40	5.55	35.1	0.016	0.290	1.65	0.021	1.66	14.43	81.71*
27	—	7.2	7.16	7.10	33.5							
30	—	7.1	8.00	6.25	33.2	0.020	0.325	1.87	0.019	2.31	10.02	82.78*

* Average value of the 2nd half of the year only

The vertical distribution of plankton in the Konar reservoir for the year 1971 is presented in table 8.

Table 8.

Depth (m)	Unit/m^3	Average volume (ml/m^3)
0	13,870	0.400
3	1,31,008	1.382
6	99,615	0.818
9	30,396	0.518
12	29,416	0.455
15	25,745	0.451
18	22,987	0.576
21	25,443	0.338
24	16,618	0.218
27	16,070	0.634

The average density of plankton in the Konar reservoir during the year was 41,117 u/0.579 ml/m^3.

B. Bottom biota : The studies on the bottom macrofauna made at 2 m depth intervals upto a depth of 30-m revealed a dominance of insects represented by *Tendipes* sp. The average number and weight (mg) of bottom macrofauna/sq m are presented in table 9.

Table 9.

Depth (m)	Units/m^2	Average weight (mg/m^2)
2	143	373
4	258	1,033
6	214	571
8	100	272
10	43	186
12	72	258
14	nil	nil
16	nil	nil
18	43	115
20	72	215
22	28	120
24	57	171
26	28	115
28	172	773
30	186	158

On an average the bottom macrofauna in the Konar reservior was 109 u/376 mg/m².

3.2.3 Effect of impoundment on reproduction and survival of fishes

Personnel: A. V. Natarajan (upto 8.4.1971), S. P. Ayyar (upto 28.5.1971), M. Ramakrishnaiah and M. A. Khan

The trash fish populations, as revealed by the analyses of *Khadijal* (close meshed drag-net) collections, were dominated by *Ambassis nama* followed by *E. danrica* and *O. bacaila*. Other species encountered were *O. cotio, A. mola, P. stigma, D. rerio, R. corsula* and juveniles of *G. giuris*. In general, the trash fishes were more abundant during post-monsoon months. Juveniles of the Gangetic major carps were totally absent in the collections.

3.2.4 Biology of commercially important fishes

Personnel: A. V. Natarajan (upto 8.4.1971 and S. P. Ayyar (upto 28.5. 1971)

The catch was estimated as 2.989 t of which catla formed 60.60%; mrigal, 16.32% ; rohu, 5.40% ; calbasu, 9.04% ; and other fishes, 8.64%. The annual production from the Konar reservoir was computed as 1,628 Kg/hr.

Catla occurred in the catch in the size range 200-975 mm (modal values 325/675 mm) ; mrigal, 240-660 mm (m.v. 480 mm) ; rohu, 240-640 mm (m.v. 380/520 mm) ; and calbasu, 195-480 mm (m.v. 360 mm). The mean size of major carps in the caches was 558 mm/2,750 gm for catla ; 446 mm/820 gm for mrigal ; 410 mm/700 gm for rohu ; and 362 mm/530 gm for calbasu.

The mean coefficients of condition for *C. catla, C. mrigala, L. calbasu* and *L. rohita* were 0.949, 0.962, 1.011 and 0.981 respectively.

Major carps (*C. Catla, C. mrigala, L. rohita* and *L. calbasu*) started maturing from March and during June, all were found to be fully mature. In July, most of the specimens encountered in the reservoir were spent and beyond July, no mature specimens was found. Fecundity studies showed that total number of mature eggs in *C. Mrigala* (437-508 mm) ranged from 1,29,336 to 2,22,066 ; in *L. calbasu* (394 mm), 1,40,919 ; and in *C. catla* (663 mm), 6,91,260 ova.

3.2.5 Experimental fishing

Personnel: A. V. Natarajan (upto 8.4.1971), B. V. Govind (upto 30.6.1971), S. L. Kar and B. K. Banerjee

Meshwise catch (gm/m² net area) for experimental gill-net fishing is given in table 10, which shows that 100-150 mm mesh bar is effective for catla ; 40-50 mm mesh bar for mrigal and calbasu ; and 35 mm mesh bar for miscellaneous species ; *viz., P. sarana, L. bata, N. notopterus, C. carpio, O. bimaculatus* and *L. dyocheilus*. The over-all fish density at various zones (table 11) for the reservoir indicated that riverward zone of the reservoir is the

Table 10. Meshwise average catch (gm/10 sq m net area/day) in the Konar reservoir (experimental gill-net fishing)

Gill-net mesh bar (mm)	Catch unit of effort (gm 10 sq m net area)	Species composition (%) in catch/unit of effort				
		Catla	Rohu	Mrigal	Calbasu	Others
30	100.0	—	—	9.00	8.90	82.10
35	166.8	3.66	0.54	32.13	—	63.67
40	129.1	5.96	0.54	59.88	11.46	22.16
45	93.0	—	1.18	70.86	12.36	15.60
50	77.4	12.79	1.42	69.64	2.97	13.18
55	33.3	—	—	67.27	24.62	8.11
60	99.1	52.17	1.51	24.02	1.01	21.29
65	121.2	62.79	—	7.01	—	30.20
100	342.8	100.00	—	—	—	—
150	18.2	100.00	—	—	—	—

N.B. Others include *P. sarana, L. bata, N. notopterus, C. carpio, O. bimaculatus, L. dyocheilus.*

most productive (16.454 Kg/day) followed by the minimum of 1.361 Kg/day in deep zone in April. The total fish catch by departmental gill-net was 528.725 Kg for the period January-May, 1971, of which catla formed 36.46%; mrigal, 30.07%; rohu, 1.00%; calbasu, 5.80%; and others, 2.67%.

Problem : 3.3 Fisheries of the Loni reservoir
Duration : Five years
Personnel: H. P. C. Shetty (upto 9.12.1971), A. G. Jhingram (upto 1.5.1971), D. V. Pahwa, S. N Mehrotra, K. P. Srivastava, S. Jena, M. R. Sinha, A. G. Godbole (upto 18.5. 1971), S. D. Gupta, B. Singh, R. K. Sexena, V. R. Desai, R. Chandra, S. C. Pathak and P. M. Pathew

Hydrology : Water temperature fluctuated between 16.29 (January) and 29.93°C (September). The transparency of water ranged as 14.25 (July)—107.30 cm (January). pH varied from 7.67 to 8.20. From January to May, pH remained above 8.0 except in February when there was slight decline. From June to November, pH was found to range between 7.67 and 7.95. Alkalinity was because of carbonate and bicarbonate ions except during monsoon months when only bicarbonate ions were noticed. Carbonate conteent varied between 3.70—8.92 ppm whereas bicarbonate ions ranged between 71.47—121.72 ppm. Free CO_2 was present only during June to November, fluctuating between 1.12 and 5.69 ppm. Antagonistic calcium ions varied from 14.37 (June) to 31.36 ppm (November). Magnesium ions were found to range between 2.44 (June) and 6.86 ppm (April). Of the inorganic nutrients,

both nitrate-N and phosphate-P were moderately rich in the Loni reservoir. Nitrate-N ranged between 0.075 and 0.247 ppm whereas phosphate-P varied from 0.058 to 0.157 ppm. Silicates were more (11.17-20.17 ppm) during June-September, whereas in other months, the silicate contents varied from 0.91 to 6.01 ppm. The dissolved oxygen ranged between 5.22 (July) and 9.31 ppm (January). The organic matter ranged between 2.79 and 4.66 ppm.

Table 11. Zonewise monthly catch (Kg) per fishing day (experimental gill-net fishing) in the Konar reservoir

Month	Total catch			Total fishing days			Catch/day		
	Deep zone	Mid zone	Riverward zone	Deep zone	Mid zone	Riverward zone	Deep zone	Mid zone	Riverward zone
Jan	29·600	34·400	58·925	6	7	4	4·933	4·914	14·731
Feb	25·200	43·025	37·825	4	7	4	6·300	6·146	9·456
Mar	25·525	7·250	53·625	4	4	4	6·381	1·812	13·406
Apr	12·250	22·200	98·725	9	3	6	1·361	7·400	16·454
May	21·250	4·825	54·100	6	1	5	3·541	4·825	10·820

Primary productivity : The average monthly gross productivity varied from 38.23 to 98.37 mg C/m³/hr. The data (for January to November) revealed two peaks, one in April (84.3 mg C/m³/hr) and the other in September (98.37 mg C/m³/hr). Net production fluctuated between 21.66 (January) and 86.71 mg C/m³/hr (September). Net production also indicated two peaks, one in April (53 mg C/m³/hr) and the other in September (86.71 mg C/m³/hr).

Respiration rate was more predominant in January (51.14). The minimum respiration was noticed in July (12.18) and during rest of the months, the values ranged between 13.12 and 45.93.

Soil : Analysis of soil samples for the period from January, 1970 to November, 1971 revealed the following characteristics : pH, 6.2-7.2 ; organic carbon, 0.57-1.17% ; free calcium carbonate, 1.75-4.00%.

Plankton : The average monthly surface plankton was higher in February (71 u/l) than in January (37 u/l) due to the increase in both phyto- and zoo-plankton. *Fragillaria* spp. and *Navicula* spp. were mainly responsible for the increase in phytoplankton quantity. Rotifers, comprising *Brachionus* spp., *Karetella* spp., *Filinia* spp. and *Polyarthra* spp., increased the zooplankton. Zone I was richer in plankton quantity in both the months (77 & 87 u/l respectively), the minimum being observed in zone IV (20 u/l) in January and in zone II (40 u/l) in February, 1971.

During March-December, 1971, vartical hauls of plankton samples were made. The quantitative fluctuations of plankton during different months are presented in table 12.

Table 12. Quantitative fluctuations of plankton (u/l) during different months in the Loni reservoir

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec*
Bacillariophyceae	8	111	5	20	20	364	49	85	30	150
Chlorophyceae	5	51	13	10	6	16	–	9	7	4
Myxophyceae	1	21	1	4	1	14	–	2	5	2
Dinophyceae	2	17	4	2	–	–	–	3	9	5
Englininae	–	–	–	–	2	2	5	8	2	2
Total phytoplankton	16	200	23	26	29	396	54	107	51	163
Rotifera	43	40	73	32	3	3	6	4	15	22
Nauplii	13	64	29	19	–	–	–	2	8	11
Copepoda	4	14	19	32	9	3	17	2	2	3
Cladocera	2	5	9	48	1	2	6	1	2	3
Protozoa	–	–	–	–	–	1	–	1	–	–
Total zooplankton	62	123	130	131	13	9	29	10	27	39
TOTAL PLANKTON	78	323	153	157	42	405	83	117	78	202

*Data for one fortnight only

Bottom biota : The macro-benthic fauna mainly comprised molluscs, annelids and insect larvae, being recorded at all depths of operation in varying numbers. Amongst molluscs, gastropod and pelecypod shells were encountered. Gastropod shells were the maximum at 2-3 m depth (193 u/m^2) and the minimum at 5-6 m depth (23 u/m^2). Five species of gastropods ; *viz., Viviparus bengalensis, Melanoides tuberculatus, Lymnea* sp., *Gyroulus* sp. and *Indoplanorbis exustus* were identified in the collections. The maximum (204 u/m^2) and minimum (3 u/m^2) pelecypod shells were recorded at depths ranging between 2-3 and 5-6 m respectively. *Pisidium clarkamum, Indonaia caerulea* and *Paneysia favidem* were the main species identified. Annelids were represented by Hirudinea and Oligochaeta. Only one genus of Hirudinea (*Hirudine* sp.) was recorded occasionally from the shallow areas of the reservoir. Oligochaetes were represented by *Aulodrilus pluriseta* and *Branchiura sowerbyi*. Their numbers varied from 92 to 1,140 u/m^2 at depths ranging between 0-2 and 5-6 m.

The depthwise distribution of various macro-benthic groups is given in the table 13.

Insect larvae : Insect larvae sampled consisted of Diptera, Trichoptera, Odonata and Plecoptera. Diptera larvae was the maximum (188 u/m^2) at depths ranging between 3-4 m and the minimum (78 u/m^2) at depth ranging between 5-6 m.

Macrovegetation : Macrovegetation encountered was identified upto species. It is noted that *Hydrilla verticillata* (Linn.) Royle and *Vallisneria spiralis* Linn. are found generally near the bank and in shallow waters during

Table 13. Average numbers of organims per m^2 from January to June, 1971

Organisms	Depth (m)				
	0-2	2-3	3-4	4-5	5-6
Pelecypoda	173	193	72	49	23
Gastropoda	121	204	99	28	3
Oligochaeta	81	441	210	342	553
Hirudinea	13	—	*	—	13
Diptera	139	180	188	101	78
Trichoptera	9	15	7	—	6
Odonata	1	3	2	3	—
Plecoptera	1	—	—	—	—

*less than 1 u/m^2

all seasons. In deep waters, *Najas minor* Linn., *Potamogeton pectinatus* Linn. and *Potamogeton crispus* Linn. were observed in rotted condition in the mud. No floating species was seen during the year.

Experimental fishing : Since the catches from the gill-nets operated till the end of 1970, were not satisfactory, new nets made of thinner twine and different mountings were used, resulting in considerable improvement of fish catches. 4 sets of new nets consisting of 3 pieces of different mesh sizes with the following particulars were put into operation along with six old multi-meshed nets (40, 60, 75 and 95 mm mesh sizes).

(i) Gill nets (50, 60 and 135 mm mesh size) having head rope, breast line and floats.

(ii) Gill nets (45, 50 and 60 mm mesh size) having head rope, foot rope and breast line with floats.

(iii) Gill nets (50, 60 and 65 mm mesh size) having head rope, foot rope, breast line with floats and sinkers.

(iv) Gill nets (50, 60 and 105 mm mesh size) having head rope, foot rope, breast line and frame lines (1.10, 1.13 and 1.18 m^2 frames) with floats and sinkers.

During January to November, 1971, 70 days of fishing yielded a remarkably high catch of 1,105.02 Kg from all the nets, being highest as compared to previous years when by 53 days fishing, a total of 333.68 Kg ; by 45 days fishing, 204.35 Kg ; and by 55 days fishing, 337.51 Kg were recorded during the years 1968, 1969 and 1970 respectively.

A total of 362.10 Kg was recorded from nets having both, floats and sinkers and 742.92 Kg from nets having floats only (Table 14). Zone III proved to be the most productive as 391.80 Kg of fish was recorded being closely followed by 309.39 Kg of Zone I. Zones II and IV recorded 256.10 and 147.73 Kg respectively. Monthwise distribution revealed the maximum catch of 212.47 Kg in June and the minimum of 8.47 Kg in October when fishing was done only for one

Table 14. Zonewise catch (Kg) from gill-nets with two types of nets used in the Loni reservoir

Months	Zone I		Zone II		Zone III		Zone IV		Total		Grand Total
	a	b	a	b	a	b	a	b	a	b	
Jan	8·240	11·094	11·385	11·150	8·029	29·746	—	10·807	27·654	62·797	90·451
Feb	28·100	3·265	11·520	4·050	0·565	38·165	—	18·740	40·185	64·220	104·405
Mar	13·190	19·770	3·670	28 020	10·750	49·400	8·380	9·120	35·990	106·310	142·300
Apr	1·720	15·510	7·010	13·630	18·730	31·510	—	11·900	27·460	72·550	100·010
May	8·220	12·300	6·010	29·260	20·140	42·340	—	2·670	34·370	86·570	120·940
Jun	—	82·325	28·357	33 950	29·465	16·220	7·850	14·300	65·672	146·795	212·467
Jul	—	18·505	10·715	3·540	22·110	—	4·420	15·442	37·245	37·487	74·732
Aug	24·580	—	2·540	13·490	4·770	6·070	—	12·860	31·890	32 420	64·310
Sep	—	23·630	12·650	0·580	9·790	3·460	—	14·670	22·440	42·340	64·780
Oct	—	—	—	2·440	5·330	—	—	0·700	5·330	3·140	8·470
Nov	4·470	34·470	10·640	11·500	8·180	37·030	10·580	5·290	33·870	88·290	122·160
Total	88·520	220·869	104·497	151·610	137·859	253·941	31·230	116·499	362·106	742·919	1,105·025

a=with floats and sinkers b=with floats only

day during the month (Table 15). Night catches were invariably better as a total of 890.55 Kg was recorded during 18.00-06.00 hour of operation as against 214.47 Kg recorded during 06.00-18.00 hour of operation of nets.

Table 15. Catch (Kg) in different zones combined with two types of gill-nets and catch from Hook and line

Months	Gill-nets					Hook and line
	Zone I	Zone II	Zone III	Zone IV	Total	
Jan	19·334	22·535	37·775	10·807	90·451	13·505
Feb	31·365	15·570	38·730	18·740	104·405	17·260
Mar	32·960	31·690	60·150	17·500	142·300	13·700
Apr	17·230	20·640	50·240	11·900	100·010	15·580
May	20·520	35·270	62·480	2·670	120·940	0·130
Jun	82·325	62·307	45·655	22·150	212·467	1·260
Jul	18·505	14·255	22·110	19·862	74·732	3·230
Aug	24·580	16·030	10·810	12·860	64·310	2·040
Sep	23·630	13·230	13·250	14·670	64·780	1·100
Oct	—	2·440	5·330	0·700	8·470	—
Nov	38·940	22·140	45·210	15·870	122·160	6·450
Total	309·389	256·107	391·800	147·729	1,105·025	74·255

From the analysis of available catch data, it was observed that efficiency of new nets was almost three times of the old nets (Table 16).

Table 16. Average catch/day and average catch/net for the years 1968-1971

Year	Fishing days in the year (No.)	Nets operated (No.)	Total catch (Kg)	Average catch (Kg)	
				Per day	Per net
1968	53	12	333·88	6·30	27·80
1969	45	12	204·35	4·50	17·00
1970	55	12	337·51	6·10	28·10
1971	70 (New nets)	112	930·83	13·30	77·57
1971	70 (old nets)	6	174·20	2·48	29·03
1971	70 (continued)	18	1,105·02	15·79	61·39

During the year, the species, in order of abundance by weight, caught by gill-nets, were : *M. seenghala,* 299.820 Kg, 27.13% ; *C. mrigala,* 221.073 Kg, 20.01% ; *L. calbasu,* 158.942 Kg, 14.38% ; *L. rohita,* 141.868 Kg., 12.84%, *L. bata,* 77.053 Kg, 6.97% ; *W. attu,* 55.750 Kg, 5.04%; *P. sarana,* 54.831 Kg, 4.95% ; *L. gonius,* 34.380 Kg, 3.11% ; *C. catla* 15.260 Kg, 1.38% ; *N. notopterus,* 14.777 Kg, 1.34% ; *L. fimbriatus,* 8.140 Kg, 0.75% ; *E. vacha,* 7.790 Kg, 0.70% ; *C. marulius,* 5.805 Kg, 0.53% ; *L. pangusia,* 3.890 Kg, 0.35% ; *T. tor,* 2.750 Kg, 0.25% ; *Barilius* spp., 2.170 Kg, 0.19% ; *O. bimaculatus,* 0.400 Kg, 0.04% and *L. ariza,* 0.320 Kg, 0.03%, the total catch being 1,105.019 Kg.

Hook and line and cast-net were also operated along with gill-nets. A marked increase in the catch from hook and line was noticed this year as 74.26 Kg was recorded during 1971 against 3.71, 2.00 and 0.53 Kg recorded during 1968, 1969 and 1970 respectively. Wheat flour when used as bait was successful for catching *P. sarana* and *O. bimaculatus.* Hooks baited with live fish caught *C. marulius, W. attu, M. armatus, M. seenghala* and *N. notopterus.*

Tagging of major carps : A total of 500 fingerlings obtained from the Fisheries Department of Madhya Pradesh were tagged and released in the Loni reservoir.

Biology of commercially important species—(a) C. mrigala : 202 specimens (123-689 mm) were examined for gut analysis. The fish was found to feed mainly on decayed organic matter which constituted as high as 77.4% of food. Other items of food, recorded during the year were semi-decayed matter (9.5%), diatoms (5.8%), green algae (1.6%), blue-green algae (3.9%), rotifers (5.6%), other zoiplankters (0.3%) and miscellaneous items comprising insect parts, plant roots, eggs, etc. (0.9%). For maturity studies, 119 ovaries of *C. mrigala* were examined. Examination of scales from 64 specimens ranging between 271 and 683 mm revealed that I age group lies between 271 and 377 mm, II age group between 395 and 448 mm, III age group between 445 and 504 mm, IV age group between 546 and 632 mm and V age group between 649 and 683 mm.

(b) *L. calbasu* : 254 specimens (279-465 mm) were examined for biological studies. The fish was found to subsist mainly on decayed organic matter containing 72.1% of the total food. The phytoplankton constituted 13.1%, mud and debris 7.4% and vegetable debris 7.1%. Mature eggs from 10 ovaries of fish (292-431 mm) were counted and their fecundity was found to range as 50,896-4,66,440 eggs, showing the relative fecundity between 63 and 370 eggs/gm of body weight.

(c) *L. bata* : 188 specimens (65-480 mm) were used for biological investigations. The food of the fish (above 100 mm) consisted of detritus (73.8%), phytoplankton (12.2%), and mud and debris (13.0%). Specimens (below 100

mm) were found to have consumed mainly phytoplankton (65.5%). The ova diameters of 160 specimens were taken. The modal value of I stage ranged from 0.0482-0.1164 mm, II stage from 0.1358-0.2522 mm, III stage at 0.2716 mm, IV stage from 0.5820-0.7760 mm, V stage from 0.9312-1.0670 mm and VI stage from 1.1640-1.2610 mm. 15 ovaries of fish (354-374 mm) revealed that their fecundity ranged between 38,262 and 2,23,440 eggs and thus the relative fecundity was found to range between 83 and 446 eggs/gm of body weight.

(d) *P. sarana* : The length-weight relationship of the fish, calculated according to general allometric equation, was found to be :

$$W = 9.2215 \times 10^{-6} L^{3.071504}$$

The studies revealed the fish to be an omnivore and bottom feeder, feeding mainly on macrovegetation and molluscs, with no seasonal variation in its diet. However, two distinct size-groups (below and above 200 mm) could be delineated in relation to its food habits. The main difference in the diet of these two groups was in amount of intake of molluscs (1.6% by smaller groups against 30.2% by bigger groups), the lack of which was compensated in the smaller ones by excess intake of macrovegetation (73.9% by smaller groups against 51.5% by bigger group). The total length : intestinal length relationship was found to be at an average 1 : 1.59.

The measurements of ova diameter revealed seven arbitrary stages of maturity, having modes of the most mature group of ova at 0.171, 0.243, 0.423, 0.603, 0.783 and 0.891 mm respectively. The seventh stage was the spent stage having ova of all size ranges.

Occurrence of mature fish during May to August with the peak in June (58.0%) and the appearance of spent fish in July with dominance in August and September (81.8 and 100% respectively), indicated the breeding period from June to August.

In case of females, the gonadosomatic index showed a peak value of 0.09654 in June and the minimum of 0.00384 in September.

Fecundity count of 24 ovaries of fish (241-326 mm/220-500 gm) were taken during the year and the values ranged between 39,213 and 1,99,022 ova.

The scales and otoliths are not found useful for age determination. The operculum has shown some promise and work is in progress to determine the age with the help of marks present on the same.

(e) *Catla catla* : 13 specimens (336-935 mm) collected in 1970 and 1971 were studied in detail. Feeding intensity of the fish was found to be very poor as the 'condition' of most of the guts was "$\frac{1}{4}$ full". The analysis of gut contents revealed that the fish subsisted on crustaceans (copepods, cladocerans and ostracods)—20.0% ; digested macrovegetation—1.0%, algae (*Cosmarium* sp.)—0.5% ; unidentified digested matter—8.0% ; mud—60.5% and sand particles —10.0%. The ovary of one specimen (935 mm) was found to be in III stage of maturity in August whereas others were immature.

(f) *M. seenghala* : 101 specimens (405-1,587 mm) were examined from May to November for collecting biological data. The feeding intensity of fish as seen from average volume of feed, increased from May (3.7 cc) to June (7.1 cc) but declined in July (5.8 cc) and August (4.3 cc). In September, the feeding intensity showed slight improvement (4.8 cc) ; but it again declined in October-November (2.3 cc). The fish subsisted mainly on teleosts (89.5%) followed by prawn (4.3%) fish scales (3.4%) and insects (1.2%). Among teleosts, the species ; *G. chapra, Puntius* spp., *Ambassis* spp., *C. reba* and *L. rohita* were the major items of diet. Fish was mostly in maturing condition (stage III & IV) in May-June, while during July to November the ovaries were in II-III stage of maturity.

(g) *Wallago attu* : 19 specimens (386-909 mm) were examined from May to November. Fish was found to feed exclusively on fish matter. The overies were in resting stage from May to November and no mature fish could be collected.

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

Hydrology : The surface water temperature ranged between 19.1 (January) and 29.2°C (April) and transparency of reservoir water, between 59.2 (June) and 102.7 cm (February). pH fluctuated between 8.00 and 8.15 from January to September. The total alkalinity showed upward trend from January (35.41 ppm) to May (56.50 ppm) and thereafter downward trend upto September (27.38 ppm). Hardness of water increased from January (21.875 ppm) to May (28.875 ppm) and thereafter decreased regularly upto September (14.980 ppm). Dissolved oxygen decreased from January (11.285 ppm) to June (6.610 ppm) and fluctuated irregularly from July to September (5.655-7.480 ppm). Free CO_2 fluctuated between 1.612 (March) and 3.650 ppm (May). Phosphates, nitrates and silicates did not show any regular trend and fluctuated from traces (January and February) to 0.0325 ppm (July), from traces (January, February and September) to 0.03325 ppm (June), and from 1.950 ppm (September) to 4.925 ppm (June) respectively.

Soil analysis : Calcium carbonate ranged from 1.792 (January, February, September and December) to 3.625% (June) and the organic matter from 1.330 (October) to 2.252% (June).

Primary productivity : Gross organic production varied from 221.25 (June) to 943.125 mg C/m^3/6 hr (January) and net organic production varied from 178.13 (June) to 603.75 mg C/m^3/6 hr (January).

Plankton : The total surface plankton content (by number) was the maximum in winter months—January and February (1,897.5—1,845.8 u/l) and the minimum during summer and monsoon months—April to September (313.0—480.0 u/l). The total plankton count in samples from vertical hauls ranged between 93.2 (June) to 681.3 u/l (March). The plankton contents of surface water and samples from vertical hauls were high in zone I (28.4 and 37.5%) and zone II (28.3 and 26.5%) and low in zone III (23.1 and 18.8%) and zone IV (20.2 and 17.2%). The plankton count of surface water was rich at 06.00 and 18.00 hours (28.3 and 28.9%) and poor at 12.00 and 24.00 hours (21.1 and 21.7%).

In surface plankton, the phytoplankton (83.0%) dominated over zooplankton (17.0%). The phytoplankton varied from 250.0 (July) to 1,806.5 u/l (January) and 1,745.0 u/l (February) and the zooplankton from 25.1 (April) to 172.7 u/l (May). The phytoplankton comprised dinoflagellates (40.3%), diatoms (15.1%), blue-green algae (14.0%) and green algae (13.6%). *Ceratium* sp. and *Peridinium* sp. among dinoflagellates, *Melosira* sp. among diatoms, *Microcystis* sp. among blue-green algae, and *Pediastrum* sp. and *Ophiocytium* sp. among green algae were dominant forms. The zooplankton was made up of crustaceans (9.5%), rotifers (3.9%) and protozoans (3.6%). Nauplii, *Cyclops* sp. and *Ceriodaphnia* sp. among crustaceans ; *Brachionus* sp. and *Keratella* sp. among rotifers ; and *Difflugia* sp. among protozoans were dominant forms.

In vertical hauls, the phytoplankton (73.2%) showed dominance over zooplankton (26.8%). The phytoplankton varied from 57.9 (June) to 84.5 u/l (March) and zooplankton from 15.5 (January) to 42.1 u/l (June). The phytoplankton consisted of dinoflagellates 20.3%, diatoms 22.8%, blue-green algae 18.5% and green algae 11.6%. The zooplankton was made up of crustaceans 18.5%, rotifers 5.6% and protozoans 3.1%.

Bottom biota : The number of the bottom organisms ranged from 327 (January)—1,019 u/m^2 (March). The dominance of the bottom organisms was 36.7% in zones II, 35.0% in zone IV, 25.9% in zone III and 2.4% in zone I. The percentage composition by number of bottom biota was, chironomid larvae 82.1%, nematodes 9.1%, and insect larvae and pupae 8.8%.

Experimental fishing : During the period from January to November, 1971, experimental fishing with gill-nets of various mesh sizes, with floats and sinkers and with floats only was conducted in 3 zones of the reservoir on 45 days and a total quantity of 314.3 Kg of fish was landed. The percentage composition (by weight) of the catches was *Labeo rohita,* 46.7% ; *Tor tor,* 22.2% ; *Catla catla,* 14.4% ; *Cirrhina mrigala,* 13.8 % ; *Labeo gonius,* 2.5% ; *W. attu,* 0.2% ; and *P. sarana,* 0.2%.

Biology of commercially important fishes—(a) *Tor tor* : The gut contents comprised digested matter including plant matter 75.0%, sand and mud 17.9%, chironomid larvae 1.4%, algae 1.4%, grass 1.3%, twigs 1.2%, plant seed

1.0%, fish remains 0.5% and insect larvae 0.3%. The gastrosomatic index ranged between 12.85 (August) and 20.43 (September).

(b) *Labeo rohita* : The guts contained sand and mud 21.23%, decayed organic matter 29.46%, diatoms 10.98%, green algae 15.52%, blue-green algae 1.35%, dinoflagellates 20.76% and rotifers 0.7%. Fecundity of 13 ripe specimens (550-750 mm) ranged from 4,50,000-11,25,000 ova.

(c) *Cirrhina mrigala* : The guts contained sand and mud 56.03%, decayed organic matter 29.53%, diatoms 6.23%, green algae 7.92%, blue-green algae 0.25% and dinoflagellates 0.04%. Fecundity of 10 mature specimens (450-725 mm) ranged from 1,74,000-6,24,000 ova.

(d) *Catla catla* : The gut contents were made up of sand and mud 10.0%, decayed organic matter 32.5%, phytoplankton 11.11% and zooplankton 46.39%. The phytoplankton comprised diatoms 2.48%, green algae 4.06%, and dinoflagellates 4.57%, and the zooplankton comprised rotifers 2.84% and crustaceans 43.55%.

Tagging experiments : 543 fingerlings of major carps were tagged and released in the reservoir.

Location of breeding grounds of major carps : A breeding ground of major carps was located near the waste weir of the reservoir during 1971 monsoon season. The earlier observations made in 1967 monsoon season indicated that the major carps breed in the reservoir as soon as the water starts overflowing the waste weir. Although during the 1971 season, the water started overflowing in early June owing to heavy rains, the actual breeding took place on 19.7.1971 and *Labeo rohita* and *Catla catla* were observed to breed in shallow regions near the waste weir. Large numbers of fertilised eggs were collected and reared in the nursery tanks at Govindgarh. The observations made so far have indicated that the water flow maintained by the outgoing water, among other factors, has induced the major carps to breed.

Problem : 3.5 Fisheries of the Kulgarhi reservoir
Duration : Five years
Personnel: G. K. Bhatnagar (upto 10.6.1971), S. J. Karamchandani, D. N. Mishra, J. B. Rao, H. C. Joshi and R. K. Dwivedi

Hydrology : The surface water temperature varied between 15.0 (January)—27.2°C (September) and transparency of reservoir water between 9.4 (June)—40.3 cm (March). pH ranged between 8.0 and 8.2 from January to September. Total alkalinity showed an upward trend from January (74.5 ppm) onwards and then declined from June (52.2 ppm) to September (37.9 ppm). Hardness of water increased from January (45.5 ppm) to May (73.1 ppm) and decreased from June (39.0 ppm) to September (29.8 ppm).

The dissolved oxygen decreased from January (10.45 ppm) to June (6.22 ppm) and thereafter increased upto September (7.35 ppm). Free CO_2 fluctuated between 3.10 (July) and 5.25 ppm (January). Phosphates, nitrates and silicates did not show any regular trend and fluctuated from 0.0090 (August) to 0.0322 ppm (May), traces (January and February) to 0.0405 ppm (June) and 2.525 (September) to 14.100 ppm (January) respectively.

Soil analysis : Analysis of soil samples showed that calcium carbonate ranged from 1.375 (August) to 5.150% (October) and the organic matter from 0.307 (July) to 1.140% (January).

Primary productivity : The total gross organic production varied from 195.0 to 834.4 mg $C/m^3/6$ hr during the year and net organic production varied from 112.5 (March) to 590.6 mg $C/m^3/6$ hr (June).

Plankton : The total plankton content was the maximum in May (53.8 u/l) and the minimum in August (12.4 u/l). Phytoplankton made up 51.3% and zooplankton 48.7% in the total plankton. The former ranged from 6.5 (August) to 24.8 u/l (April) and the latter from 5.9 (August) to 32.7 u/l (May). The total plankton content was high in zones I and II—29.6 and 29.9% and comparatively low in zones III and IV—21.3 and 19.2%.

Bottom biota : The number of the bottom organisms fluctuated from 60 (May) to 457 u/m^2 (January). The dominance of the bottom biota was 54.0% in zone III, 17.8% in zone II, 14.9% in zone I and 13.3% in zone IV. The bottom biota was made up of chironomid larvae (26.3%), nematodes (6.3%), and insect larvae and pupae (67.4%).

Experimental fishing: During the period January to November, 1971, experimental fishing with gill-nets of various mesh sizes, with floats and sinkers and with floats only, was conducted in the reservoir for 44 days, when a total of 476.7 Kg of fish was landed. The percentage composition by weight of various species in the catches was : 82.7 (*Catla catla*), 9.2 (*Labeo rohita*), 3.4 (*Cirrhina mrigala*), 2.1 (*H. molitrix*), 2.0 (hybrids of major carps), 0.5 (*Tor tor*), and 0.1 (*Ompak bimaculatus*).

Biology of commercially important fishes—(a) Catla catla : The presence of sand and mud 22.1%, decayed organic matter 13.9% and grass seeds 2.0% in the guts, has indicated occasional bottom feeding. Most of the food was found in digested condition (54.5%). The fish appeared to have subsisted on zooplankton (4.1%) and phytoplankton (3.4%). The gastrosomatic index ranged from 5.51 (July) to 18.17 (May). The condition factor of females ranged from 0.832 (January) to 1.883 (June) and that of males from 1.178 (October) to 1.676 (June). Fecundity of three ripe specimens (865—885 mm) ranged from 29,00,000 to 32,00,000 ova.

(*b*) *Labeo rohita* : The gut contents comprised sand and mud 54.0%, decayed organic matter 33.1%, phytoplankton 11.6% and zooplankton 1.3%, indicating bottom feeding habit. The gastrosomatic index ranged from 19.0 (January) to 47.0 (August). The condition factor of females ranged from 1.114 (November) to 1.389 (August) and that of males from 1.120 (February) to 1.272 (August).

(*c*) *Cirrhina mrigala* : The presence of large quantities of sand and mud (65.2%) and decayed organic matter (30.3%) in the guts showed bottom feeding habit of the fish. The fish was found to subsist on phytoplankton (4.2%) and zooplankton (0.3%). The gastrosomatic index ranged from 15.4 (October) to 91.6 (March). The condition factor of females ranged from 0.938 (January) to 1.340 (May) and that of males from 0.805 (May) to 1.131 (November).

(*d*) *Hypophthalmichthys molitrix* : The gut contents comprised sand and mud 17.9%, decayed organic matter 7.5%, digested matter 37.8%, phytoplankton 18.0% and zooplankton 18.8%. The fecundity of one ripe female specimen (755 mm) was found to be 7,25,000 ova.

(*e*) *Ompak bimaculatus* : The contents of stomachs were made up of fish matter only. The gastrosomatic index ranged from 15.05 (March) to 18.90 (January).

Biology of uneconomic species—(*a*) *Labeo boggut* : Large quantities of sand and mud (69.16%) in the guts showed the bottom feeding habit of the species. The fish was found to subsist on decayed organic matter (23.18%), phytoplankton (7.60%) and zooplankton (0.06%). Fecundity of seven ripe specimens (135-165 mm) was found to range between 8,500 and 16,000 ova.

(*b*) *Puntius sophore* : 52.5% sand and mud in the guts indicated bottom feeding habits. The fish was found to subsist on decayed organic matter (36.17%) and phytoplankton (11.33%).

(*c*) *Puntius ticto* : The gut contents comprised sand and mud (36.25%), decayed organic matter (37.75%) and phytoplankton (16.00%) indicating bottom feeding habits.

(*d*) *Puntius sarana* : The gut contents comprised sand and mud (36.25%), decayed organic matter (41.25%), plant matter (17.50%) and insects (5.00%) indicating bottom feeding habit of the fish.

(*e*) *Garra mullya* : The gut contents comprised sand and mud (59.0%), decayed organic matter (31.2%), phytoplankton (7.0%), plant matter (0.8%) and fish remains (2.0%), indicating bottom feeding habit.

(*f*) *Puntius phutunio* : The guts contained sand and mud (48.0%), decayed organic matter (42.6%) and phytoplankton (9.4%), indicating bottom feeding habits of the fish.

(*g*) *Puntius amphibius* : The gut contents were made up of sand and mud (58.34%), decayed organic matter (37.33%) and phytoplankton (4.33%).

(*h*) *Rasbora daniconius* : The gut contents comprised sand and mud (14.0%), decayed organic matter (17.0%), digested matter (25.0%) and phytoplankton (44.0%). This fish appears to be a partial bottom feeder.

(*i*) *Oxygaster bacaila* : The gut contents comprised digested animal matter (76.7%), decayed organic matter (3.3%) and zooplankton (20.0%).

(*j*) *Mystus tengra* : The stomach contents were sand and mud (5.0%), insects (5.0%), fish and prawns (17.5%), plant matter (6.0% and digested matter (66.5%).

(*k*) *Mystus vittatus* : The stomach contents comprised sand and mud (30.0%), decayed organic matter (20.0%) and insects (40.0%).

Parasitic infection in catla by Ligula : Out of 58 specimens of catla (437-888 mm) examined during July, 1969 to November, 1971, 12 specimens (495-878 mm) were found to be infected by *Ligula* sp. The condition factor in the infected fish varied from 1.144 to 1.961, whereas in healthy ones, it ranged from 1.755 to 2.018. The condition factor was found to have correlation with number of parasites present rather than their weight or size.

Tagging experiments : 132 fingerlings of major carps were tagged and released in the reservoir in November, 1971.

Problem : 3.6 Fisheries of peninsular tanks : Assessment of biological productive potentialities
Duration : Three years
Personnel: A. David, R. M. Rao (upto 7.6.1971), S. L. Raghavan, M. F. Rahman and S. A. S. Kumar

Primary productivity : Photosynthetically fixed carbon, the index of primary productivity, was in the following ranges during the year.

Tanks in Bangalore district (January-May, 1971)

Hutchammankere	200.0— 225.0 mg C/m³/day
Sakalwara	200.0— 314.0 mg C/m³/day
Karpur	250.0— 833.9 mg C/m³/day
Bellandur	845 4—1,563.0 mg C/m³/day

Ponds

Kadagrahara	250.0— 402.0 mg C/m³/day
Side-Hoskote	350.0— 524.9 mg C/m³/day

Tanks in semi-malnad area (June, 1971 onwards)

Arsikere	200.0— 293 2 mg C/m³/day
Nidige	325.0— 450.0 mg C/m³/day
Milghatta	250.0— 474.9 mg C/m³/day
Hutcharayankere	293.2— 325.5 mg C/m³/day
Madaga	322.4— 574.9 mg C/m³/day

Among the semi-malnad tanks, Madaga showed the highest values.

Biomass production—(*a*) *Epiphytic organism* : These were mainly presented by desmids, Chlorophyceae and rhizopod protozoans.

(*b*) *Settled particulate organic matter* : Extent of settled particulate organic matter assessed by slide submersion experiments indicated carbon production range of 5.0 to 20.8 mg on 30 sq cm slide area (59.53—462.40 mg C/m^2/day) in the Hutchammankere and 3.0 to 14.0 mg on 30 sq cm area (36.08—166.60 mg C/m^2/day) in Kadagrahara pond. The value in the semi-malnad tanks ranged between 3.0 and 8.6 mg on 30 sq cm area (36.08—131.30 mg C/m^2/day) during the period under study.

Plankton : Plankton density ranged from 4 to 1,43,800 u/l in tanks (0.02—510.00 ml/m^3 by volume) and 16 to 1,340 u/l in ponds in Bangalore district (0.08—11.00 ml/m^3 by volume). *Microcystis* sp. bloom was responsible for the high concentration of plankton in some tanks. The plankton encountered in tanks and ponds were : *Microcystis* sp., *Ulothrix* sp., *Navicula* sp., *Cosmarium* sp., *Spirogyra* sp., *Phormidium* sp., *Ceratium* sp., *Synedra* sp., *Closterium* sp., *Melosira* sp., *Desmidium* sp., *Eudorina* sp. etc. among phytoplankters and among zooplankters, *Cyclops* sp., *Diaptomus* sp., *Brachionus* sp., *Keratella* sp., *Ceriodaphnia* sp., *Diaphnosoma* sp. and nauplius larvae. There was a general tendency for the dominance of phytoplankters in tanks and zooplankters in ponds.

Littoral and benthic organisms : The organisms encountered in the littoral and benthic zones in ponds and tanks in Bangalore district and semi-malnad area) were chironomid larvae, gastropods (*Amnicola* sp., *Gyraulus* sp., *Limnaea* sp., *Melanoides* sp., and *Viviparus* sp.), bivalves represented by fresh water mussel, insects (*Nepa* sp., *Corixa* sp., *Plea* sp., *Betles* sp., *Ranatra* sp-, *Notonecta* sp., *Belostoma* sp., mayflies and dragonflies) and prawns (*Macrobrachium idae, M. scabriculum* and *Caridina* spp.). Density of organisms in Bangalore

district ranged from 1 to 1,115 u/m^2 in tanks and from 1 to 211 u/m^2 in ponds and the range in semi-malnad tanks was between 1 and 1.732 u/m^2.

Fish production : From Chembenahalli pond, 55 Kg of common carp were netted out between January and May, 1971. In the same period, Hutchammankere tank yielded 311 Kg of fish excluding weekly removals. The catch comprised common carp (80%), major carps (10%) and catfishes (10%). Major carps ranged from 98 to 442 mm in length.

Physico-chemical conditions of the water and soil : The physico-chemical conditions of water and soil in the tanks and ponds during the period are shown in table 17.

Table 17

Factors	In tanks in Bangalore District (Jan—May, 1971)	In ponds	In semi-malnad tanks (June, 1971 onward)
A. WATER PHASE :			
Physical factors			
Temperature (°C)	24.6—27.2	27.2—29.2	23.9—29.1
Turbidity (ppm)	100—520	100—800	100
Chemical factors			
pH	6.8—8.6	8.1—8.5	7.1—9.6
Dissolved oxygen (ppm)	5.60—2.40	3.78—8.00	3.76—7.68
Alkalinity (ppm)	54.0—378.0	120.0—254.0	16.0—180.0
Hardness (ppm)	24.0—48.0	40.0—48.0	32.0—170.0
Specific conductivity (×10 mhos)	94—828	232—482	115—848
Nutrient factors			
Nitrate (ppm)	0.176—0.324	0.176—0.212	0.131—0.336
Silicate (ppm)	14.00—24.00	15.00—17.00	30.45—56.30
Phosphate (ppm)	Trace	Trace	Trace—0.35
Iron (ppm)	0.42—2.84	0.20—2.00	0.07—0.59
B. SOIL PHASE :			
Chemical factors			
pH	6.5—8.5	7.5—8.0	7.0—8.0
Calcium (ppm)	400—1,200	200—1,200	400—1,200
Magnesium (ppm)	8—25	8—25	8—25
Phosphorous (ppm)	Trace—5	Trace—5	Trace—15
Ammonia (ppm)	3—25	3—25	3—15

Hutchammankere tank, Anekal Chikkere tank and Chembenahalli pond exhibited higher values of turbidity which were mainly due to silt suspension, while in Bellandur tank and Side-Hoskote pond, it was due to *Microcystis* sp. blooms. Because of the very high infestation of the weed *Eichhornia* sp. in Bellandur tank, the dissolved oxygen concentration was low. Higher alkalinity values were noticed in both Bellandur and Side-Hoskote ponds which

were rich in *Microcystis* sp. Anekal Chikkere tank exhibited an acidic water medium with the lowest alkalinity and nutrient values. Direct relationship among turbidity, silicate and iron was noticed.

Tanks in semi-malnad areas showed higher pH, the maximum of 9.6 being observed in Arsikere tank. Arsikere tank exhibited higher values of pH, alkalinity, specific conductivity, nitrates and phosphates than those in the other tanks, while iron was in the low concentration. The tanks in semi-malnad areas were found to have higher concentration of silicate (over 30.00 ppm). Carbonate alkalinity was high in these tanks than the bicarboonate alkalinity. These tanks differ from tanks in Bangalore district in showing high pH, low alkalinity and moderately higher quantity of nutrients.

Problem : 3.7 Fisheries of peninsular tanks : Conservation of fishery in the sewage fed Bellandur tank
(Research completed in 1970)

Problem : 3.8 Fisheries of Peninsular tanks : Introduction and propagation of cultivable species

Duration : Three years

Personnel: A. David, R. M. Rao (upto 7.6.1971), S. L. Raghavan, M. F. Rahman and S. A. S. Kumar

Feeding experiments were conducted in three stages on the efficacy of weed consuming and weed clearance capacities of the indigenous major carp (*Puntius pulchellus*). The results are summarized in the table 18.

Table 18

Experiments	I	II	III		
			a	b	c
Duration (days)	20	23	26	26	20
Experimental pools (No.)	5	5	2	2	2
Fish used in each pool (No.)	20	20	10	10	10
Total length of fish (mm)	90—141	90—141	90—160	90—160	90—160
Total weight of weed given (gm)	1,500	2,000	2,400	1,000	1,000
Weed consumed (%)	44.0	61.0	51.8	37.0	12.0
Ratio of weeds given by weight	1 : 1 : 1	1 : 1 : 1 : 1	1 : 1 : 1 : 1	1 : 1 : 1 : 1 : 1	1 : 1
Combination of weeds (No.)	3	4	4	5	2
Consumption rate (%)					
Vallisneria sp.	54.40	31.14	31.73	21.62	100.0
Hydrilla sp.	39.70	33 61	30.52	29.73	—
Agrastis sp.	5.90	1.64	4.82	0.00	0.00
Potomogeton sp.	—	33.61	32.93	21.62	—
Chara sp.	—	—	—	27.03	—
Average length increase (mm)	1.60	1.02	1.80	1.40	1.00
Average weight increase (gm)	20.00	24.00	18.60	15.00	10.00

The results indicated that consumption of food varied between 12 and 61% under different weed combinations. The maximum weed consumption was in experiments with four combinations. *Vallisneria* sp. was preferred much more to the other weeds. *Hydrilla* sp., *Potomogeton* sp. and *Chara* sp. were of next preference, whereas *Agrastis* sp. was preferred least.

In the Anjanapur reservoir, where even submerged grass was not available during December, 1971, the species had fed extensively on the vegetable debris, submerged rotting barks and pieces of timber, indicating that the species, besides ingesting submerged vegetation, can also take a cellulose diet provided by grass and rotting timber.

225 fingerlings of *Puntius pullchellus* were stocked in Bhadra Fish Farm and they were found to be growing well along with grass carp, feeding upon *Hydrilla* sp., *Vallisneria* sp. etc. The maximum length of 300 mm was recorded by September, 1971.

P. pulchellus caught in Milghatta tank during September, 1971 showed IV stage of maturity.

Individual adult fish in Anjanapur reservoir showed I & V stages of gonadial development. The fish bred from September onwards and one specimen in December, 1971 was observed in V stage of maturity yielding ova on stripping. This indicated that the species breeds interruptedly several times during an extended period after August-September.

New nursery grounds of the species were located in December, 1971 at Shimoga on the Tunga river and at Honnali on the Tungabhadra river where fry and fingerlings ranging between 22 and 102 mm were collected.

During October, 1971, 1,400 fingerlings of *P. pulchellus* (40-90 mm) collected from Madaga tank were transported to Bangalore and 300 and 200 of them were stocked in Vanivilas Sagar and Byramangala Fish Farms respectively for studies on growth, feeding and possible breeding in still waters. 540 numbers were despatched to Cuttack Substation of the Institute for similar studies, while 200 were stocked in Krishnarajasagar reservoir.

Problem: 4.1 Location of new spawn collection centre and assessment of their potentiality
(Studies are being conducted under a Co-ordinated project)

Problem: 4.2 Standardisation of spawn collection techniques
(Studies are being conducted under a Co-ordinated project)

Problem: 4.3 Commercial spawn catch in the lower sector of the Ganga river system
Duration: Four years
Personnel: G. N. Mukherji, R. N. Seth and S. N. Sar

The total production of fish spawn in 1971 from the lower sector of the Ganga river system in Bihar and West Bengal was found to be 32,900 *hundies*

on the basis of railway booking figures collected from selected spawn exporting centres within the stretch from Koelwar on the river Son to Patuli on the river Bhagirathi, and Lalgola on the river Padma, covering in between stations which fall on the river Ganga. This registered a decline by 37.37%, as compared to the production in 1970.

The stationwise export figures of fish spawn from different railway stations are given in table 19. Colgong exporting 3,984 *hundies,* followed by Lalgola 3,525 *hundies* and Sahibgung 3,523 *hundies,* contributed 12.10, 10.71 and 10.70% respectively to the total production.

The 16 common spawn exporting centres which were visited in 1970 and 1971, showed a decline by 15.34%, the production being 30,120 *hundies* of spawn in 1971 as against 35,581 *hundies* in 1970.

TABLE 19

Station	Year		Fluctuations over the year	
	1970	1971	By numbers	By percentage
Koelwar	1,918	1,353	− 565	−29.46
Jamalpur	2,089	1,199	− 890	−42.60
Sultanganj	2,287	2,861	+ 574	+25.10
Bhagalpur	2,447	1,372	−1,075	−43.93
Colgong	3,138	3,984	+ 846	+26.96
Sahibganj	5,505	3,523	−1,982	−35.02
Rajmahal	4,695	2,273	−2,422	−51.59
Nimtita	1,019	236	− 783	−76.84
Sajnipara	870	782	− 88	−10.11
Jangipur	2,029	1,612	− 417	−20.55
Gankar	778	913	+ 135	+17.35
Azimganj	1,433	2,376	+ 943	+65.81
Katwa Jn.	1,627	2,509	+ 882	+54.21
Tenya	1,037	692	− 345	−33.27
Dainhat	1,324	910	− 414	−31.27
Lalgola	3,385	3,525	+ 140	+ 4.14
Total	35,581	30,120	−5,461	−15.34

Problem : 4.4 Comparative growth rate of spawn from different river systems

Duration : Three years

Personnel: H. P. C. Shetty (upto 9.12.1972), B. Singh, P. M. Mathew, G. N. Mukherji and R. N. Seth

At Bhagalpur: By conducting the growth experiments under identical conditions with spawn obtained from the rivers Kosi and Ganga, it was found that the Kosi-spawn was of better quality in relation to growth rate. From

the experiments conducted with spawn obtained during different floods in the river Ganga (Manik Sarkar Ghat, Bhagalpur), it was noted that the spawn from the second spurt showed better growth rate than that of the first. The results are summarised below :

Spawn source	Survival (No.)	Size range (mm)	Average size (mm)
River Kosi (Lalbaheti)	120	14–39.5	27.6
River Kosi (Khursela)	76	19—45	29.0
River Ganga (Bijlighat)	94	12—42	21.2
River Ganga (Bijlighat)	102	11–40	22.7
River Ganga (Manik Sarkarghat)—Spurt I	95	18—44	24.3
River Ganga (Manik Sarkarghat)—Spurt II	110	15—38	26.2

At Allahabad : Studies on the comparative growth rate of major carp spawn obtained from different sources ; *viz.,* (i) induced bred progenies from Allahabad (L. rohita and *C. mrigala*), (ii) the river Gomti at Jaunpur and (iii) the river Yamuna at Allahabad, were made under identical conditions in plastic pools at Allahabad. The spawn from each source was stocked at the rate of 500/pool in replicate.

The first observation on growth was made after 30 days of stocking. Differential survival was noticed in the various pools. Out of 1,000 spawn of each source stocked, the number that survived after 30 days along with their average sizes are presented below:

Spawn source	Survival (No.)	Size range (mm)	Average size (mm)
River Gomti	123	13—63	20.24
River Gomti	238	9—33	17.22
River Yamuna	198	7—41	17.62
River Yamuna	236	8—42	16.60
Induced bred (*C. Mrigala*)	234	9—44	17.05
Induced bred (*C. Mrigala*)	259	7—52	15.31
Induced bred (*L. rohita*)	348	13—25	20.26
Induced bred (*L. rohita*)	236	7—47	18.76

Among riverine spawn, mainly *L. bata* was encountered and hence, further studies were terminated as no comparative study could be made with induced bred spawn.

Project 5 : Brackish water fish farming

Problem : 5.1 Brackish water fish farming in the lower Sunderbans.

5.1.1 Productive potential of polyculture in the lower Sundarbans and behaviour of pond dykes.

Duration : Two years.

Personnel: B. B. Pakrasi, A. Sengupta, N. C. Basu, R. K. Banerjee, P. N. Bhattacharya and M. K. Mukhopadhyaya

The minimum water level of 227.0 cm recorded in the rain fed central reservoir pond 'K', could be maintained under normal conditions. The level was well within the limits required for successful polyculture and indicated that the seepage loss was almost negligible during two consecutive years. The water and soil salinity of the pond 'K' came down further to 1.26‰ and 0.43% respectively during the year. Acidic conditions of the soil gradually changing over to alkaline conditions would offer better prospects of polyculture on commercial scale. Remanuring of the experimental pond with raw cow-dung and NPK helped in increasing P_2O_5 in the soil and PO_4 in the water phase, the primary productivity simultaneously indicating a rise from 104 to 260 mg $C/m^3/hr$ and the plankton volume from 0.1 to 1.3 ml/50 l.

The central pond 'K' has been stocked with 234 carp fry and fingerlings (catla, rohu, mrigal, common carp and grass carp), 594 mullet fry and fingerlings (*M. parsia, M. tade* and *M. cephalus*), 4 milk fish (*Chanos chanos*) and one *Hilsa ilisha*. The *Hilsa ilisha* registered a length of 259.5 mm weighing 330 gm in 8 months. The other fishes caught were one rohu (300 mm), one *Hilsa toli* (320 mm) and one *Chanos chanos* (510 mm/1 Kg). Further sampling in the pond was not possible due to high water level. Dewatering of the pond has been arranged to facilitate the estimation of production.

To study the salinity tolerance of carps, a pond has been stocked with 152 carp fry and fingerlings (catla, rohu & common carp) along with 858 mullet fry and fingerlings (*M. parsia, M. tade* & *M. cephalus*) and 19 prawns (*P. indicus* & *P. monodon*). Another observational pond 'S' had also been stock with 474 fry of silver carp and the observations on the growth of the fish are in progress.

5.1.2 Response of different fertilizers, both inorganic and organic, on fish productivity

Duration : One year

Personnel: R. K. Banerjee, B. B. Pakrasi and N. C. Basu

For manuring brackish water ponds, compost manure with paddy straw and 'Bain' (*Avicennia officinalis*) leaves in the ratio of 1 : 3, has been prepared. Analysis of the compost showed deficiency in available nitrogen (0.0005%) and phosphate (P_2O_5—0.0030%), the total nitrogen being 0.375%. To add extra nutrients to the manure, cow-dung, cow-urine and superphosphate have been added. Trials are in progress.

Problem : 5.2 Detailed survey of islands in the lower Sunderbans for designing brackish water fish farm (1,000 acres)

Personnel: One year nine months

Personnel: A. Sengupta, A. B. Mukherjee and P. N. Bhattacharya

The prismatic compass survey of 'Kakdwip sand' has been completed during the year and the workable area of 559 acres has been demarcated. The detailed contour survey of 200 acres of Henry's Island No. 2 has been completed and the design of the farm is being laid out. The reconnaissance surveys of the Lothian and Patibunia Islands reveal more suitable areas for fish farm construction. Detailed survey has been initiated in the Patibunia forest. 190 acres of suitable land was also located in the Fredrick Island.

Problem : 5.3 Experimental trial of model brackish water fish farm in the lower Sunderbans (wild and selective stocking)

Duration : Two years six months

Personnel: B. B. Pakrasi, N. C. Basu, R. K. Banerjee, A. B. Mukhopadhyaya

In the experimental brackish water ponds, stocked with fish and prawn seeds in 1970 (without restricting their size at the time of entering into the pond), *M. parsia, M. cephalus, M. tade, M. cunnesius* and *Chanos chanos* among fish and *P. indicus* among prawn attained average growth of 133/46.5, 213.5/155, 224/111.5, 142/31 and 329.5 mm/ 222.5 gm, and 133.5 mm respectively. The experiments on selective stocking with mullets and prawns @ 70,000/ha in 1970, have been partly vitiated due to spilling over of high tide water into the pond. However, the average growths of *M. cephalus, M. tade, M. parsia* and *M. cunnesius* among fish and *P. indicus* and *M. monoceros* among prawns have been observed to be 310/312.5, 237/110, 169.5/62.5 and 155.5 mm/42.5 gm, and 176 mm/31 gm and 157.5 mm respectively. The other experiments on wild stocking have been vitiated by the breach of dykes due to excessive tidal impacts.

The brackish water pond soils remained near-neutral to just alkaline and the available nitrogen and phosphate ranged between 3 and 7 mg/100 gm, and 12.0 and 47.5 mg/100 gm respectively. In the water phase, the phosphate ranged between 0.02 and 0.64 ppm and the nitrate-nitrogen remained very low.

Trials with a newly designed sluice box capable of taking only the top layer of tide-water have been initiated.

Analysis of seed prospecting data from Bakkhali creek revealed that the average catch ranged between 9.31 and 147.60 ml/net/hr upto July, 1971. Further collections were suspended due to cyclonic conditions during August to October. *Penaeus indicus* has been found to be one of the commercially important species of prawn to occur in plenty.

Problem : 5.4 Salinity tolerance of major carp fry and fingerlings

Duration : Two years

Personnel: A. N. Ghosh and S. R Ghosh (upto 24.6.1971)

The salinity tolerance of major carp fry and fingerlings was determined by setting up statistically designed vat experiments using various salinity grades—trace, 1, 2, 3, 5, 8, 11 and 15‰. Experiment with early fry (17.6 mm) and advanced fry (26.5 mm) indicated 75% mortality at 11‰; but with further rise to 15‰, total mortality occurred within 2 hr. In another experiment with the salinity grades of 10, 11, 11.5, 12, 12.5, 13 and 13.5‰, 50% mortality of the fry occurred at 10‰ and 75% mortality in rest of the grades upto 12.5‰. The lethal tolerance limit was found to be between 12.5 and 13‰. In case of fingerlings (62 mm) of *L. rohita* and *C. catla*, no mortality occurred upto a salinity level of 8‰ confirming the results obtained in 1970. In shallow ponds (70-80 cm depth) with salinity ranging between 0.39 and 6‰, *C. catla* achieved the maximum growth of 460 mm/1.3 Kg in a period of 11 months while *L. rohita* and *C. mrigala* attained 444 mm/900 gm and 352 mm/400 gm respectively.

Problem : 5.5 Nursery management in brackish water ponds
Duration : Three years
Personnel: A. N. Ghosh, S. R. Ghosh (upto 24.6.1971), N. K. Das (upto 9.7.1971), L. K. Das (upto 25.5.1971) and P. K. Pandit

In mixed culture of *Lates calcarifer, Eleutheronema tetradactylum, Elops saurus, Megalops cyprinoides, Scatophagus argus, Lutianus argentimaculatus* and *Mugil parsia* in a pond (0.13 ha) at a total stocking density of 15,000/ha, with the carnivorous and herbivorous fishes in the ratio of 1 : 10, the sizes reached, without supplementary food, by the end of November, 1971, were found to be 294, 247, 487, 440, 140, 169 and 157 mm respectively.

In a pond (0.13 ha), *Mugil tade* and *Mugil parsia*, at stocking densities of 5,000 and 12,500/ha, attained an average length of 228 and 148 mm respectively by the end of October, 1971, when fed with rice bran and mustard oilcake at weekly intervals.

Lates calcarifer and *Mugil tade* when stocked at the rate of 1,000 and 2,000/ha in a pond (0.14 ha) attained 398 mm/815 gm (range : 198-630 mm/0.50-2.55 Kg) and 475 mm/1.1 Kg (range : 470-482 mm/1.0-1.2 Kg) respectively by the end of November, 1971.

In monoculture at the nursery stage, *Mugil parsia* was stocked in two ponds (0.02 ha) at a density of 20,000 and 40,000/ha, one provided with supplementary food and the other without it. In the latter case, the growth rate was found to be 0.24 mm/day as against 0.13 mm/day in control, while the former experiment was vitiated due to sudden cyclonic weather and continuous rain during the later part of September and in October.

In order to select suitable food for *Penaeus monodon*, vegetable matter, cockle meat, flesh of trash fish and uneconomical varieties of prawns were tried. Though the best growth (21 mm in 24 days) was observed in the set provided with trash fish, the survival was extremely poor (15%). With cockle meat, the growth obtained was 19 mm in the same period, with 48.7% survival.

Dried algae, prawn powder, vegetable peelings, rice brand and mustard oilcake have been tried in different combinations in order to ascertain suitable food for *Mugil tade*. Experiment conducted in 10 l jars with 20 fingerlings of *Mugil tade* in each, indicated that the mixture of vegetable peelings, prawn powder and dried algae was the best diet, the average growth being 4 mm in 20 days with 85% survival.

In monoculture of *Lates calcarifer* (345 mm/450 gm) in a pond (0.2 ha) at a stocking density of 300/ha, the growth rate showed seasonal variations. In post-winter months, the growth rate which was very slow (1 gm/day) increased (5 gm/day) with the onset of summer. The maximum growth rate (9 gm/day) was observed just before the monsoon. It decreased (5 gm/day) again during the monsoon. A check in the growth rate was observed during September—October. In November, the growth rate was estimated to be 4 gm/day. No supplementary food was provided. The ultimate length/ weight achieved was 530 mm/1.55 Kg.

The relation between N : P ratio and plankton production in loamy saline soil was studied in jar-experiments by using organic and inorganic fertilizers. The reaction of the virgin soil has been found to be alkaline and the release of N : P to the water phase was estimated to be 10.2 : 1. Treating with mustard oilcake + superphosphate and urea + superphosphate at $N_{90}P_{40}$ Kg/ha, it was observed that the maximum plankton (694 ml) was produced in low salinity (below 6‰) and N/P was 4.0 in case of the former treatment ; while the latter treatment yielded the maximum plankton (390 ml) with N/P at 3.75. The main constituent of the plankton was phytoplankters (94%) comprising *Amphora* sp., *Amphipleura* sp., *Caloneis* sp., *Closterium* sp. *Cocconies* sp., *Cymbella* sp., *Fragillaria* sp., *Gyrosigma* sp., *Nitzchia* sp., *Navicula* sp., *Pinnularia* sp., and *Synedra* sp., Among Zooplankters, *Brachionus* sp.. *Cypris* sp., *Keratella* sp., *Monostyla* sp. and nauplii were present. In field experiments conducted in 20 ponds with the same fertilizers (@ 90-120-60 Kg. : N-P-K/ha mustard oilcake alone and urea + superphosphate in combination gave good results, the values of primary productivity with the latter two fertilizers being 247 and 165, 143 and 275, and 168 and 190 mg $C/m^3/hr$ after 1, 2 and 4, weeks of treatment respectively as against 97 mg $C/m^3/hr$ after 1 week in the control. The phytoplankters were mainly *Closterium* sp. and *Amphora* sp., while the zooplankters were *Brachionus* sp., *Cyclops* sp. and nauplii.

Problem : 5.6 Brackish water fish farm management techniques
Duration : Three years
Personnel: A. N. Ghosh, S. R. Ghosh (upto 24.6.1971) P. K. Pandit, H. S. Mazumder (upto 31.7.71) and N. N. Sarkar

A survey to locate collection centres for *Lates calcarifer* fry was initiated in March. Intertidal pools which were away from the main canal and had grassy vegetation, were found to harbour tender fry of *Lates calcarifer* (18—36 mm). The maximum quantity of fry was available during July (10/day).

Scooping of intertidal pits appeared to be a better device for collecting mullet fry as compared to collection by shooting net from the estuary. The number of fry in the collection during January to May, 1971 were 8,729 in 31 days by scooping nets as against 544 in 66 days by shooting net. In contrast, shooting net appeared to be a better collection gear for young prawns (9.60 lakh in 66 days), as against scooping net (0.04 lakh in 31 days). *Mugil tade* started appearing in pit collections from the second week of June. Fry of *M. parsia* were available from December to June with peak in December-January.

700 fry of *M. tade* collected during the early part of November were supplied to the Sunderban Survey Unit for stocking the fish farm at Bakkhali. Postlarvae of *P. monodon* were available in large numbers during July (703/day).

Soil loss due to monsoon effect was estimated to range between 5.6 and 9.3 gm/500 cc of run off water from unprotected dykes following continuous rain fall for an hour. In a similar period, the soil loss from dykes provided with drains was estimated to vary between 1.5 and 3.4 gm/500 cc of run off water while from completely protected dykes, where the run off water was allowed to percolate through either bamboo pins or brick edging, the loss was estimated to vary between 0.11 and 0.13 gm/500 cc of run off water.

Provision of supplementary food, particularly young prawn and gobiids, was found to enhance the growth of large *Lates calcarifer* (97 mm/590 gm in 11 months; stocking density 200/ha). In case of young ones (134-208 mm), the growth patterns at stocking densities of 400, 1,000, and 1,100/ha were observed to be 40/35.0, 21/19.3 and 12 mm/7.6 gm respectively in 45 days.

Problem : 5.7 Culture of brackish water fish food organisms
Duration : Three years
Personnel: A. N. Ghosh, S. R. Ghosh (upto 24.6.1971), K. K. Bhanot (Mrs.) and S. K. Saha (upto 8.10.1971)

Laboratory cultures of selected brackish water organisms were done in brackish water pond soil extract and maintained at a temperature of 25°C ± 1 and artificial illumination of 100, 200 and 500 lux.

Problem : 5.8 Induced breeding of grey mullet, *Mugil cephalus*
Duration : Three years
Personnel: R. M. Bhowmick, G. V. Kowtal (upto 22.6.1971) and M. M. Bagchi (upto 6.5.1971)

12 sets of mullet breeders transported to Puri from the Chilka lake and kept in plastic tanks filled with sea water, were administered both homo- and heteroplastic pituitary at an interval of 7-8 hr. Fertilization and hatching took place in all cases, but the thousands of hatchling produced, died within 6 days of rearing.

Project 6 : Freshwater prawn culture

Problem : 6.1 Freshwater prawn culture techniques
Duration : Six years six months
Personnel: K. Raman

Artificial feeding of prawn fry, stocked @ 25,000/ha in nursery ponds, with mustard oilcake, rice bran and prawn powder improved their growth nearly twice as much as in the control ponds. Survival and production of artificially fed prawns averaged about 29% and 147 Kg/ha as compared to 41.3% and 95 Kg/ha in controls. Catla and silver carp stocked @ 2,000/ha along with prawns gave gross production of 812.5 Kg/ha as against 487.5 Kg/ha in control. Prawn larvae reared in saline water and fed with finely pasted plankton moulted to the second stage.

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

Ponds (0.005 ha) at Katheru Fish Farm stocked with prawns in December, 1970 were harvested in September, 1971. Details of total yield and average growth are presented in table 20.

Table 20

	Pond No. 29	Pond No. 31	Pond No. 33	Pond No. 34
Fertiliser treatment/rate (Kg/Quarter for 3 quarters) :				
Cow-dung	12.5	12.5	12.5	—
Lime	0.2	0.2	0.2	—
N : P : K (6 : 8 : 4)	—	—	—	1.25
Stocking rate	15,000	15,000	15,000	15,000
Date of harvesting	1.9.71	1.9.71	1.9.71	1.9.71
Total production in 9 months (gm)	248	345	67	70
Average size of fast growing group (mm/gm) in 9 months	128.8/31.00	102.3/23.00	92.0/12.00	113.5/23.50
Average size of slow growing group (mm/gm) in 9 months	—	51.0/1.25	38.0/0.30	50.0/0.80

Of the 4 ponds, 3 were treated with organic fertilizer and the other with inorganic fertilizer. For better utilization of manure, fertilization was conducted once in each quarter.

Growth rate was good ; but survival rate was poor. It was also noticed that there were distinct groups, one with fast growth and another with slower growth. This division was observed in both sexes and in almost all ponds.

Artificial feeding : An artificial diet consisting of rice bran and broken rice + oilcake + waste from fish or liver meal in the ratio of 8: 88 : 1 was added @ 1 Kg/pond. In laboratory trials, this food was readily taken in by the prawns.

Gut content analysis : 75.5% of gut contents was debris. Among identifiable materials, diatoms constituted 10.98% ; algae, 10.72%; crustacean appendages, eggs etc., 1.72% ; and sand, about 1.1%.

Studies on plankton productivity and primary productivity were continued.

6 ponds at Katheru (0.005 ha each) and 4 ponds at Kadium (0.05 ha each) have been stocked with 5,000 and 20,000 juveniles respectively in early December, 1971.

Berried females brought to the laboratory were released @ 5,000 to 75,000 larvae as per the size of female. The larvae were transferred in different containers @ 2,000 to 3,000 per container. Aeration of water was done by means of aerator. Rock salt used for preparing saline water was not successful. In oxygenated and filtered sea water (salinity 20‰) of Kakinada coast, immediate success in moulting of the larvae to II stage and then to III stage with two days interval was obtained. The survival from I to II stage was 99% and between II and III stage, 60%. Further rearing was unsuccessful.

Larvae were fed on finely powdered white of egg, rice, rice bran and plankton. However, no feeding activity was observed in the larvae. Hatching and rearing were successful at temperatures of 29 to 31°C.

Juvenile prawns : Juveniles measuring upto 20 mm were obtained at Kotipalli. 3-5 minutes hauls yielded 200-250 juvenile (8-10 mm) and 50-70 juveniles (11-20 mm). This appeared to be a new collection centre for juvenile prawns.

Between Dowlaiswaram and Vijjeswaram anicuts, prawn migration was intense for a few days in the month of September and October. Because of constant fluctuations in the water overflowing the anicut due to local rain fall and water supply from rain fed hill channels, and also due to diversion of water by the construction of barrage at one anicut, there was practically no juveniles prawn movement over the anicuts in late September, October and November. Sampling initiated to estimate the abundance indicated that the catch ranged from 0.25 (October to 14.00 Kg (December)/night in sem-commercial net capture.

Tagging and marking trials : Peterson type double disc tags are being tried on prawns in trial attempts. Disc tags have been used on 50 prawns. 25 prawns were marked by Trypan Blue and also by a PVC body tag. The tagged prawns could survive for the maximum period of 30 days only.

Project 7 : Murrel and live fish culture

Problem : 7.1 Induced breeding of murrels
Duration : Three years
Personnel: R. M. Bhowmick, G. V. Kowtal (upto 22.6.1971) and M. M. Bagchi (upto 6.5.1971)
(work suspended due to lack of ponds)

Problem : 7.2 Breeding of *Anabas, Clarias* and *Heteropneustes*
Duration : Three years
Personnel: H. A. Khan (upto 8.4.1971) and S. K. Mukhopadhyay

Carp pituitary glands preserved in absolute alcohol and kept at room temperature for 1 year were found to be potent in inducing spawning of *Anabas testudineous* and *Heteropneustes fossilis.* Success was achieved in induced breeding of *Clarias batrachus* through hypophysation. Hatchlings of *A. testudineus, H. fossilis* and *C. batrachus* were reared in the laboratory. 1-year old induced bred *A. testudineus* was observed to be fully mature. The average size at the first maturity of *A. testudineus* was 85 mm in ♀ and 90 mm in ♂ . Spawning of *H. fossilis* could be extended from June to December exposing the fish to long photoperiods.

Project 8 : Estuarine and brackish water lake fisheries

Problem : 8.1 Brackish water fish seed prospecting
Duration : Four years
Personnel: V. Gopalakrishnan, Apurba Ghosh, K. K. Bhanot, P. R. Das, P. U. Verghese (upto 14.6.1971) and S. N. Dutta (upto 12.7.1971)

Investigations on the brackish water fish seed potential in the Hooghly-Matlah estuarine system were continued during the period under report. The collections were made from the Hooghly estuary at Diamond Harbour, Kulpi and Namkhana and from the Matlah estuary around Port-Canning.

Diamond Harbour (Hooghly estuary) : The most abundant species of fish seed were sciaenids (10-20 mm), *M. gulio* (20-40 mm) and *M. parsia* (20-40 mm). Among prawns, *P. monodon* (12-18 mm) was obtained in great abundance during May, the other important species being *P. styliferus* (20-50 mm) and *M. brevicornis* (15-50 mm).

Kulpi (Hooghly estuary) : In a stretch of about 5-Km in the canal emptying into the main river at Kulpi which is provided with sluice gates, collections were made both from the canal as well as from the portion between the main river and the sluice gates. *P. monodon* (15-18 mm) was obtained there mostly during May and June.

Namkhana (Hooghly estuary) : At Namkhana centre, the maximum abundance of *P. indicus* (424.08/net/hr) and *P. sculptilis* (287.92/net/hr) was observed during June. The catch/net/hr in respect of seed of different species of fishes and prawns is presented in table 21.

Table 21. Fish and prawn seed catch/net/hr (Vol/No.)

Species	Diamond Harbour			Kulpi			Namkhana		
	April	May	June	April	May	June	April	May	June
P. indicus	—	—	0.05/ 0.09	1.40/ 2.89	0.25/ 0.85	0.40/ 6.00	6.88/31.35	8.50/29.50	48.62/424.08
M. brevicornis	0.30/ 0.43	0.89/ 1.29	0.30/ 1.66	1.55/ 4.60	2.40/ 4.00	0.90/ 1.70	0.20/ 0.43	2.64/ 5.17	5.17/17.71
M. rude	—	—	—	0.20/ 0.90	1.90/ 7.55	2.00/11.00	0.06/ 0.44	0.36/ 0.19	—
P. styliferus	0.45/ 1.00	1.12/ 9.96	1.17/ 4.28	1.40/ 5.18	2.75/12.60	2.80/13.60	1.29/ 5.13	2.32/ 7.41	0.73/ 2.90
M. affinis	—	—	—	0.24/ 0.76	0.80/ 4.15	1.30/14.30	—	—	—
P. monodon	0.02/ 1.20	2.35/66.26	0.02/ 0.12	0.10/ 3.91	0.45/10.40	0.20/17.80	0.01/ 1.29	0.40/ 3.70	—
P. sculptilis	0.26/ 0.36	0.39/ 0.73	0.28/ 1.29	0.90/ 3.18	3.60/ 9.95	1.30/ 3.10	2.42/17.85	8.39/44.00	27.60/287.92
M. monoceros	—	—	—	0.79/ 3.88	—	—	—	—	—
M. parsia	0.09/ 0.30	0.84/ 1.21	0.29/ 1.63	0.02/ 0.09	0.15/ 1.90	0.20/ 0.50	0.13/ 0.66	0.76/ 1.06	0.47/ 9.63
M. tade	0.02/ 0.02	0.02/ 0.02	0.01/ 0.02	—	0.76/ 1.40	0.30/ 1.00	—	—	—
Sillago sp.	0.02/ 0.02	0.01/ 0.03	0.02/ 0.03	0.20/ 0.18	0.35/ 2.20	0.60/ 0.70	—	—	—
H. fossilis	—	—	—	0.13/ 0.03	0.85/ 2.05	0.90/ 2.50	—	—	—
M. gulio	—	0.71/ 1.80	0.36/ 2.06	0.20/ 0.06	1.85/ 0.50	1.40/ 1.00	—	2.01/ 0.06	—
H. nehereus	0.56/ 1.25	0.35/ 0.21	0.32/ 0.20	0.35/ 2.53	1.55/ 1.85	—	—	—	—
Sciaenids	0.37/ 0.34	0.51/ 7.48	0.14/ 0.11	0.43/ 0.83	0.55/ 6.05	0.40/ 2.40	0.52/ 0.88	2.07/ 6.11	—
E. tetraductylum	0.33/ 0.23	0.04/ 0.08	0.19/ 0.40	0.22/ 0.33	0.25/ 0.85	0.40/ 2.50	—	0.09/ 0.02	—
Coilia sp.	—	—	—	—	0.15/ 0.50	—	—	—	—
S. phasa	—	—	—	0.03/ 0.06	0.30/ 0.15	—	—	—	—
I. elongata	0.04/ 0.05	0.09/ 0.24	0.58/ 1.26	—	—	—	0.44/ 0.87	0.09/27.15	57.54/223.65
T. savala	—	—	—	—	—	—	—	0.57/ 0.20	12.71/ 3.72

Port-Canning (Matlah estuary) : Seed prospecting work in the Matlah estuary was carried out at Port Canning jetty, Khuskumrakhali and Bhangankhali *P. styliferus* (30-50 mm), *M. monoceros* (20-40 mm), *P. sculptilis* (35-50 mm), *P. indicus* (20-65 mm) and *M. brevicornis* (20-70 mm) among the prawns and *M. parsia* (30-45 mm), *E. tetradactylum* (25-35 mm), *P. indicus* (20-35 mm) and *S. panijus* (25-50 mm) among the fish were available almost throughout the year.

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

Altogether 13 rearing experiments using *Macrobrachium resenbergii* were conducted at Barrackpore and Uluberia, using artificial sea water, freshwater with dissolved common salt and estuarine water. Attempts to control water temperature within the desired limits (26-29°C) were successful in a few cases only. Satisfactory results were obtained upto the IV zoeal stage.

Problem : 8.3 Fisheries of the Pulicat lake

8.3.1 Studies on larvae and juveniles of fishes and prawns
Duration : Five years
Personnel: Ch. Gopalakrishnayya (upto 11.5.1971), A. V. P. Rao (upto 25.6.1971) and K. J. Rao

The postlarvae and juveniles of fishes and prawns were collected throughout the year except in October and November due to the closure of the lake-mouth. The recruitment of postlarvae and juveniles of fishes indicated four peaks of abundance in January (2,442.1), May (1,726.5), June (3,640.6) and August (1,304.7). The incursion of postlarvae and juveniles of economically important fishes showed a marked increase during the year as compared to the last year as shown below :

Average number sampled per month

Species	1970	1971
Mugil spp.	70.8	447.3
Sillago sihama	98.6	137.3
Gerres spp.	122.5	1,203.2
Chanos chanos	66.7	145.5
Elops saurus	11.0	391.0
Megalops cyprinoides	3.6	55.7

The peaks of abundance of postlarvae and juveniles of various species were : *Gerres* spp.—January, April and May (790.7, 181.7 and 198.0 No./net/hr) ; *Mugil* spp.—January, May and July (171.0, 150.0 and 64.8 No./net/hr) ; *Chanos chanos*—May and June (92.3 and 26.2 No./net/hr) ; *Sillago sihama*—

January and June (83.7 and 21.0 No./net/hr); *Megalops cyprinoides*—June (20.8 No./net/hr); *Therapon jarbua*—May (31.7 No./net/hr); *Elops saurus*—May and June (78.8 and 220.2 No./net/hr); and *Anchoviella* spp.—January, July and September (230.3, 195.2 and 126.0 No./net/hr).

Salient features regarding the important species of postlarval prawns encountered in the collections are given below :

Penaeus indicus : Postlarvae of this species were dominant throughout the year, with peaks in January, May, June and September, being 2,693,0, 399.6, 1,865.6 and 2,095.5 No./net/hr respectively. Tow-net hauls also indicated a similar trend but with one peak in August (213.66 No./net/hr).

Penaeus semisulcatus : Postlarvae of this species were available throughout the year. The incursion was the maximum in January, April, May and June, being 320.0, 102.0, 123.8 and 444.0 No./net/hr respectively.

Penaeus monodon : Postlarvae were encountered throughout the year with the maximum in January, June and September, being 488.0, 42.5 and 47.0 No./net/hr respectively. Tow-net collection indicated the maximum incursion in September (20.5 No./net/dr).

Metapenaeus dobsonii : Postlarvae occurred throughout the year. The maximum occurrence was in June (377.0 No./net/hr). Tow-net collections showed the maximum incursion in February (84.5 No./net/hr).

Metapenaeus monoceros : Postlarvae were available round the year with the peaks noticed in June, August and September, being 29.2, 86.3 and 123.5 No./net/hr respectively. In the tow-net collections, the maximum occurrence was in September (3.0 No./net/hr).

8.3.2 Studies on mullets

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971). C. P. Rangaswamy and R. D. Prasadam (upto 17.5.1971)

8.3.2 (a). Biology of *Mugil cephalus*
(Studies concluded in 1970)

8.3.2 (b). Experimental feeding of mullets

Mugil cephalus : Experiments were conducted in the laboratory with nine items of powdered feed mixtures; *viz.*, (i) mustard oilcake + prawn powder, (ii) ground-nut oilcake + prawn powder, (iii) cotton seed cake + prawn powder, (iv) linseed oilcake + prawn power, (v) rice bran + prawn powder, (vi) cow-dung powder, (vii) prawn powder, (viii) cow-dung + prawn powder + rice bran and (ix) cow-dung + prawn powder + mustard oilcake, to find out the efficacy of

these items as feed for the fry of *M. cephalus*. The results indicated that the maximum increase in weight (30%) with 20% survival was obtained by feed—(iii) and the maximum survival (100%) with 10% increase in weight by feed—(vi).

Mugil macrolepis : Based on the preliminary screening trials of six artificial feeds; *i.e.*, (i) wheat bran + bean meal + tapioca, (ii) wheat bran + ground-nut oilcake + tapioca, (iii) dried weeds + fish meal + tapioca, (iv) rice bran + prawn mean + tapioca, (v) rice bran + pea meal + tapioca and (vi) dried weeds + prawn meal + tapioca, it was observed that two feeds, (iii) and (vi), were efficacious. In three series of experiments conducted with the former feed, (dried weeds + fish meal + tapioca), the gain in weight, the percentage gain in weight, the survival rate and conversion ratios ranged from 7.10 to 16.00 gm, 110.38 to 140.87, 100% and 14.75 to 17.14 respectively in 30 days, while with the second type of feed (dried weeds + prawn meal + tapioca), the values were 5.64 to 15.15 gm, 83.16 to 106.69, 70-100% and 17.68 to 21.34 respectively in the same period.

8.3.3 Studies on bottom biota

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and K. N. Krishnamurthy (upto 24.6.1971)

Three zones could be distinguished in the Pulicat lake based on a study of the physical nature of the bottom sediments. Zone I is characterised by sandy substratum with an admixture of mud, zone II has both sand and mud in equal proportions with weedy areas in patches and zone III a predominantly muddy area. In zone I, the dominant fauna was polychaetes compris ing 83% of the total number of animals. They were available throughout the year, with two peaks, one in March and another in December in zone I. Tanaids and amphipods were next in importance. In zone II, amphipods were the dominant form, the area being the richest both in respect of quantity and quality. The bottom biota of zone III was poor (385 u/m^2) as compared to 985 u/m^2 in zone I and 3,767 u/m^2 in zone II. In zone III also amphipods and tanaids were dominant.

8.3.4 Studies on hydrography, plankton and productivity

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and M. Kaliamurthy

Air temperature : The atmospheric temperature (°C) at the mouth region of the lake, southern sector and northern sector varied from 24.1 (January) to 29.9 (June), 25.0 (December) to 32.0 (May) and 25.9 (January) to 33.7 (May) respectively.

Water temperature : The ranges of water temperature (°C) in the three zones; *viz.*, lake mouth, southern and northern sectors of the lake were 24.0

(December) to 30.1 (May), 23.8 (December) to 30.3 (May) and 26.5 (December) to 31.8 (May) respectively.

Depth of water : The water depths (cm) in the three zones ; *viz.*, lake mouth, southern and northern sectors of the lake were 60 (August) to 217 (December), 200 (June-August) to 283 (September) and 76 (April) to 170 (December) respectively.

Water transparency : The water transparency (cm) varied from 37 (January) to 70 (August) at lake mouth region, from 45 (October) to 66 (February and April) in the southern sector and from 26 (August) to 55 (October) in the northern sector.

pH : The ranges of pH values at the lake-mouth, southern and northern sectors were 8.3 (July-September and December) to 8.5 (January), 8.3 (March, April, June, September and December) to 8.4 (January, February, May, July and October) and 8.2 (June and October-December) to 8.4 (January-May and September) respectively.

Dissolved oxygen : Dissolved oxygen of the water of the lake-mouth, southern sector and northern sector ranged from 5.0 (September) to 7.1 (January), 5.2 (October) to 7.5 (December) and 5.7 (September) to 8.0 (November) ppm respectively.

Salinity : The ranges in salinity (ppt) at lake-mouth, Southern sector and northern sector were 27.4 (December) to 36.2 (April and September), 8.0 (October) to 36.8 (September) and 5.8 (October) to 39.0 (April) respectively.

Total alkalinity : The total alkalinity (ppm) varied from 85 (January) to 116 (August) at the mouth region, from 87 (May) to 120 (October) in the southern sector and from 87 (March) to 126 (July) in the northern sector.

Inorganic phosphates : The inorganic phospsate (mg/l) at lake-mouth region, southern and northern sectors varied from 0.3 (January) to 0.9 (June), 0.7 (January, February, April and December) to 0.9 (June and July) and 0.3 (September) to 0.7 (October and November) respectively.

Silicate : The ranges in the silicate content (mg/l) in the three zones were as follows : 1.5 (September) to 10.4 (December) at mouth region ; 1.0 (September) to 10.5 (December) in the southern sector and 1.0 (September) to 10.0 (October) northern sector.

Plankton—Phytoplankton : The phytoplankton production (u/haul) varied from 410 (December) to 41,850 (February) at the mouth of the lake, from 100 (October) to 4/1,850 (April) in the southern sector and from 60 (November) to 2.370 (May) in the northern sector.

Zooplankton : The zooplankton fluctuations (u/haul) in the three zones were as follows : 722 (December) to 6,480 (April) at the lake mouth ; 100 (October) to 4,560 (August) in the southern sector and 200 (October) to 2,000 (January) in the northern sector.

Standing crop of plankton : The plankton biomass (ml) varied from 0.8 (March) to 7.3 (July) at the mouth of the lake, from 0.2 (July and December) to 5.1 (February) in the southern sector and from 0.1 (July) to 5.1 (August) in the northern sector.

Primary production : The rate of organic production varied from 0.72 (March) to 1.62 (July and December) gm $C/m^2/day$. The annual organic production of the lake was computed as 462.0 gm $C/m^2/year$.

8.3.5 Experimental fishing in the Pulicat lake

Duration : Three years

Personnel: Ch. Gapalakrishnayya (upto 11.5.1971), K. N. Krishnamurthy (upto 24.6.1971) and S. Srinivasagam

The average catch/net/day was 157 gm of crabs and 487 gm of fish. The important species of fish were *Platycephalus* spp., *Teuthis* spp., *Therapon* spp. etc. and the crabs, *Scylla serrata* and *Neptunus pelagicus.*

8.3.6 Food habits of *Penaeus indicus*

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and K. Gopinathan

Experimental studies on the food preferences, survival and growth rate of *Penaeus indicus* were initiated, using artificial feeds ; like, fish meal, prawn meal, rice bran, oilcake, tapioca and dried weeds under different combinations and the data obtained are being analysed.

8.3.7 Marking experiments of *Penaeus indicus*

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and K. J. Rao

Trypan Blue, Fast Green, Malachite Green and Alizarin Red were tried in 2.5% solutions ; but it is too early to make definite conclusions.

8.3.8 Rearing of crabs

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and S. Srinivasagam

Successful spawning of *Scylla serrata* under laboratory conditions was achieved and the eggs could be reared upto 1st zoeal stage. The zoeae were fed with *Artemia* nauplii but they survived only for 21 hr after hatching.

8.3.9 Induced breeding of *Mugil cephalus*

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and S. Radhakrishnan

No breeder could be collected due to the lack of transportation facilities and hence, induced breeding experiments could not be conducted during the period.

8.3.10 Flora of the Pulicat lake

Duration : Three years

Problem : Ch. Gopalakrishnayya (upto 11.5.1971) and S. Radhakrishnan

The study indicated the presence of a continuous band of aquatic vegetation on the eastern side of the lake from Annamalaicheri to Zonangipalem. The growth of vegetation was usually restricted to the shallow regions of the lake where the bottom was sandy or with mud and organic debris. *Halophila* sp. was most common and was found to dominate throughout the eastern side of the lake. The western side of the lake was generally devoid of any dense growth of vegetation. In the southern sector, filamentous algae ; like, *Gracilaria corticata, Gracilaria* sp., *Enteromorpha* sp., *Polysiphonia* sp. and *Hypnia* sp. were encountered along with *Halophila* sp. The average number of plants in the southern and northern sectors ranged from 164 (November) to 523/m^2 (September) and from 514 (November) to 1,244/m^2 (May) respectively. The average biomass in the southern sector varied from 0.130 (November) to 0.366 Kg/m^2 (September), while in the northern sector it ranged from 0.337 (November) to 0.713 Kg/m^2 (May).

8.3.11 Studies on oysters of the Pulicat lake

Duration : Three years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971) and K. N. Krishnamurthy (upto 24.6.1971)

The size range of oysters varied from 31 to 120 mm with 51-90 mm group being the dominant. The sex-ratio was found to be 1 (male) : 3.3 (female). Almost all the female oysters had fully developd gonads and ranged in size from 40 to 85 mm. No fresh spat fall could be detected except in stray cases.

Project 9 : Selective breeding and hybridization

Problem : 9.1 Biological and genetical features of some Indian carp hybrids

Duration : Three years

Personnel: R. M. Bhowmick, G. V. Kowtal (upto 22.6.1971) and M. M. Bagchi (upto 6.5.1971)

30,000 specimens of hybrids of mrigla ♂ × catla ♀ and calbasu ♂ × catla have been produced, the latter for the first time. All hybrids showed satisfactory growth rate in nurseries.

Problem : 9.2 Storage of fish sperms
Duration : Four years
Personnel: R. M. Bhowmick and M. M. Bagchi (upto 6.5.1971)

Sperms of *Cyprinus carpio* kept in coconut milk under refrigeration were motile for 24 hr.

As during 1970, it was possible to induce catla, rohu and mrigal a second time during the same season.

The technique of pituitary administration has been simplified to enable ordinary fish farmers do it by themselves. The freshly collected glands are macerated and suspended in distilled water and injected as such, 80% positive result was obtained.

Problem : 9.3 Hybridization between silver, grass and common carp
Duration : Three years
Personnel: S. B. Singh and D. S. Murty

The hybrids, produced in 1970, could not be maintained for more than 10 months due to farm repairs. Two surviving specimens of silver carp female and grass carp male are being reared in plastic pools. Growth of the hybrids is poor.

Project 10 : Fish Farm Designing

(Unit being set up)

Project 11 : Economics in fishery investigations

Problem : 11.1 Ecomonic evaluation of fish cultural operations in West Bengal and Orissa
Duration : Two years
Personnel: M. Randhir

During 1971, data relating to various economic aspects of fish culture operations were collected from 31 farms (16 in public sector and 15 in private sector) in West Bengal and Orissa. Differences were found in the pattern of investment and recurring expenditure between public sector and private sector, prominent among them being in the purchase of fish farming equipment, managerial costs and cost of labour and feeds. In private sector, the investment and return ratio was found to vary between 20 and 30%, which is considered as a high rate of return in comparison with some other activities, involving the use of land. Fry culture activity in West Bengal has been yielding a high rate of net return on working capital (35%).

Problem : 11.2 Economic evaluation of various spawn production methods
Duration : Two years
Personnel: M. Randhir

Data were collected from 6 fish seed farms in Orissa and 2 fish seed farms in West Bengal, all the Public sector, for working out the cost of fish seed production through induced breeding. At Dhokardah Fish Farm (Kalyani, West Bengal), the production cost of *Cyprinus carpio* fry and Indian major carp fry, produced through hypophysation and reared to a size of 20-30 mm was found to be rupees five per thousand.

Problem : 11.3 Economic evaluation of different weed control methods
Duration : Two years
Personnel: M. Randhir

Data from 6 ponds in West Bengal were obtained for working out the economics of weed control by chemical treatments and they are being analysed.

Project 12: Exotic fish culture

Problem : 12.1 Standardization of techniques of breeding of grass and silver carps
Duration : Five years six months
Personnel: S. B. Singh and P. C. Chakraborti (upto 17.5.1971)

Out of 101 sets of silver carp, 31 of grass carp, administered with pituitary hormones from rohu and silver carp, 82 sets of the former and 7 of the latter could be stripped, of which only 52 and 6 sets respectively yielded healthy fry. Catheter was used to select suitable females. Dose of pituitary gland administered ranged from 10-14 mg/Kg body weight for females and 4-5 mg/Kg for males of silver carp and 3-4 mg/Kg for males of grass carp. 2.61 lakh of silver carp and 0.28 lakh of grass carp spawn were produced. Generally, successful breeding took place in rainy cool weather with plenty of cool (27-30°C) freshwater in the pond.

The poor condition of breeders was possibly due to the crowded conditions under which they were maintained in the few available ponds. Neither regular artificial feeding nor periodic administration of pituitary hormones could improve the condition of the fish.

Mortality among developing embryos and hatchlings of silver carp and grass carp was reduced by substituting thick outer hatching *hapa* with a thin nylon one. Altogether 1,14,585 silver carp seed were given to Orissa Fisheries Department, 1,050 fry to Tamil Nadu Fisheries Department and 13,535 to private parties.

Problem : 12.2 Monoculture of silver carp
Duration : Three years
Personnel: S. B. Singh, P. C. Chakrabarti (upto 17.5.1971) and M. M. Bagchi (upto 6.5.1971)

In a monoculture experiment in two 0.12 ha ponds, fingerlings of silver carp were stocked @ 3,000/ha. Slow growth was observed in one pond with abundant *Spirodela* sp. and poor survival was recorded in the other with plenty of filamentous algae.

Problem : 12.3 Food preference of grass carp
Duration : Five years six months
Personnel: S. B. Singh, P. C. Chakrabarti (upto 17.5.1971), M. D. Rout and G. N. Saha

Grass carp fingerlings was observed to consume the legume fodder Berseem in feeding experiments conducted in *hapas*.

Project 13 : Cold water fish culture

Problem : 13.1 Control of whirling disease in adult trout
(Work completed in 1970)

Problem : 13.2 Studies on the food and feeding habit of trouts
Duration : Two years
Personnel: K. L. Sehgal and K. V. Ramakrishna

Experiments on artificial feeding of brown and rainbow trouts were initiated. At Harwan in three nursery ponds with inter connected outlets, a pond was stocked with 150 fry (average size 36.0 mm/0.450 gm) and each of the remaining two ponds with 300 fry (average size 24.6 mm/0.100 gm). In the first pond, minced sheep liver @ 10% of body weight of fish and in the remaining two ponds @ 7 and 15% of body weight was given as feed. The experiments were vitiated due to flooding of the farm.

At Laribal, two ponds with cemented bottom and under ground outlets and one control pond (uncemented bottom but provided with separate underground outlet) were stocked with 250, 500 and 250 fry (average size 27.3 mm/0.177 gm) respectively. In all the ponds, the fry were fed with finely minced sheep liver @ 15.0% body weight. Percentage survival after one month was 48.5 in cemented ponds as against 13.2 in uncemented pond. Segregation of fry was done and they were restocked in the cemented ponds. Sampling done in July indicated an average survival of 26.0% in cemented ponds as against 6.8% in uncemented pond. The loss of the fry in the three ponds was on account of Fin-rot, Myxosporadiasis, Ichthyophthiriasis and escape through the side walls.

Problem : 13.3 Standardisation of trout culture techniques
Duration : Three years
Personnel: K. L. Sehgal, K. V. Ramakrishna, C. B. Joshi and Shyam Sundar

The work has been concluded and the data are being processed for preparation of final report.

Problem : 13.4 Propagation of mirror carp in hilly areas
(Research completed in 1970)

Problem : 13.5 Survey of mahaseer seed resources in Jammu
(Research completed in 1970)

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

The fish catches at Hazratbal, during the first half of the year, comprised *Schizothorax* spp. (3.34%), *Cyprinus carpio* (68.76%, *Crossochilus latius* (26.79%), *Labeo daro* (1.11%) as against 4.06, 50.83 and 43.29 and 1.82% of respective species at Saidakadal.

The physico-chemical factors of the lake as observed between 08.30 and 09.30 hour were in the following ranges:—depth, 2.06-4.10 m ; turbidity, 57-350 cm ; water temperature, 0.5-21.0°C ; pH, 8.4-8.8 ; DO, 9.8-11.2 ppm ; free CO_2, 0-4 ppm ; total alkalinity, 90-180 ppm ; and silicates, 0.5-0.8 ppm.

The surface plankton was in the range of 18-374 u/l at Saidakadal as against 58-175 u/l at Hazratbal. The half-metre organdie tow-net samples gave 7,944-52,860 u/min at Saidakadal as against 8,987-49,290 u/min at Hazratbal. The common forms recorded were *Amphora* sp., *Anabaena* sp., *Asterionella* sp., *Closterium* sp., *Cosmarium* sp., *Cymbella* sp., *Eunotia* sp., *Fragillaria* sp., *Gomphonema* sp., *Melosira* sp., *Navicula* sp., *Spirogyra* sp. and *Synedra* sp. among phytoplankton and *Asplanchna* sp., *Brachionus* sp., *Chydorus* sp., *Cyclops* sp., *Lecane* sp., *Polyarthra* sp. and *Naupali* sp. among zooplankton.

The analysis of bottom and mud samples at the two stations has shown that Naididae, Tubificidae and Chironomidae were the dominant groups. The respective percentages (by number) were 48.68, 37.50 and 13.82.

The vegetation of the lake consisted mainly of *Ceratophyllum* sp., *Myriophyllum* sp., *Potamogeton* sp., *Nymphaea* sp., *Salvinia* sp., *Hydrilla* sp. and *Wolffia* sp. The fauna inhabiting the lake vegetation was constituted by Nematoda (14.48%), Oligochaeta (2.72%), Cladocera (34.42%), Copepoda (12.83%), dipteran larvae (29.99%), Mollusca (1.37%), fish including eggs and hatchlings (2.19%) and miscellaneous (2.0% by number). The miscellaneous forms included *Gammarus* sp., naiads of Agrionidae and Lebellulidae and nymphs of Ephemeroptera. The periphytic forms recorded from washings of the lake weeds were Myxophyceae (0.14%), Chlorophyceae (5.23%), Desamidaceae (5.30%), Bacillariophyceae (84.27%), Protozoa (0.74%) and Rotifera (4.32%). The predominant genera of periphytic forms were *Amphora* sp., *Navicula* sp., *Synedra* sp., *Eunotia* sp., *Gomphonema* sp., *Pinnularia* sp., *Closterium* sp., *Cosmarium* sp., *Centrophyxis* sp., *Brachionus* sp., *Conochilus* sp. and *Lecane* sp.

A general fishery survey of the Dal lake was initiated in April, 1971. In cast-net sample fishing, the average catch/man/hr was 171 gm in first season (April-July) against 106 gm in the second season (August-November). The fish catch consisted of *Schizothorax* spp., *Cyprinus carpio, Crossocheilus latius, Barbus conchonius* and *Botia birdi* in percentages of 8.88, 36.91, 14.96, 23.83

and 15.42% in the first season and 13.27, 48.81, 7.11, 3.80 and 27.01% in the second season respectively.

The physico-chemical factors observed during first season (April-July) between 08.00-13.00 hour were in the following ranges: depth, 1.20-3.50 m; turbidity, 65-250 cm; water temperature, 18-32°C; pH, 8.0-8.8; DO, 6.2-11.4 ppm; free CO_2, 0-5 ppm; total alkalinity, 40-180 ppm and silicates, 0.15-1.00 ppm; while during the second season (August-November) the respective ranges were: 0.75-4.00 m, 75-220 cm, 11-29°C, 7.6-8.6, 7.4-11.8 ppm, 0-1 ppm, 64-160 ppm and 0.37-0.94 ppm.

The vegetation of the lake comprised *Potamogeton* sp., *Myriophyllum* sp., *Ceratophyllum* sp., *Hydrilla* sp., *Nymphaea* sp., *Azolla* sp., *Salvinia* sp., *Wolffia* sp. and *Trapa* sp. in both the seasons.

The fauna inhabiting the lake vegetation during the first season were: Oligochaeta (7.19%), larvae of Chironomidae (9.02%), Cladocera (14.07%), Copepoda (5.59%), Mollusca (4.75%) and fish (56.05%). The remaining 3.33% was contributed by *Hydra* sp., *Gammarus* sp. and nymphs of Odonata and Ephemeroptera, while during the second season, larvae of Chironomidae (6.25%), Mollusca (6.25%), fish (82.74%) and miscellaneous (4.76%) were recorded. The miscellaneous group included *Gammarus* sp., Oligochaeta, and nymphs of Odonata and Ephemeroptera.

The range of the periphytic genera growing over the lake vegetation was 1,493-5,34,400 u/m^2 of weed area during the first season. During the second season, the range was 2,278-82,696 u/m^2 of weed area. The common genera encountered among phytoplankton were *Amphora, Navicula, Eunotia, Pinnularia, Gomphonema, Cymbella, Fragillaria* and *Synedra* while among the zooplankton, *Centrophyxis* sp., *difflugia* sp., unidentified ciliates and nematodes were the dominant forms.

The analysis of the bottom biota samples, during first season, has shown Tubificidae (42.77%), Naididae (45.40%) and Chironomidae (11.83% by number/15 cm^2 of the area) as against 64.06, 16.88 and 3.59% respectively in the second season, the remaining 15.47% being contributed by Mollusca and Insecta.

Shore siene sampling was done at 18 stations during the first season and at 24 stations during the second season. The shore flora consisted of *Salvinia* sp., *Wolffia* sp., *Myriophyllum* sp., *Hydrilla* sp., *Azolla* sp., *Ceratophyllum* sp., *Potamogeton* sp., *Nymphaea* sp., *Trapa* sp. and *Vallisneria* sp., the percentages being 45.38, 10.06, 9.15, 8.91, 7.68, 7.15, 5.49, 5.46, 0.49 and 0.23 respectively during the first season as against 55.51, 8.60, 3.60, 4.44, 16.79, 7.61, 1.30, 2.13, 0.02 and 0.00 respectively in the second season. The fauna, inhabiting the shore, consisted of *Crossocheilus latius, Barbus conchonius, Gambusia affinis,* molluscs, insects, and *Gammarus* sp. and amphibian tadpoles in percentages of 3.61, 9.86, 84.29, 0.79, 1.05 and 0.40 respectively by number during the first season, the respective percentages during the second season being 0.18, 3.80, 73.69, 8.97, 5.91 and 7.45 (including *Hirudinea* sp.).

Problem : 13.7 Creel census of certain trout streams in relation to ecological conditions
(Research completed in 1970)

Problem : 13.8 Commercialisation of trout culture
Duration : Three years
Personnel: K. V. Ramakrishna, C. B. Joshi, M. J. Bhagat and Shyam Sundar

The work was initiated at Laribal trout farm. The breeders of brown trout were segregated and fed with artificial feed of partially boiled fish @ 3% body weight, twice daily. The stripping of the breeders (250-360 mm/150-700 gm) was done during the second week of November. The average number of eggs/Kg of body weight was 1,364. The average percentage of fertilisation was 94.2. The total number of eggs stripped was 60,720 which were arranged in trays @ 2,500/tray. Weekly treatment with Malachite Green at a dose of 1 : 2,00,000 for 1 hr duration (flush method) was given to green eggs.

Problem : 13.9 Estimation of mahseer and allied fisheries in deep waters of hill streams of Jammu province
Duration : Two years
Personnel: K. L. Sehgal, C. B. Joshi and Shyam Sundar

In April, experimental fishing for exploitation of mahseer was done in certain deep pools of the river Chenab and its tributaries. In the main river and one of its principal tributaries (Kalnoi), a newly fabricated gill-net was operated on trial basis.

The insect samples collected from the river Chenab and its tributaries during April, were analysed. The insect population mainly comprised nymphs, larvae and adults of Odonata (2.50%), Ephemeroptera (44.35%), Plecoptera (0.60%), Trichoptera (25.76%), Coleoptera (3.09%) and Diptera (23.70%).

Problem : 13.10 Food of *Salmo trutta fario* in natural streams
Duration : Three years
Personnel: K. L. Sehgal, Shyam Sundar and Kuldip Kumar

Two natural streams ; *viz.*, Verinag (spring fed) and Erin (snow fed) were selected for studies on food of *Salmo trutta fario*. Specimens (195-630 mm/100-3,500 gm at Verinag and 143-240 mm/100-275 gm at Erin) were used for gut content analysis. The macro-fauna encountered in the guts comprised Ephemeroptera, Trichoptera, Coleoptera and Diptera among insects and *Gammarus* sp. among Amphipoda and the semidigested unidentified matter. The percentages of different food items for the specimens examined in both the streams are given in table 22.

Table 22. Percentage composition of different food items in the guts of *Salmo trutta* fario at Verinag and Erin streams

Gut content	at Verinag	a: Erin
Ephemeroptera	5.76	29.17
Trichoptera	21.81	31.78
Coleoptera	4.94	1.18
Diptera	2.68	4.00
Amphipoda	35.86	3.57
Unidentified food matter	28.95	0.30

The average percentages of mucous, detritus, plankton and miscellaneous items were 34.30, 30.20, 13.30 and 22.20 at Verinag and 23.29, 45.65, 13.35 and 17.71 at Erin respectively.

Collections of insect samples were also made from the two streams near the angling spots. The average number of insects per m^2 of stream bed was 79 at Verinag and 67 at Erin. Insects, amphipods and others accounted for 5.59, 94.10, and 0.31% at Verinag as against 90.89, 8.65 and 0.46% respectively at Erin. Among insects, Ephemeroptera, Plecoptera, Trichoptera, Coleoptera and Diptera were recorded, while *Gammarus* sp. was recorded among amphipods. The other forms comprised mainly *Hirudinea* sp., *Planaria* sp., *Gyraulus* sp. The physico-chemical factors of the two streams were also recorded.

Project 14 : Riverine and estuarine fish catch statistics

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

Duration : Four years

Personnel : K. K. Ghosh (upto 23.3.1971), S. P. Singh, S. Jana, S. K. Wishard, G. N. Srivastava, N. K. Srivastava and S. N. Mehrotra

(a) Fish catch statistics : Data on market arrivals at various araths located at Sadiapur, Rasulabad, Daraganj, Meja Road, Mirzapur and Chunar were continued to be collected all through the year, periodically, to assess the variation pattern in the landings. Analysis of data suggests that the co-relation between the numbers of araths and the mean landings/araths/day within a market is significant. The coefficient of variation of the number of araths at each centre is lesser than that of the mean landings/arath/day. Hence, the ratio-estimate based on the number of the araths as the concomitant variable appears to be quite efficient. The data collected so far under the project during the last four years is being analysed to design suitable sampling techniques.

The market arrivals of catches from the river Ganga at the assembly centre at Buxar were collected on a complete enumeration basis excepting holidays. The estimated monthly marketed fish catches of selected species are given in table 23.

Table 23. Monthwise market arrivals of the fish (in Kg) caught from the river Ganga at Buxer in 1971

Month	Mrigala	Catla	Rohu	Calbasu	Major carps	Kantia	Seenghala	Padhin	Catfish	Hilsa	Others	Total
Jan	25.58	—	19.20	—	47.78	22.54	9.67	—	32.21	68.14	148.14	296.27
Feb	—	21.15	94.64	—	115.79	18.94	77.19	—	96.13	55.80	272.60	540.32
Mar	8.24	2.66	31.03	10.53	52.46	35.03	56.86	—	91.89	153.94	82.39	380.68
Apr	2.94	110.46	55.53	2.76	171.69	8.46	24.26	—	32.72	120.79	31.58	356.78
May	50.45	48.98	45.00	—	144.43	51.91	33.37	9.56	94.84	1,902.77	—	2,142.04
Jun	52.79	9.60	32.76	6.54	101.69	83.34	15.30	5.60	104.24	1,976.83	1,111.56	3,294.32
Jul	1.20	—	—	—	1.20	20.64	8.38	20.90	49.92	289.15	470.85	811.12
Aug	21.83	14.12	6.88	10.23	53.06	30.42	29.38	2.91	62.71	126.94	305.08	547.79
Sep	347.31	195.56	58.16	46.64	647.67	382.34	384.72	84.98	852.04	1,649.76	1,654.31	4,803.78
Oct	139.00	180.36	199.21	84.58	603.15	1,418.62	862.07	2,094.62	4,375.31	10,069.70	2,101.53	17,149.69
Nov	298.95	184.23	102.86	11.92	597.96	245.64	223.16	574.53	1,043.33	915.08	1,306.14	3,862.51
Dec	46.82	156.05	72.75	3.91	279.53	69.94	114.24	124.74	308.92	1,619.82	930.62	3,038.89
Total												
(Kg)	998.11	923.17	718.02	177.11	2,816.41	2,387.82	1,838.60	2,917.84	7,144.26	18,948.72	8,414.80	37,324.79
(%)	2.67	2.47	1.92	0.47	7.55	6.40	4.93	7.82	19.14	50.77	22.54	100.00
Average of 1958-59 *to* 1969-70												
(%)	0.93	1.45	1.40	0.09	3.87	3.18	0.79	1.35	5.32	36.74	20.32	66.25
(t)	1.40	2.19	2.11	0.14	5.84	4.80	1.19	2.04	8.03	55.46	30.67	100.00

The same table contains the average landings and percentage composition based on earlier data of eleven years (1958-59 to 1969-70). This shows a fall of 44% in the total landings of 1971 as compared to the average. Hilsa shows a short fall of about 48% as compared to the average but a rise of 21% over the landings of preceding year. The composition of the catches of other fishes did not vary much from the average, though a fall of total major carp landings, this year, from an average of 3.87 to 2.82 t and an increase of total catfish landings from 5.32 to 7.14 t is quite apparent. The most notable fall is witnessed in the landings of other fishes, showing a sort fall of 53% from the average.

(b) Primary productivity of the Ganga river system : As in the previous years, the observations were made at three centres, one on the river Yamuna and two on the river Ganga (one above and the other below the confluence). Gross primary production in the river Yamuna ranged between 26.52 and 141.25 mg C/m^3/hr whereas in the river Ganga above the confluence the range was 17.5-187.5 mg C/m^3/hr and below the confluence, 25.0-94.5 mg C/m^3 hr. In the rivers Yamuna and Ganga above the confluence, the maximum carbon assimilation was in November, whereas in the Ganga river below the confluence the maximum production was recorded in January. Every centre showed two peaks, one in summer and the other in winter.

Net primary production of the river Yamuna varied from 18.75 to 102.5 mg C/m^3/hr, the river Ganga above the confluence showing 12.2 to 212.5 and below, 12.25 to 37.5 mg C/m^3/hr, considering the net production as an index of productivity. The Ganga river above the confluence was found to be more productive followed by the Yamuna river.

Problem : 14.2 Fish catch statistics of the lower stretch of the Ganga river system

Duration : Four years

Problem : G. N. Mukherji, S. N. Sar, R. C. Singh, B. L. Pandey and R. N. Seth

(a) Fish catch statistics : The total estimated fish landings from the four centres ; *viz.*, Bhagalpur, Rajmahal, Dhulian and Lalgola during the first 11 months of the year was estimated to be 366.39 t as against 300.54 t during the corresponding period of 1970, thus registering an increase in production by 21.29%. Miscellaneous varieties dominated the catches followed by hilsa, major catfishes and major carps.

Fish catches from two new centres Sahibganj and Farakka for the corresponding period of 1971 were estimated to be 133.69 t of which Sahibganj catches formed 55.51%. The production from Sahibganj and Farakka formed 26.73% of the total catch (500.08 t) from the entire lower stretch. Contribution of various species at different centres is presented in the table 24.

(b) Primary productivity : The average gross carbon assimilation for the first 11 months of the year was 85.53 mg C/m^3/hr as against 32.07 mg

Table 24. Centrewise fish landings (in t) in the lower stretch of the Ganga river

Centres	*C. mrigala*	*C. catla*	*L. rohita*	*L. calbasu*	*M. aor*	*M. seenghala*	*W. attu*	*H. ilisha*	Misc.	Total	%
Bhagalpur	3.07	5.67	2.84	1.04	5.53	5.38	24.91	3.95	61.43	113.82	22.76
Rajmahal	0.55	1.27	0.33	0.18	1.77	1.46	4.29	8.80	38.51	57.16	11.43
Dhulian	0.67	1.58	0.20	0.12	1.38	1.43	3.97	33.98	41.47	84.80	16.97
Lalgola	—	—	—	—	—	—	—	89.27	21.34	110.61	22.11
Sahibganj	2.36	7.04	3.41	0.85	4.04	4.56	11.72	3.81	36.43	74.22	14.84
Farakka	1.85	3.10	1.57	0.43	2.64	2.70	4.11	24.32	18.75	59.47	11.89
Total	8.50	18.66	8.35	2.62	15.36	15.53	49.00	164.12	217.93	500.08	100.00

$C/m^3/hr$ during the corresponding period of 1970. The maximum and minimum values were recorded in May (133.33 mg $C/m^3/hr$) and September (34.38 mg $C/m^3/hr$) respectively.

The phytoplankton density varied from 445 to 4,870 u/l in August and May respectively. Phytoplankton dominated over the zooplankton throughout the year, the ratio being 30.79 : 1.

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

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

Duration : Four years

Personnel: P. Datta, G. C. Laha, P. M. Mitra, 2 Senior Research Assistants, 4 Research Assistants, and 5 Junior Survey Assistants

During the period from the 1st of December, 1970 to the 31st of October, 1971, a total of 13,734.3 t of fish and prawn was landed. Zone III (the lower Sunderbans) yielded 63.8% of the total catch, while zone II and IV contributed 17.8 and 10.1% respectively (Table 25). Contribution of zones II and III to the total landing during the period under review was 10,156.5 t which was due to the increasing abundance of *H. ilisha* during the monsoon season.

The species which dominated the catches were *H. ilisha* (6,391.1 t). *H. nehereus* (1,640.7 t), prawns (1,398.2 t), and *S. phasa* & *S. taty* (596.6 t).

Gearwise dissection of the catch showed that drift-net which landed the bulk of the hilsa catches, contributed 6,096.2 t, followed by bag-net (5,178.8 t) and large seine (1,025.4 t).

The most remarkable feature of this year's fishery was the abundance of *H. ilisha* during the monsoon months. The landings of the species during July—October of 3 recent years are : 742.5, 793.1 and 5,741.4 t during 1969, 1970 and 1971 respectively.

Problem : 14.5 Fish catch statistics of the Pulicat lake

Duration : Six years

Personnel: Ch. Gopalakrishnayya (upto 11.5.1971), K. J. Rao, S. Srinivasagam, K. Gopinathan and P. M. A. Khadir

The total landings from the lake during the year 1971 were 1,173.341 t, indicating a slight rise of 0.2% over that of the previous year. There was a fall of 26.32% in prawn landings and 16.28% in clupeid landings as compared to last year, which might have been due to the closure of the lake-mouth during October and November. The maximum catch of 125.467 t was recorded in February and the minimum of 60.082 t in November.

During the year, prawns contributed 417.401 t (35.55% of the total landings). The peak landing was recorded in December (62.117 t) and the lowest in September (4.758 t). *Penaeus indicus* contributed 41.56% and *Metape-*

Table 25. Zonewise catches (in Kg) during December, 1970 to October, 1971 in the Hooghly-Matlah estuary

Zones	December	January	February	March	April	May
Nabadwip to Calcutta (I)	1,27,617	1,06,836	89,983	96,340	94,120	93,424
Calcutta to Diamond Harbour (II)	18,156	29,820	37,572	30,989	20,893	40,376
Lower Sunderbans (III)	22,35,840	18,20,534	4,50,856	2,29,254	1,25,890	1,31,557
Rupnarayan (IV)	69,678	1,15,957	1,13,450	98,956	1,11,424	2,04,974
Port Canning (V)	11,344	10,498	9,348	9,967	8,030	12,078
Total	24,62,635	20,83,645	7,06,209	4,65,506	3,60,365	4,82,409

	June	July	August	September	October	Total	%
Nabadwip to Calcutta (I)	98,371	48,670	54,431	1,19,892	89,197	10,18,889	7.6
Calcutta to Diamond Harbour (II)	28,028	49,147	2,85,404	18,59,893	50,531	24,50,809	17.8
Lower Sunderbans (III)	1,65,447	3,80,196	11,87,443	16,29,919	4,10,688	87,67,624	63.8
Rupnarayan (IV)	77,364	5,107	34,903	4,96,122	55,974	13,88,909	10.1
Port Canning (V)	8,826	8,159	9,891	9,573	10,335	1,08,049	0.8
Total	3,78,036	4,91,279	15,72,072	41,15,399	6,16.725	1,37,34,280	99.9

naeus monoceros, P. nonodon, P. semisulcatus and *M. dobsonii* accounted for 25.42, 10.18, 7.54 and 6.60% respectively.

Mullets contributed 297.988 t forming 25.38% of the total landings. The highest catch was recorded in August (37.375 t) and the lowest in November (15.185 t). *Mugil cephalus* formed the bulk of the catch (67.76%), while *M. cunnesius, M. tade* and *M. macrolepis* contributed 13.52, 13.69 and 4.50% respectively.

Perches contributed 125.402 t accounting for 10.64% of the total landings. The maximum landing was in August (18.606 t) and the minimum in December (7.745 t). The important species were *Sillago sihama* (28.66%), *Lates calcarifer* (13.33%), *Gerres* spp. (11.67%) and *Siganus* sp. (7.41%).

Clupeids amounted to 105.127 t and formed 9.15% of the total landings. The highest catch was recorded in January (16.293 t) and the lowest in December (2.767 t). The important species were *Nematolosa nasus* (54.60%), *Chanos chanos* (22.12%), *Thrissocles* sp. (11.65%) and *Elops saurus* (6.63%).

Crabs contributed 102.234 t and accounted for 8.71% of the total landings. The highest catch was recorded in July (18.876 t) and the lowest in November (1.617 t). The main species were *Scylla serrata* (24.11%) and *Neptunus pelagicus* (75.89%).

The other important groups in the catches were Beloniformes (30.120 t), sciaenids (17.899 t) and polynemids (11.715 t).

The annual fish landings from the southern and northern sectors of the lake were 624.617 and 548.724 t respectively.

The gearwise break up to the catch was : drag-net, 371.991 t ; stake-net, 295.1 t ; shore seines, 143.216 t ; hook and lines, 114.968 t ; and bag-net, 68.959 t.

The dominant sizes (mm) of the commercially important species were : 61-115 (*P. indicus*), 71-170 (*P. monodon*), 51-105 (*P. semisulcatus*), 46-75 (*M. monoceros*), 41-60 (*M. dobsonii*), 121-390 (*M. cephalus*), 161-270 (*M. macrolepis*), 126-160 (*M. parsia*), 101-230 (*Sillago sihama*), 116-200 (*G. oyena*), 71-130 (*G. filamentosus*), 71-125 (*G. limbatus*), 71-250 (*N. nasus*), 151-380 (*C. chanos*) and 241-370 (*E. saurus*).

Badivalai recorded the highest catch/net/hr with 112.869 Kg. The important gears used and catch per unit effort analysed in the southern sector were : *Panthavalai* (11.407 Kg), *Oivalai* (7.857 Kg), *Kondavalai* (7.801 Kg) and *Kalvalai* (4.991 Kg). The gears used in the northern sector were *Peria kondavalai* (7.067 Kg.), *Kondavalai* (4.958 Kg) and *Sillappu* (3.100 Kg).

Project 15 : Fish Pathology

Problem : 15.1 Etiology and control of parasitic diseases of cultured warm-water fishes

Fish culture in jute-retting pond

(The work was suspended due to nonavailability of the staff)

Problem : 16.1 Standardisation of methods of control of emergent and floating weeds with hormone weedicides
Duration : Five years
Personnel: V. Ramachandran, T. Ramaprabhu, S. Patnaik, P. V. G. K. Reddy and K. M. Das

The phosphate level in 450 l of tap water in which 10 Kg of water-hyacinth was killed and allowed to disintegrate, was 0.31 ppm compared to 0.08 ppm in pools with 10 Kg live weeds and traces in pools with tap water only. The average yield of fish in the water-hyacinth disintegrated pools, was nearly twice as high as in pools with living weeds and with plain water only.

2,4,5-T (40% amine salt) proved to be as effective as 2,4-D against water-hyacinth but its use has not been recommended on account of its toxicity to warm blooded animals.

Problem : 16.2 Control of algae in fish ponds
Duration : Three years
Personnel: S. Patnaik, V. Ramachandran, P. V. G. K. Reddy and K. M. Das

Efficiency of Simazine (as Tafazine-50), in controlling *Microcystis* sp. blooms in ponds even at 0.3 ppm, has been established in field trials. Simazine has also been proved, in laboratory experiments, to have no adverse effect upon fish even upto 6 ppm, in 48 hr.

Problem : 16.3 Evolution and evaluation of weedicide formulations
Duration : Continuing
Personnel: T. Ramaprabhu, V. Ramachandran, S. Patnaik, P. V. G. K. Reddy and K. M. Das

Efficacy of laboratory prepared sand granular form of copper sulphate and Simazine (1% active ingredient in each case), in controlling patches of submerged weeds in vast water areas, was tested in the field. *Hydrilla* sp. infestation was reduced by about 73% in 3 months in the case of copper sulphate @ 32 Kg active ingredient and by about 49% in case of Simazine @ 8 Kg active ingredient/ha.

Weedicide formulations of 2,dichloropheny 1-4-nitrophenyl ether (TOK E-25) and of 1-(3,4-dichlorophenyl)-3-methyl-2-pyrrol-dinone were tested against weeds and for toxicity to fish. Tok E-25 applied @ 20 Kg a.i./ha damaged leaves and stems of *Panicum* sp. but regeneration was not checked. B.V. 201, though effective in killing *Hydrilla* sp. at 10 ppm, was lethal to fish even at 1.25 ppm in 24 hr.

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

Duration : Four years

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

Aqueous ammonia has been proved to be effective in the field against floating aquatic weeds *Pistia* sp. and *Salvinia* sp. A sprinkler type of nozzle has been devised to achieve effective application and optimum coverage. Addition of wetting agent 'Surf' (0.25%) in the spray solution enhanced the effect so that 0.5% solution was far more effective than the plain solution.

Problem : 16.5 Eradication of weeds by treatment of bottom soil

Duration : Two years

Personnel: E. Mitra (Miss), A. C. Banerjee, M. K. Banerjee (upto 1.5.1971) and S. C. Thakurta

Laboratory experiments : To control *Eichhornia* sp., superphosphate (16%) solution at a dose of 500, 750, 1,000 and 1,500 Kg/ha was applied. The plants were killed and completely decomposed in both the higher doses of 1,000 and 1,500 Kg/ha ; but much less time was taken for complete decomposition at a higher dose of 1,500 Kg/ha.

Part treatment of the plants in an aquarium showed that those not treated also died and decayed along with the treated plants. From water analyses, it was found that the increase in phosphate content in the non-treated water was 20 ppm from trace and in the treated portion, the increase was 12 ppm. From this part treatment experiment, it was concluded that the increase of 20 ppm of phosphate content in water is capable of destroying *Eichhornia* sp. Further trials are in progress.

Experiments in which commercial copper sulphate solution sprinkled on *Eichhornia* sp. at the rate of 10, 20, 25, 30 and 35 Kg/ha, indicated that the plants could be killed at the dose of 25-35 Kg/ha, the quickest action being at 35 Kg/ha.

Field experiments : A small area of a canal in the Howrah Botanical Garden which was thickly infested with *Eichhornia* sp., was directly treated with three intermittent doses of copper sulphate solution @ 35 Kg/ha. Within a month of the treatment even when there was inward and outward flow of water, the mature plants died and started disintegrating. However, a few new plants were found to grow.

Problem : 16.6 Autecology of aquatic weeds

(Due to nonavailability of the staff the work was suspended)

Problem : 17.1 Induced breeding of commercially important species of Indian frogs
Duration : Four years
Personnel: A. K. Mondal and R. K. Jana

In the pre-breeding and breeding seasons, 22, 10 and 4 sets of *Rana tigrina, R. hexadactyla* and *R. crassa* respectively were bred with homo- and heteroplastic pituitary gland extracts. Two more sets of *R. hexadactyla* bred during the post-breeding season. Extract of 10 mg pituitary gland per Kg of body weight has been recommended for general adoption. Artificial fertilization by dry method yielded 100% success.

Induced hybridization of one set of *R. tigrina* and *R. crassa* was successful. The cannibalistic tendency of hybrid tadpoles was found to be much less than that of parent species.

In 18, 5 and 4 specimens of *R. tigrina, R. hexadactyla* and *R. crassa* respectively the fecundity varied from 3,657 to 13,231 in *R. tigrina* (85-140 mm), 2,932 to 7,649 in *R. hexadactyla* (92-119 mm) and 1,869 to 6,323 in *R. crassa* (68-99 mm).

Problem : 17.2 Raising and rearing of tadpoles to early frogs of indigenous commercial species
Duration : Five years
Personnel: A. K. Mondal, R. K. Jana and V. Panigarhi

Incidental to various experiments 84, 3.7 and 8.1 thousand tadpoles of *R. tigrina, R. hexadactyla* and *R. crassa* respectively were produced. 2.5 thousand hybrid tadpoles of *R. tigrina* and *R. crassa* were also produced. In rearing experiments in cisterns with 250 l water and 500 tadpoles of *R. hexadactyla*, only 89% tadpoles survived to early frog stage. In nursery ponds, a survival of 1,421 early frogs of *R. tigrina* out of 3,200 tadpoles stocked @ 80,000/ha was obtained after 3-4 weeks.

In jar experiments on mixed rearing of advanced tadpoles of *R. hexadactyla* (25-33 mm) and hybrid spawn of Indian major carps (8-10 mm) with/without food, no adverse effect on either form was noticed.

Problem : 17.3 Culture of frogs and study of productivity in frog farming
Duration : Five years
Personnel: A. K. Mondal and R. K. Jana

A net production of 772.6 Kg/ha with a survival of 75.4% of small *R. hexadactyla* stocked @ 6,000/ha in weed infested ponds (0.04 ha) was obtained after 1 year of rearing.

Problem : 17.4 Frog-cum-fish culture
Duration : Five years
Personnel: A. K. Mondal, R. K. Jana, D. P. Chakraborty (upto 8.4.1971), A. C. Nandy (upto 9.6.1971) and V. Panigrahi

In a frog-cum-fish culture experiment, small *R. hexadactyla* (45 mm/9 gm) were stocked @ 6,500/ha along with major Indian and exotic carp fiingerlings (91 mm/9 gm) @ 4,500/ha in the ratio of catla 2.75 : rohu 3.75 : mrigal 1.5 : grass carp & common carps : 1.75, for a period of 3 months. The results are shown in table 26.

Table 26. Average size of fish and frog obtained after 3 months' rearing

	Fish		Frogs
Central ponds (Separate rearing of frogs and fish)	Catla	228 mm/164 gm	74mm/49gm
	Rohu	227 mm/137 gm	
	Common carp	237 mm/172 gm	
Experimental ponds (Joint rearing of frogs and fish)	Catla	223 mm/152 gm	71 mm/43 gm
	Rohu	280 mm/216 gm	
	Grass carp	254 mm/210 gm	

Problem : 17.5 Stock-building of *R. catesbeiana*
Duration : Five years
Personnel: A. K. Mondal

The work received a set back due to escape of breeders during cyclone on account of collapse of fences.

Project 18 : Sewage fed fisheries

Problem : 18.1 Ecology of sewage fed fisheries
(Project has been kept in abeyance due to local disturbance at the work site)

Project 19 : Hilsa investigations

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

(a) *Observations on the winter spawning of hilsa* : Observations on the winter spawning of hilsa initiated at Mahewapatti on the river Yamuna and Sirsa on the river Ganga indicated that hilsa larvae were not available in good number at either of the centres. The collections were made during February and March. However, in the river Ganga a few larvae were available in the 3rd and 4th weeks of March.

(b) *Observations on post-monsoon and early winter spawning* : Field collections were initiated in the first week of October and were continued till first week of December, 1971. The collections were made at Mahewapatti on the river Yamuna and Sirsa, Vindhyachal, Sindhoraghat and Sujabad on the river Ganga. The details of catches are given in table 27.

Table 27. Catch/net/hr of larvae and postlarvae of hilsa

Date	Larvae (No.)	Postlarvae (No.)	Larvae (catch/net/hr)	Postlarvae (catch/net/hr)
Mahewapatti				
11.10.71	4,450	—	742	—
26.10.71	16,000	1	2,666	negligible
30.10.71	8,930	—	1,490	—
6.11.71	114	2,100	19	350
11.11.71	6	88	1	15
30.11.71	3	2	0.5	negligible
27.11.71	2	10	negligible	1.5
2.12.71	negligible	negligible	—	—
10.12.71	negligible	negligible	—	—
Sirsa				
6.10.71	40	—	7	—
13.10.71	320	—	53	—
29.10.71	140	222	23	27
3.11.71	127	195	21	32
10.11.71	105	160	17	27
18.11.71	4	43	0.5	7
25.11.71	—	30	—	5
4.12.71	—	31 (fry)	—	5
8.12.71	—	225 (fry)	—	38
Vindhyachal				
6.10.71	400	—	67	—
13.10.71	716	—	119	—
30.10.71	1,940	—	323	—
3.11.71	27,300	—	4,550	—
10.11.71	18,735	3,000	3,122	500
17,11.71	300	380	50	63
24.11.71	50	8	6	—
3.12.71	—	200	—	33
7.12.71	—	5 (fry)	—	1
Sujabad				
7.10.71	25	—	4	—
14.10.71	1,100	—	193	—
26.10.71	1,62,000	6,280	27,000	1,047
30.10.71	2,450	260	408	43
4.11.71	24,050	840	4,008	140
11.11.71	205	430	34	71
24.11.71	—	5	—	1
3.12.71	—	2	—	negligible
7.12.71	—	21 (fry)	—	2.5

Date	Larvae (No.)	Postlarvae (No.)	Larvae (catch/net/hr)	Postlarvae (catch/net/hr)
Sindhoraghat				
7.10.71	3,000	—	500	—
14.10.71	18,000	—	300	—
30.10.71	1,27,500	—	21,750	—
4.11.71	37,000	—	6,500	—
11.11.71	505	—	94	—
17.11.71	120	—	20	—
25.11.71	17	—	3	—
3.12.71	—	—	—	—
8.12.71	5	—	1	—

As evident from the foregoing table, the breeding of hilsa commenced from mid-September and continued till about the mid-November. The peak period was observed in the last week of October and the first week of November, except at Sirsa, where mid-October happened to be the peak period.

Breeding of hilsa during the year 1971, was much prolific than during the year 1970. It may be mentioned that the landings of hilsa also were much higher during 1971 than in 1970. The hilsa landings at Sadiapur and the abundance of larvae in the river Yamuna during the breeding season of different years are presented in table 28. For the landings, the main breeding season of hilsa (July-December) was considered.

Table 28. Hilsa larvae

Year	Estimated landings (July-December)	Catch/hr
1967	10,960.92	207
1968	21,657.00	—
1969	17,524.26*	13,127
1970	8,727.51	96
1971	11,249.76	819

* Data for September and October only.

As found during the earlier years, Sindhoraghat indicated the heaviest breeding within this stretch.

Studies on the bathymetric distribution of larvae : The distribution of hilsa larvae in relation to water depth was studied by operating a special type of net which had 3 independent mouths and 3 tail ends each set being in a vertical series. The tail end which was designed in the fashion of a tow-net was attached with a cylindrical bucket, the rear end of which was blocked with a piece of organdie cloth. Netwise collections made on the peak days were :

Date	Number of larvae caught by		
	Upper net (at 10-30 cm depth)	Middle net (at 30-40 cm depth)	Lower net (at 40-65 cm depth)
26.6.71	1,400	2,250	nil
4.11.71	75	95	25
18.11.71	80	3	nil

The above observations indicated that hilsa larvae prefer surface waters.

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

Duration : Five years

Personnel: K. V. Rao (upto 17.5.1971), G. N. Mukherji, S. N. Sar and B. L. Pandey

The total landings of hilsa from the lower stretch of the Ganga river system, were recorded to be 146.49 to as against 122.45 t during the preceding year. The species contributed 34.20 and 38.16% to the total fish production during 1971 and 1970 respectively. Dhulian (37.51 t) and Lalgola (97.06 t) contributed 91.86% to the total production of hilsa, while Rajmahal (9.25 t) contributed considerably as against negligible catches at Bhagalpur (2.67 t). A comparison between the years revealed that the landings increased at all the centres except Rajmahal, the percentage increase being 81.63 at Bhagalpur, 7.79 at Dhulian and 34.12 at Lalgola as against 33.02% decrease at Rajmahal over that of the preceding year. The monthwise production of hilsa at individual centre revealed that the period, June to November, incorporating the monsoon season, was responsible for the bulk of the catches from the whole stretch, contributing 78.20% to the total production. Hilsa measuring less than 180 mm were conspicuous by their absence in catches at Lalgola, while the bulk of the production in April (96.76%) at Bhagalpur, May (66.56%) at Rajmahal comprised juveniles. They were represented in negligible quantity in the month of April at Dhulian.

The intermingling pattern of the three sub-populations of hilsa, indicated that the 'broader' variety contributed 37.01% of the total production, while 'slender' and 'broad' varieties contributed 26.86 and 36.13% respectively. The fishery of the entire stretch was supported by all the three sub-populations, with the 'slender' variety forming the mainstay at Bhagalpur (60.69%), Rajmahal (69.73%) and Dhulian (47.47%). The catches at Lalgola centre comprised 'broad' (43.78%) and 'broader' (42.26%) varieties respectively. The proportion of the 'broad' variety in hilsa catch was 18.73% at Bhagalpur, 15.57% at Rajmahal and 22.53% at Dhulian. The 'broader' variety was the lowest (14.70%) at Rajmahal.

The pattern of intermingling between the three sub-populations during different months at a centre indicated that while at Bhagalpur and Rajmahal

consistent dominance was observed for the 'slender' sub-population, Lalgola presented the maximum concentration of 'broader' variety throughout the year. At Dhulian in January and November only, 'broader' (39.29%) and 'broad' (42.85%) varieties dominated by number and 'slender' sub-population was the maximum during rest of the months of the year.

Studies on larval abundance of hilsa in the Ganga river system indicated independent spawning activity at Bhagalpur, Rajmahal and Dhulian sectors. Two separate spawning seasons, one during the post-winter months (March and April) and the other during the monsoon months (July to October), as evident by the availability of larvae (4 mm) in the 1/16" mesh shooting net and ½-m organdie tow-net collections in these sectors were discernible. The intensity of spawning, per 1,000 m^3 water filtered, was found to be higher during the post-winter months at all the three centres of observations. While the number per 1,000 m^3 water varied between 0.24 in May and 32.37 in April at Bhagalpur, it varied between nil in March and 26.20 in May at Rajmahal, and 15.84 in May and 173.25 in April at Dhulian. The spawning activity was of low magnitude during the monsoon months, the number of larvae per 1,000 m^3 water being 7.48 (July) at Bhagalpur, nil (September)-19.51 (October) at Rajmahal and nil (August)-115.90 (July) at Dhulian. Two distinct spawning peaks at each centre, April and July for Bhagalpur, May and October for Rajmahal and April and July for Dhulian, were observed. The availability of larvae (4 mm) at Benigramhat, located at a distance of 1 Km downstream of the Farakka barrage, which is midway between Rajmahal and Dhulian, tends to indicate a continuous spawning belt in this stretch.

Problem : 19.3 Artificial propagation of the Gadavari hilsa
Duration : Five years
Personnel : T. Rajyalakshmi, P. L. N. Rao, G. R. M. Rao and L. H. Rao

Sampling for length, weight and age-composition and maturity of *H. ilisha* was carried out at Yanam and Kotipalli on the Goutami estuary and at Bobbarlanka and Dowleswaram in freshwater stretch. The fishery commenced late by about 1st of September. It was observed that males in the III age group dominated the catches throughout the season. Females in the V group were poorly represented in the catches. Details of monthly catch (Kg) in respect of different age-groups are presented below :

	Age-group				
	II	III	IV	V	Total
August	—	128.35	646.87	13.33	788.55
September	644.66	5,921.62	3,743.38	399.68	10,709.34
October	241.94	2,272.45	1,985.54	135.13	4,635.08
November	—	111.48	73.17	—	184.65
Total	886.60	8,433.90	6,448.96	548.16	16,317.62
%	5.40	51.70	39.50	3.40	

There was considerable variation in the sex-ratio throughout the season and the males predominated the fishery.

15 attempts made in inducing hilsa to breed were not successful.

The size of ovary varied enormously, from 65 to 255 gm. Data on the weight of ovary in relation to total length and weight of fish were obtained and relationship between the variables was calculated. Fecundity was estimated from 168 ovaries adopting a uniform methodology and was found to range between 2.68 to 18.10 lakh ova.

The fecundity in relation to length showed increase as compared to the data of the year 1960. The average weight of gonads showed further reduction to 126.4 gm. It was 164 gm in 1965 and 148 gm in 1969. Significant difference was found between the ovary weights of the three years.

Oozing fish were encountered only on two occasions at Kotipalli centre and no spent fish were observed during the season at any centre. Since the flood water level never reached the 335.28 cm mark over the anicut in the season, no migration over the anicut appears to have taken place as confirmed by the absence of juvenile fish in the catches during November and December months.

Problem : 19.4 Hilsa fisheries of the Hooghly-Matlah estuarine system
Duration : Four years
Personnel : Apurba Ghosh, V. Gopalakrishnan, K. K. Bhanot and P. U. Verghese (upto 14.6.1971)

Delimitation of *Hilsa ilisha* spawning grounds in the Hooghly estuary and estimation of larval abundance in selected stretch of the river Hooghly :—

In the year 1971, the stretch for study was further restricted and collections were made from Kalna, Dathrigram and Medgachi centres (near Balagarh) situated within a 25-Km length of the river Hooghly. Organdie tow-net was more effective for the collection of prolarvae of hilsa. Due to heavy early monsoon rains this year, the water discharge of the Hooghly river increased tremendously and high flooding conditions prevailed in August and Setptember. Though huge landings of adult hilsa were reported from the lower reaches of the estuary from the beginning of July, mature hilsa were caught from the upper stretch of the estuary in appreciable numbers only from early August. Tow-net collections made at the above mentioned centres during July and August recorded negligible numbers of hilsa larvae. In the month of September, due to complete flooding of the stretch, no collections could be made. However, collections were continued in the month of October when the flood water receded. The availability of hilsa larvae by the tow-net collections during October is indicated below :

Centre	Period of operation (hr)	Hilsa larvae collected	Catch/net/hr (No.)
Kalna	8	2,744	343.00
Dathrigram	8	4,531	566.37
Medgachi	12	5,942	495.10

The data collected indicated that the breeding activity of hilsa increased tremendously in the month of October in the 25-Km stretch of the river studied. Majority of the hilsa seed collected at Kalna and Dathrigram was prolarvae (4-6 mm) and was about 7 to 10 days' old, whereas majority of the seed collected from Medgachi was postlarvae (6-10 mm). As the abundance of hilsa prolarvae and postlarvae was observed at the fag-end of October, peak breeding of the fish in the vicinity of Kalna-Dhatrigram stretch had probably taken place during mid-October, indicating late breeding of the fish in the stretch.

Problem : 19.5 Artificial propagation of *Hilsa ilisha* (Hamilton)
Duration : Five years
Personnel: J. C. Malhotra, P. K. Mathur and M. Y. Kamal (upto 17.5.1971)

Experiments on the artificial propagation of *Hilsa ilisha,* were continued near Allahabad at Sirsa on the river Ganga and in the farm pond at Taraon. Experiments were also carried out at Bobbarlanka on the Godavari river downstream of the Dowleswaram Anicut.

A *At sirsa on the river Ganga—Artificial fecundation* : Because of nonavailability of mature females, the experiments could not be undertaken during the spring season.

Artificial fecundation of hilsa through stripping employing 'wet method' was again successfully achieved during the post-monsoon (October, 1971) run of the fish in the river Ganga at Sirsa. Out of the nine experiments carried out, 6 were successful and in the other three, fertilisation of the eggs did not take place (Table 29).

Table 29. Details of the stripping experiments of *Hilsa ilisha* carried out at Sirsa during October, 1971

Date	Time (hr)	Females		Males		Eggs stripped (lakh)	Fertilisation (%)	Hatching (%)
		Total length (mm)	Maturity condition	Total length (mm)	Maturity condition			
20.10.71	15.20	447	VI	386	Oz	0.0	0.0	0.0
20.10.71	17.15	453	G	315	Oz	7.6	70.0	33.0
				341	Oz			
21.10.71	17.30	477	G	340	Ps	5.2	90.0	75.0
				349	Ps			
21.10.71	17.00	375	Ps	325	Ps	0.6	10.0	20.0
				320	Ps			
21.10.71	16.15	450	Ps	310	Oz	0.8	5.0	2.0
22.10.71	16.35	495	Ps	335	Ps	1.4	15.0	0.0
				324	Ps			
23.10.71	20.15	460	Ps	340	Ps	0.8	80.0	43.0
				366	Ps			
29.10.71	17.55	460	Ps	290	Ps	4.8	60.0	56.0
				300	Ps			
30.10.71	17.15	465	Ps	315	Ps	0.0	0.0	0.0
				345	Ps			
				327	Ps			

Ps = Partly spent G = Gravid Oz = Oozing

The respective lengths of the females and the males employed in these experiments were 375-495 and 290-386 mm. It was observed during the experiments that one unspent male yielded milt sufficient enough to fertilise all the eggs stripped from an unspent female and still had much left in the gonads. In cases where partly spent males were used, it was observed that more than one male was necessary for the maximum fertilization of the stripped eggs, as these partly spent males did not yield more than a few drops of milt. Further, it was again observed that hilsa in the right stage of maturity suitable for stripping was available only in the afternoon between 16.00 and 22.00 hours. In experiments No. 6 and 9, the males used had died earlier than 30 minutes prior to stripping, confirming the observations of earlier years.

Hatching of the fertilised eggs : Experiments to hatch the fertilised eggs were carried out in the *hapas* made of markin cloth and nylon in white, red, yellow and green colours fixed in flowing waters (close to the bank) and in pools left behind in the Ganga bed after the floods had receded. In the riverine environment, the hatching percentage fluctuated between 2 and 75, while in the river pools, it was between 15 and 60.

In the riverine water, the fluctuation of the values of CO_3, HCO_3, Ca and Fe were 6.2-16, 86-172, 36-40 and 0.14-0.8 ppm respectively, while in the pool water, respective fluctuations varied as 4-16, 160-190, 19-39 and 0.13-1.0 ppm. The pH of the waters varied from 8.2 to 8.4. When the hatching success is compared with that of the corresponding period of 1969 and 1970 it is observed that probably higher values of bivalent Ca ions play a vital role in the process of hatching, pH of the water being more than 8.0 even when Fe ion concentration is low ; but in water with low pH, comparatively low values of antagonistic Ca ions, in face of higher Fe concentration result in higher hatching success.

It was also observed that hatching was comparatively earlier in nylon *hapas* as compared to markin *hapa*. Further, amongst the nylon hapas of different colours, hatching was earliest in red ones, though the percentage of hatching was high in yellow and green *hapas*.

Transport of hatchlings : In one experiment, 3-day old hilsa hatchlings (4-5 mm) were packed in sealed containers under oxygen @ 75,000 and 1,50,000/tin and transported to a distance requiring 5 hr for the travel. Only 57 hatchlings died during transportation. In another experiment, 2,000 hatchlings (3.5-4.0 mm) were packed in a sealed container under oxygen and transported to a distance of 160 Km requiring 20 hr to cover. Mortality was estimated to be only 2% when 5,000 hatchlings (4-5 mm) were transported to a distance requiring 5 hr for the travel, only 5% morality at the end of the experiment being observed.

Rearing of hilsa hatchlings in confined freshwaters : Hilsa hatchlings, produced through artificial fecundation during October, 1970 and stocked in two ponds at the Mogerson Fish Farm during the first week of November, 1970,

grew to an average size of 41.25 mm in the length range of 38-45 mm in a pond (45.72 m x 15.24 m) manured with 150 Kg raw cow-dung, 10 Kg lime (CaO), 70 Kg mahuwa oilcake and inoculated with Co (50 gm), Mn (5.0 gm) and Zn 2.5 gm) during a period of about 4 months. In another nursery pond manured with fertilizers ; *viz.*, 7.5 Kg of potassium nitrate, 7.5 Kg of urea, 15 Kg of superphosphate, 10 Kg of lime, 70 Kg mahuwa oilcake and micro-nutrients ; like, Co (5 gm), Zn (2.5 gm) and Mn (5 gm), the hatchlings (2.5-3.0 mm) had grown to 40.9 mm in average in the length range of 35-47 mm in about 4 months of pond rearing. Thereafter, total mortality was observed in both the ponds. Further, it was observed that the growth of hatchlings in the ponds at Mogarson was poorer in comparison to that in the ponds at Taraon where 2.5-3.0 mm long hatchlings grew to an average length of 43.0 mm in about 40 days of pond rearing.

2,00,000 hatchlings of hilsa (4-5 mm) were stocked in one nursery pond (30.48 m x 15.24 m) at the Taraon Fish Farm on October 24, 1971. The pond was manured on October 8, 1971 @ 150 ppm of mahuwa oilcake. After 40 days of pond rearing on December 2, 1971, the hatchlings had grown to an average size of 26.2 mm in the length range of 23-29 mm and the survival was estimated to be about 80-90%. On December 23, 1971, the 60-day old hatchlings had grown to an average size of 32 mm in the length range of 25-36 mm and are continuing to grow satisfactorily. In comparison to the growth recorded in 1969 and 1970, the present growth was less. In 1969, after 60 days of nursery rearing, 2.5-3.0 mm long hatchlings had grown to an average size of 47.5 mm in the length range of 46-52 mm in one pond and in the other, the average length attained was 53.0 mm in the range of 49-59 mm. During 1970, 5-9 mm long hatchlings grew to an average size of 27.4 mm in 43 days of nursery rearing.

Hilsa hatchlings produced through artificial fecundation during October, 1969 and reared in freshwater ponds completed 25 months of life in pond on November 18, 1971 and had grown to an average size of 342.5 mm in the length range of 320 to 365 mm. This compares favourably with the estimated total length of 355 mm in case of hilsa of age 1+ year in the Godavari estuary.

Experiments to measure the rate of oxygen consumption : Experiments to determine the rate of oxygen consumption by hilsa hatchlings (5-6 mm) adopting the closed chamber technique were carried out. The data obtained are being processed.

B. At Bobbarlanka on the river Godavari—Artificial fecundation : Investigations on artificial propagation of hilsa of the Godavari estuary were undertaken from 23.9.71 to 9.10.71. In the early phases, it was observed that the gonads of fish had not attained the desired maturity condition necessary for artificial fecundation. Later, due to heavy floods in the river, the fishery was extremely poor throughout the season and hence, no experiments could be carried out.

Problem : 20.1 Pollution in the Hooghly-Matlah estuarine system
Duration : Four years
Personnel: P. Ray, V. Gopalakrishnan, S. B. Saha (upto 12.7.1971) and B. B. Ghosh

The number of industries contributing to pollution of the Hooghly estuary are : paper & pulp—6 ; textile—5 ; distillery—2 ; tannery—1 ; rubber—1 ; miscellaneous—15 ; power stations—6 and jute—55. The average flow of the industrial wastes was 352.74×10^6 l whereas that of the domestic and municipal waste was 798.00×10^6 l. The industrial wastes contributed 30.6% of the total flow and the rest was contributed by the domestic and municipal wastes. Amongst the industrial waste waters, pulp and paper mills contributed to the maximum (15.5%) of the total flow. The Bagh canal discharged 7.9% of the total flow. Tannery, rubber, paints & varnishes, metal & steel, hydrogenated vegetable oil and soap industries contributed to 0.99% of the total flow. The discharges from distillery & yeast, match and shellac works were negligible.

Daily total pollution loads in terms of 5-day BOD at 20°C, total solids, suspended solids and dissolved solids contributed by the industrial, domestic and municipal waste waters were 106.11, 2,308.44, 1,057.33 and 1,251.11 t respectively. The industrial wastes as a whole contributed 66.03, 884.08, 411.93 and 472.15 t/day of total pollution load in terms of BOD, total solids, suspended solids and dissolved solids respectively, whereas the corresponding values for domestic and municipal wastes as a whole were 40.08, 1,424.36, 645.40 and 778.96 t/day respectively.

The important physico-chemical characteristics of the waste waters are given in table 30.

It is evident that the wastes discharged mainly by pulp & paper, tannery, cotton textile, distillery and yeast contribute to considerable pollution load in the Hooghly estuary and the waste waters from rayon textile mills discharging highly acidic waste, together with toxic metal (zinc) require adequae treatment before discharge into the river. The survey and characterisation of different types of wastes have been completed during this year.

A programme of investigations to characterise individual process wastes has been initiated in respect of rayon textile sulphate and sulphite wastes.

As observed during earlier years, clarity of water of the estuary was evident during the post-monsoon period upto February, when pH was 8.1 at all the centres. DO ranged between 5.35 and 6.60 mg/l and BOD was below 5 mg/l. With considerable fall in water level and slight rise in turbidity from March, DO was partially affected (between 4.35 and 6.50 mg/l) without affecting the BOD value while appreciable improvement in pH (8.3) was noticed in April. Appreciable fall in DO level (between 4.88 and 5.34 mg/l) was observed during July on account of high turbidity during the monsoon period which did not signify any organic pollution. This was also reflected from the BOD values which were always below 5 mg/l and oxidisable organic matter was not high.

Table 30. Characterisation of waste waters during 1971

Type of wastes	Temperature (°C)	Suspended solids (mg/l)	Dissolved solids (mg/l)	pH	DO (mg/l)	½ hr OC at 100° C by $KMnO_4$ (mg/l)	5-day BOD at 20° C (mg/l)	Pollution load in terms of 5-day BOD at 20° C (t/day)
Biological wastes (Tanneries, cotton textile, pulp and paper, yeast and distillery)	21.0 to 47.0	40 to 6,078	22 to 13,394	5.0 to 10.5	Nil to 8.0	4 to 31,300	12 to 21,600	45.91
Miscellaneous organic chemical wastes (paints and varnishes, shellac)	22.0 to 34.5	4 to 8,070	304 to 5,220	5.0 to 10.5	Nil to 9.6	8 to 1,420	8 to 1,600	1.88
Hydrocarbon waste (Rubber)	22.0 to 34.0	2 to 590	262 to 3,440	6.6 to 8.0	1.5 to 6.7	9 to 89	10 to 106	0.43
Wastes chiefly mineral in nature or partly organic (Rayon, match, metal and steel)	26.0 to 41.0	22 to 2,574	360 to 4,096	2.0 to 8.1	Nil to 6.2	8 to 438	10 to 1,175	5.01

Samples collected during high tide did not show any appreciable change in the water quality. The plankton concentration was uniform (48-94 u/l) with slight variation at almost all centres.

The study on the extent of pollutional effect around the outfall areas of India Pulp & Paper, Tribeni Tissue, Kesoram Rayon, Distillery and Yeast, and Dunlop Rubber (India) indicated that plankton concentration was extremely poor during June, July and November (Table 31). Except at the outfall area of Kesoram Rayon where pollution might be on account of the presence of zinc in highly acidic waste (25 mg/l, 24-m below the outfall area), at all other places, the pollution were organic in nature containing highly oxidizable substances.

Table 31. Average number of plankters per litre around the outfall area of various industries

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Nov	Dec
The river Hooghly	270.0	54.0	103.0	86.0	94.0	51.0	48.0	—	7.5	257.0
India Pulp & Paper	49.0	—	—	37.5	53.3	8.4	13.0	—	21.0	—
Tribeni Tissue	177.0	—	—	44.0	—	14.3	20.0	—	56.0	—
Kesoram Rayon	—	—	—	42.0	125.6	31.4	12.0	—	17.0	—
Distillery & Yeast	—	—	—	17.0	—	134.7	17.0	22.0	12 0	—
Dunlop Rubber	190.0	—	—	75.0	65.6	10.6	23.0	—	—	—

(c) *Research contemplated*

Over and above the problems on which work is continuing during the year relating to this report, a number of problem under different projects which could not be initiated in view of limitations of facilities and resources or which need confirmation, are also envisaged to be taken up in 1972. All these are shown below:

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

1.1—1.4 : Old programme will continue.
1.5 : Work completed in 1970.
1.6—1.7 : Old programme will continue.
1.8 : Work completed in 1971.
1.9—1.19 : Old programme will continue.

Project 2: Induced fish breeding

2.1 : Work completed in 1970.
2.2—2.6 : Old programme will continue.

Project 3 : Reservoir fisheries

3.1—3.2 Studies on the problems of the fisheries of the Tilaiya and Konar reservoirs will be continued and problems (population dynamics of commercial fishes, and fishery management and development in the reservoirs) will be taken up.

3.3 : While old programmes will continue, preparation of contour maps, eradication of unwanted fishes, studies on upwelling of nutrient level, introduction of fish food organisms and stocking of fingerlings in the Loni reservoir will be taken up.

3.4—3.5 : Besides continuing old programmes, studies on macrovegetation, preparation of contour map, eradication of unwanted fishes, studies on upwelling of nutreient level, introduction of fish food organisms and stocking of fingerlings in the Govindgarh and Kulgarhi reservoirs will be taken up.

3.6 : Old programme will continue and in addition studies on feeding, maturity and fecundity of fishes and attempts on induced breeding of *Puntius pulchellus* in peninsular tanks will be taken up.

3.7 : Work completed in 1970

3.8 : The old programmes will continue and collection of morphometric and meristic data for *P. pulchellus* and culture and biological studies of *P. pangasius* and *M. malcolmsonii* for developmet of peninsular tanks will also be taken up.

Project 4 : Riverine carp spawn prospecting and collection techniques

4.1—4.2 : Studies will be conducted under the Co-ordinated project

4.3 : Assessment of the magnitude of spawn disposal from the lower Ganga through the road transport and studies on flood level, current velocity turbidity, types of net used etc. at the important spawn production centres will be studied.

4.4 : Comparative growth rate study of fry raised from spawn of different sources will be continued.

Project 5 : Brackish water fish farming

5.1 : Studies on phreatic line for the dykes of 2 ponds of Bakkhali Farm and studies on the growth and survival of fish stocked in the farm ponds will be taken up.

5.2 : Tidal reading in relation to land under survey, studies on the discharge etc. of different canals which feed the brackish water ponds at Bakkhali, soil exploration test in the engineering line, preparation of blue prints for new farms and studies on scouring of Henry's Island will be coontinued.

5.3—5.4 : Old programme will continue.

5.5 : Determination of the cause for disintegration of the induced bred

fertilised eggs of *M. parsia,* experiments on gonadial development of *L. calcarifer* and *M. tade* through homoplastic pituitary injection and studies on the effect of trace elements ; like, cobalt chloride in increasing the productivity in the brackish water fish farm at Kakdwip will be made.

5.6 : Determination of interval of raking operation to keep the ponds of Kakdwip farm at a desired level for conservation of the mutrients ; assessment of relationship between the soil texture, salinity variation and penetration of light on the growth of benthos and plankton ; prawn and fish culture in different proportions and of various sizes to explore the possibility of culturing advanced prawns and small sized fishes will be in progress.

5.7 : Crude culture of phytoplankters in glass jars and earthen vats will be continued.

5.8—5.9 : Old programmes will continue.

5.10 : Detailed survey of the Lothian and Prentice islands for designing brackish water fish farms will be taken up.

Project 6 : Freshwater prawn culture

6.1 : Limnological observations of prawn culture ponds and a few selected centres on the Mahanadi and Katjuri rivers, sampling of prawn population, nature of migration and biological conditions of prawn and experiments on tolerance limits and induced breeding of prawn will be taken up.

6.2 : Artificial propagation of *M. malcolmsonii* in the laboratory and study of early life-cycle in natural environments at Junput will be taken up.

Project 7 : Murrel and live-fish culture

7.1 : Work will remain suspended since the Co-ordinated project will take up problems of live-fish culture.

7.2 : Survey of available resources of live fishes.

Project 8 : .Estuarine and brackish water lake fisheries

8.1 : Work on the problem will continue at 3 centres in the Hooghly-Matlah estuarine system. Standardisation of gear for the collection and the methods of transport of brackish water fish seed will be made.

8.2 : Rearing of *M. rosenbergii* at Junput and location of prawn seed collection centres will be taken up.

8.3 : Location of breeding grounds of *N. nasus* and *L. calcarifer* in the Pulicat lake, rearing *Neptunus pelagicus,* induced breeding of *Mugil cephalus,* studies on the ecology of brackish water fish ponds in the Adyar farm and culture of fish food organisms under laboratory conditions will be taken up and routine work of the Pulicat lake will continue.

Project 9 : Selective breeding and hybridisation

9.1 : Rearing of hybrids (catla × rohu and mrigal × rohu) for comparison with parent species will be done.

9.2 : Liquid nitrogen, dimethyl sulphoxide and physiological saline other than Frog Ringer's and Holtfreter's solutions are to be tried for the preservation of fish sperms.

9.3 : Screening of suitable hybrids between exotic carps for detailed study regarding improved cultural possibility is to be made.

Project 10 : Fish farm designing

The unit for this work has been set up and will soon start functioning at Cuttack.

Project : 11 Economics in fishery investigations

11.1—11.3 : Old programme will continue

Project 12 : Exotic fish culture

12.1 : Old programme will continue.

12.2 : In monoculture of silver carp, experiments on intermittent harvesting of marketable fish and subsequent replainishment with the same number of fingerlings keeping record of limnological data are to be conducted.

12.3 : Studies on the control of aquatic weeds by grass carp will be continued.

Project 13 : Cold water fish culture

13.1 : Work to evolve a cheap and balanced diet for trout will be continued and completed.

13.2 : Old programme will continue.

13.3 : Work completed in 1971.

13.4—13.5 : Work completed in 1970.

13.6 : Studies on fecundity and maturity of *S. esocinus* and *S. niger* and analyses of guts of all available fishes of the Dal lake will be taken up.

13.7 : Work completed in 1970.

13.8 : Rearing of alevins, fry, fingerlings and yearling of brown trout at Laribal farm and recording physico-chemical factors of the culture ponds will be done.

13.9 : Estimation of mahseer and allied fisheries in deep waters of hill streams of Jammu province is to be taken up.

13.10 : Studies on food of *Salmo trutta fario* in natural streams will be taken up.

Project 14 : *Riverine and estuarine fish catch statistics*

14.1—14.2 : Old programme will continue.

14.3 : Work completed in 1969.

14.4 : Work will be completed soon.

14.5 : Old programme will continue.

14.6 : Effect of major environmental changes on the fisheries of commercially important stocks of the Hooghly-Matlah estuary will be studied.

Project 15 : *Fish pathology*

15.1 : Studies on fish diseases and parasites will be taken up at Cuttack as new staff for the unit are being appointed there.

Project 16 : *Weed control*

16.1 : Control of rooted, emergent and floating weeds will continue.

16.2—16.3 : Old programme will continue.

16.4 : Study of fertility value of ammonia after killing and disintegration of *Hydrilla* sp. will be in progress.

16.5 : Compost of various weeds will be used to see its effect on growth of plankton.

16.6 : Study of autecology of aquatic weeds will be in progress.

Project 17 : *Frog farming*

17.1 : Induced breeding of *R. tigrina, R. hexadactyla* and *R. crassa* with FSH, HCG and progestarone will be continued.

17.2—17.5 : Old programme will continue.

Project 18 : *Sewage fed fisheries*

18.1 : The programme will be started afresh in 1972 as new staff for the unit are being appointed.

Project 19 : *Hilsa fisheries*

19.1 : Studies on appraisal of hilsa fisheries using morphometric measurements and recording of limnological data will be carried out.

19.2 : Old programme will continue.

19.3 : Artificial fecundation of the hilsa from the river Godavari will be tried.

19.4 : Determination of the characteristics of the Hilsa shoals of the river Hooghly will be continued.

19.5 : Old programme will continue.

Project 20 : Water pollution

20.1 : Investigation on the pollution of the Hooghly estuary, as related to its fishery potential will be continued.

3. Paper Published

The following papers were published by the staff of the Institute during the year 1971 :

Banerjea, S. M. 1969
On the control and abatement of pollution of inland waters by industrial effluents. *First IIT-K Symposium on Industrial Wastes*, February 14-16, 1969 : 103-109

———— 1967
Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian J. Fish.*, **14** (1 & 2) : 115-114

Banerjea, S. M. & S. R. Ghosh 1970
Studies on the correlation between calcium-bound phosphate and free calcium carbonate in water-logged soils. *J. Indian Soc. Soil Sci.*, **18** (3) : 259-263

———— 1970
Studies on the correlation between soil reaction and different forms of bound phosphorus in pond soils. *J. Inl. Fish. Soc. India*, **2** : 113-120

Banerjee, A. C. & N. C. Roy Choudhury 1966
Observations on some physico-chemical features of the Chilka lake. *Indian J. Fish.*, **13** (1 & 2) : 395-429

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4. Extension

Extension—(a) Result of immediate practical application: Extension pamphlets on (i) techniques of nursery management, (ii) induced breeding of major carps, (iii) breeding of the common carp and (iv) intensive fish farming have been finalized in the light of the comments received from different State Fisheries Departments. Action to print these pamphlets has been taken up.

(b) Results likely to be useful to the farmers, but needing further trials: Arrangements are being made for conducting training classes of about 4 to 6 weeks duration at Cuttack Substation for the propagation and use of grass carp.

An extension pamphlet on the "use of grass carp for weed control, and raising of fry and fingerlings of grass carp" is under preparation.

Publicity activities: The Statesman, New Delhi dated 2.6.71, published an article by a staff reporter, entitled "A finder of wealth in water" where the views of Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, about aquaculture in India were reported.

Informative write-ups on weed control in fish farms and induced breeding of fishes were sent to Indian Council of Agricultural Research during July, 1971 for Satellite Television experiment programme as per agreement of Department of Atomic Energy with NASA for Programmes on Agriculture.

Twelve posters highlighting the research achievements of the Institute were sent to Indian Council of Agricultural Research for inclusion in an Exhibition on Agricultural Research held during May, 1971 in the lawns of the Parliament House, New Delhi.

A poster exhibition was arranged on the occasion of workshop on Spawn Prospecting, held in May 29 and 30, 1971 at Allahabad Substation of the Institute.

Another poster exhibition explaining the research activities of the Institute was arranged on the occasion of workshop for Reservoir Fisheries, held at Barrackpore during August 30 and 31, 1971.

5. Conferences and Symposia

Dr. H. Chaudhuri, Fishery Scientist, and Sarvashri S. B. Singh and R. M. Bhowmick, Jr. Fishery Scientists of this Institute participated in the Workshop on "Induced breeding (Hypophysation) of carps" held at Central Institute of Fisheries Education, Bombay during February 22-27, 1971.

A symposium on "Trends of Research in Zoology" was organised by the Zoological Society (Calcutta University), Ballygunge on the occasion of its Silver Jubilee held on May 23 and 24, 1971, in which the following papers were presented from this Institute.

Jhingran, V. G.
Trends of Inland Fisheries Research in India.

Gopalakrishnan, V.
Recent trends of researches in coastal aquaculture.

Ghosh A.
Observations on the larvae and juvenile of "Bhetki" *Lates calcarifer* (Bloch) from the Hooghly-Matlah estuarine system.

Khan, H. A. and S. K. Mukhapadhyay
Observation on the effect of yeast and cobalt chloride in increasing the survival rate of the hatchlings of *Heteropneustes fossilis* (Bloch).

A workshop on All India Co-ordinated Research Project on "Investigations on Riverine Carp Spawn Prospecting and Collection Techniques" was

held during May 29 and 30, 1971 at the Central Inland Fisheries Research Substation, Allahabad. The following papers were presented at the technical sessions of the workshop:—

Kulkarni, C. V.
Status of fish seed production in India.

Shetty, H. P. C.
A review of spawn prospecting work done by Central Inland Fisheries Research Institute.

Rao, K. V.
Prospects of spawn collection in river Brahmaputra.

Navathe, K. V.
Techniques of major carps seed collection from rivers.

Ghosh, K. K.
Efficiency of selected spawn collection nets.

Kamal, M. Y.
Techniques of segregation of desirable spawn in riverine collection.

Motwani, M. P.
Economics of carp seed collection from rivers.

Das, K. N.
Major carps seed trade in India.

Abstracts of the following papers were forwarded for the seminar on "Shrimp or Prawn Mariculture" to be held at Madras under the auspices of Tamil Nadu Fisheries Department:—

Jhingran, V. G.
Recent trends of research in brackish water prawn culture.

Gopalakrishnan, V.
The potential for intensive cultivation of estuarine prawns in India.

Rao, K. Janardhana
Observations on the seasonal abundance of postlarvae of *Metapenaeus monoceros* (Fabricious) and *M. dobsoni* (Miers) in the Pulicat lake.

Ghosh, A. N., N. K. Das and H. S. Mazumder
Pilot observations on the culture of prawns in brackish water ponds at Kakadwip, West Bengal.

A workshop on the All India Co-ordinated Research Project on "Ecology and Fisheries of Freshwater Reservoirs" was held on August 30 and 31, 1971 at Central Inland Fisheries Research Institute, Barrackpore. The following papers were presented at the same.

Tripathi, Y. R.
Development and management policies of reservoir fishery.

David, A.
Experimental fishing in reservoirs.

Natarajan, A. V.
Problems of fisheries development in reservoirs.

Alagaraja, K.
Sampling Techniques for fish population studies in reservoirs.

Gopalakrishnayya, Ch.
Importance of fish food studies in reservoir fisheries research.

Bhatnagar, G. K.
Importance of benthic biota studies in reservoir fisheries research.

Jhingran, A. G.
Factors relating to stocking programmes in reservoirs.

Kuriyan, G. K.
Fishing methods in freshwater reservoirs of India.

Sreenivasan, A.
Recent trends of limnological investigations in India reservoirs.

Two more workshops were held at Central Inland Fisheries Research Substation at Cuttack for (i) "Composite Culture of Indian and Exotic Fishes" and for (ii) "Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps" during August 17 and 18, and August 19 and 20, 1971 respectively.

Papers presented at the former workshop:

Alikunhi, K. H.
Development of intensive fish culture practices in India.

Sinha, V. R. P.
Review of composite fish culture techniques.

Chaudhuri, H.
Stocking and management in composite fish culture.

Chakraborti, R. D.
Role of exotic fish in composite fish culture.

Lakshmanan, M. A. V.
Nursery management practices in relation to composite fish culture.

Sukumaran, K. K.
Production of stocking materials for composite fish culture.

Khan H. A.
Artificial feeding in composite fish culture.

Banerjee, S. M.
Soil studies in composite fish culture.

Chakraborty, D. P.
Role of fertilizers in increasing fish production.

Papers presented at the latter workshop:

Kulkarni, C. V.
Fisheries potential of air-breathing fishes of India.

Parameswaran, S.
Ecology of swamps and other derelict water masses.

Chaudhuri, H.
Culture of air-breathing fishes.

Dehadrai, P. V.
Physiological adoption of air-breathing fishes in relation to adverse environmental features.

6. Summary

During the year, progress was made in 17 out of 20 projects and action was taken to set up project on "Fish Farm Designing". The work of "Fish Pathology" and "Sewage Fed Fishery" units had to be kept in abeyance during the year due to lack of staff.

Project 1 :

1.1: A net production of 2,963 Kg/ha of fish was obtained in composite culture of silver carp, catla, rohu, grass carp, mrigal and common carp stocked in the ratio 1.5 : 0.75 : 3 : 1 : 1.5 : 1.5 respectively and with continuous harvesting followed by replacing the harvested number. Catla and silver carp attained over 1 Kg at the end of 5 months. Average survival (%)/weight (Kg) of the initial stock was 88.3/0.7 in 5 to 12 months.

1.2: A feed formulation with 65% plant material and 35% fish meal or prawns waste powder, was acceptable to all cultured fishes. With fish meal 100% survival and 18% growth was obtained whereas with prawn waste, 93% survival and 19.5% growth were obtained.

Zooplankton ensured better survival and growth of spawn of catla, rohu and mrigal than those with silkworm pupae, prawn waste, soyabean and mixture of ground-nut oilcake and wheat bran. For the gain in weight, zooplankton feed was the best for catla fry and silkworm pupae for rohu. Rohu consumed artificial feed more than catla.

1.3: Artificial feed containing cobalt chloride @ 0.01 mg/day/fish was administered to rohu hatchlings. The results indicated enhanced survival and growth rates.

In another set of experiments, average growth increments 123.33 mm/117.49 gm, 127.8 mm/98.64 gm and 121.46/91.47 gm were obtained in respect of cobalt chloride, starch and manganese given @ 0.01, 3.44 and 0.01 mg/day/fish respectively, as compared to 106.17 mm/69.27 gm in the control.

1.4 : Ammonium sulphate in alkaline soil gave the maximum growth of *Cyprinus carpio* at 80 Kg N/ha and of rohu at 50 Kg N/ha. Primary production in alkaline soil was higher with urea at higher level of nitrogen ; but at medium level, ammonium sulphate gave the maximum production.

Slightly acid soil treated with nitrogenous fertilizers @ 80 Kg N/ha gave

the maximum growth of fry (44.08 mm/1.05 gm) as compared to 32.06 mm/0.34 in control.

Neutral soil treated with urea gave the maximum survival (76%) of fry followed by calcium ammonium nitrate (61%), ammonium sulphate (45%) and control (13%), the respective percentages of zooplankton being 89, 71, 41 and 16. Urea as manure increased the bottom fauna markedly.

1.5 : Research completed in 1970.

1.6 : No progress.

1.7 : Preparatory cultures of 5 algal species were done in Bristol's solution with urea and Chu-10 solution on agar plate at a controlled temperature 25°C ±1 and artificial illumination of 100, 200 and 500 lux. *Cyclops* sp., *Moina* sp and *Dophnia* sp. were cultured in glass jars in cotton seed extract, paddy straw extract and boiled and filtered pond water.

1.8 : Studies on the estimation of food value of dried fresh water algae as a nutritive source to fishes have been completed in 1971.

1.9 : Samples of two unproductive pond soils from Orissa and Tripura, treated with $N_{40}P_{40}$ in 4 divided doses at an interval of three months, showed marked response to the fertiliser combinations as measured by primary productivity. Another experiment has been initiated with $N_{40}P_{80}$

1.10 : Observations on a highly unproductive and a highly productive ponds in acid soil zones of Tripura indicated that productive pond had markedly higher organic content, dissolved phosphorus (both in organic and inorganic forms) and mitrogen (in organic and ammonical forms), while the unproductive pond had higher nitrate nitrogen concentration.

1.11 : Laboratory experiments on the prevention of seepage conducted with two highly permeable soils, (sandy loam and loamy sand types) indicated that sandy loam type soil was more percolative than the latter, the rate of seepage being 30 and 22 cm/hr respectively. Studying the effect of sticky soil and saline and sticky soil, percolation rates were reduced in both types of soils.

1.12 : Dry alcoholic extract of *Barringtonia acutangula* though effective was found unsuitable for easy handling.

1.13 : The efficiency of the modified drag-net in relation that of the conventional one was 1.52. The net having a hanging coefficient of 0.7 was suitable for collecting representative samples and the difference between the estimated and actual population was within 5% error.

1.14 : Seed of Indian major carps were not found to show any sharp differential responses to continuous depletion of dissolved oxygen, in an attempt to segregate them specieswise by such means as was the case of light of different colours and intensities in earlier experiments.

1.15 : For selective capture of predators and unwanted fishes from carp culture ponds, bamboo-, metalic- and fibre-traps were fabricated.

1.16 : Growth rings and checks on scales and bony parts did not appear to correspond with the years of life of fish grown in ponds.

1.17 : More than 1 minute exposure of rohu hatchlings to ultraviolet light killed them and the eggs exposed for more than 3 minutes did not hatch out.

1.18 : Boron and cobalt (at 0.05-0.20 ppm) in acid soils, encouraged growth of diatoms and zooplankton. Growth of rohu spawn was better with cobalt and boron (0.05 ppm) in the water than in the control.

Project 2 :

2.1 : Research completed in 1970.

2.2 : As many as 2,017 fish pituitary glands were collected. Extracts from the pitutaries of catfish (*Mystus seenghala* and *Bagarius bagarius*) were found to be efective in inducing spawning in carps.

2.3 : A total of 182 ampoules of pituitary extract in glycerine (40 mg/ml) were prepared and 84 of these distributed to different states. Nagaland achieved success in induced breeding of major carps by using these ampoules. Acetone preserved pituitary material kept under room temperature for 16 months was found effective in inducing spawning.

2.4 : Hatching and survival of spawn in newly designed hatching jars were better as compared to that in *hapas* fixed in pond.

2.5 : No adverse effect of inbreeding was observed on the survival and growth of induced bred fish in an experiment of 7-month duration.

2.6 : The breeding of the same specimens of Indian major carps has been achieved for the second time in the same reason through hypophysation. This may lead to prolongation of the breeding reason and domestication of the carps.

Project 3 :

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

3.3, 3.4 & 3.5 : Investigations on hydrology, primary productivity, soil analysis, plankton, bottom biota, macrovegitation, experimental fishing and biology of commercially important fishes were undertaken in the Loni, Govindgarh and Kulgarhi reservoirs. Investigations on the biology of uneconomic species of fish in the Kulgarhi reservoir were also continued.

3.6 : Assessment of primary productivity, biomass production, plankton, littoral and benthic organisms and physico-chemical conditions of water and soil was carried out in Hutchammankere, Sakalwara, Karpur and Bellandur tanks in Bangalore ; Arsikere, Nidige, Milghatta, Hutcharayankere and Medaga tanks in semi-malnad area and Kadagrahara and Side Hoskote ponds in Bangalore.

3.7 : Research completed in 1970.

3.8 : Feeding experiments on the efficacy of weed consuming and weed clearing capacities of *Puntius pulchellus* were carried out in three stages.

Project 4 :

4.1 & **4.2** : Research is being carried out under a Co-ordinate Project.

4.3 : The total production of fish spawn (32,900 *hundies*) in the year, from the lower sector of the Ganga river system in Bihar and West Bengal, registered a decline by 37.37% when compared to the production of the previous year. Sixteen common spawn exporting centres showed a fall over the last year's production by 15.34%.

4.4 : Observations on the comparative growth rate study of spawn from the rivers Kosi, Ganga, Gomti and Yamuna, and induced bred spawn were continued at Allahabad and Bhagalpur. Spawn from the river Kosi indicated better growth rate.

Project 5 :

5.1 : Observations on the rain fed ponds in Bakkhali Fish Farm showed that the minimum water level of about 227.0 cm was well within the limits required for successful polyculture. The water and soil salinity of the pond 'K' came down to 1.26% and 0.43% respectively. The maximum primary productivity and the plankton volume were observed to be 260 mg $C/m^3/hr$ and 0.1-1.3 ml/50 l respectively. The central pond 'K' has been stocked with fry and fingerlings of carps and mullets with a view to study their growth and salinity tolerance.

Compost manure made using paddy straw and "Bain" leaves indicated low nitrogen and phosphate contents, and the deficiency was made up by adding extra nutrients.

5.2 : Detailed survey of selected islands in the lower Sunderbans for designing a brackish water fish farm was completed and a layout of the farm is being prepared.

5.3 : Observations on the experimental brackish water fish farm in the lower Sunderbans on the rearing of fish and prawn seed (in wild and selective stocking) were made. The pond soil remained near neutral to just alkaline. Trials with a newly designed sluice box were also initiated.

5.4 : The lethal salinity tolerance limit of major carps fry was found to be 12.5-13.0‰, while in fingerlings, 100% survival was noted upto 8‰. In acclimatization experiments with major carps, growth was satisfactory between 0.39 and 6.00‰ salinity ; but total mortality occured when the level reached 12.6‰.

5.5 : Nursery management techniques experimented so far for mixed culture and monoculture of hervivores and carnivores have given promising results. Provision of supplementary food resulted in better growth. The relationship between organic and inorganic fertilisers and primary productivity was studied.

5.6 : Fish farm management techniques for *Lates calcarifer, Mugil tade* and *M. parsia* are under trial.

5.7 : The work on the culture of brackish water fish food organism was continued.

5.8 : Breeders of mullet (12 sets) were administered with homo- and heteroplastic pituitary extracts. The fertilization and hatching took place in all the sets. However, the hatchlings survived only for a period of 6 days.

Project 6 :

6.1 : In mixed farming of prawn and fish, growth of prawns fed with mustard oilcake, rice bran and prawn powder was almost twice as in control. Though survival was less than in control the production of prawn with artificial feed was 147 Kg/ha as against 95 Kg/ha in control. The production of fish with artificial feeding was also greater (812.5 Kg/ha) than in control (487.5 Kg/ha).

6.2 : Prawns stocked in December, 1970 in ponds, were harvested in September, 1971. The growth rate was good, but the survival was poor. It was also noticed that there were two distinct size groups, one showing faster growth than the other. Observations on artificial feeding, gut content analysis, tagging and marking trials were continued.

Project 7 :

7.1 : No progress

7.2 : *Anabas testudineus* and *H. fossilis* could be bred through hypophysation with 1-year old carp pituitary glands. Success has been achieved in induced breeding of *Clarias batrachus*. Spawning of *H. fossilis* could be extended when the fish was exposed to long photoperiods.

Project 8 :

8.1 : Brackish water fish seed prospecting was carried out at Diamond Harbour, Kulpi and Namkhana on the Hooghly estuary, and at Port-Canning on the Matla estuary.

8.2 : Experiments on rearing of *Macrobrachium rosenbergii* were conducted upto the IV zoeal stage.

8.3 : Influx of postlarvae and juveniles of economically important fishes into the Pulicat lake showed a marked increase during the year as compared to the last year's.

Studies on experimental feeding of mullets, bottom biota, hydrography, plankton and productivity, experimental fishing, food habits of *Penaeus indicus*, marking experiments on *P. indicus*, development of the carbs (*Neptunus pelagicus* and *Scylla serrata*), induced breeding of *Mugil cephalus*, flora and oysters of the Pulicat lake were continued.

Project 9 :

9.1: 30,000 specimens of hybrids of mrigal ♂ × catla ♀ and calbasu ♂ x catla ♀ have been produced during the year and their biological and genetical features were studied.

9.2: Sperms of *Cyprinus carpio* kept in coconut milk under refrigeration were found to be motile for 24 hr.

9.3: The hybrids between common carp ♀ × silver carp, ♂ common carp ♀ × grass carp ♂ and silver carp ♀ × grass carp ♂ produced in 1970 were reared in *hapas* fixed in ponds and in plastic pools for about 10 months.

Project 10:

Unit for research in fish farm engineering has been set up and investigations at Kaushalyaganga will be taken up shortly.

Project 11 :

11.1 : Economics of fish culture operations in 15 private and 16 public sectors in West Bengal and Orissa have been worked out.

11.2 : Economics of fish seed production from 6 fish seed farms in Orissa and 2 fish seed farms in West Bengal were worked out.

11.3 : Studies on the economic evaluation of weed control by scientific methods were continued.

Project 12 :

12.1 : 2,61,000 spawn of silver carp and 28,000 of grass carp could be produced by artificial fertilization following pituitary hormone injections. The poor condition of grass carp breeders crowded in a few available ponds was responsible for the low production. Substituting the usual hatching *hapa* with thin nylon *hapa* reduced the mortality of developing embryos.

12.2 : The growth and survival of silver carp in monoculture experiments were poor in weed and algae infested ponds.

12.3 : The legume fodder, Berseem, was found to be consumed by grass carp in feeding trial experiments.

Project 13 :

13.1 : Research completed in 1970.

13.2 : Experiments on artificial feeding of brown and rainbow trouts were initiated at Laribal in cemented bottom ponds which were stocked with fry and fed with finely minced sheep liver. Percentage survival, after one month, was higher in cemented pond than in the control pond.

13.3 : The work on standardisation of trout culture techniques has been concluded and the final report is under preparation.

13.4 & **13.5** : Research completed in 1970.

13.6 : Two centres, Hazaratbal and Saidakadal, were selected to assess the productive potential of the Dal lake. Studies on physico-chemical features, surface plankton, vegetation, bottom biota and catch/man/hr were continued. The dominant species recorded were *Schizothorax* spp., *Cyprinus carpio, Crossocheilus latius* and *Labeo dero.*

13.7 : Research completed in 1970.

13.8 : A total of 60,720 eggs were stripped from brown trout breeders at Laribal Trout Fish Farm during November, 1971. 94.2% fertilization was achieved. To reduce mortality of green eggs, Malachite Green treatment (1:2,00,000) was given for a period of 1 hr.

13.9 : To estimate the mahseer and allied fisheries in deep water of hill streams of Jammu province, gill-net of 4-cm mesh bar was operated on trial basis. Samples of insects were also collected to study their population composition.

13.10 : Two natural streams ; viz., Varinag (spring fed) and Erin (snow fed) were selected for the food study of *Salmo trutta fario.* Gut contents of the species from the two streams were examined. The physico-chemical factors along with insect samples were also recorded.

Project 14 :

14.1 : Analysis of catch statistics of the middle stretch of the Ganga river showed that the correlation between the numbers of araths and the mean landing/arath/day within a market was significant and the coefficient of variation of the numbers of araths at each centre was found to be lesser than the mean landing/arath/day. Hence the ratio-estimate based on the number of araths as the concomitant variable appears to be quite efficient. The primary productivity in the Ganga and Yamuna rivers above the confluence and in the Ganga river below the confluence ranged from 26.52 to 141.25, 17.50 to 187.50 and 25.00 to 94.50 mg $C/m^3/hr$ respectively.

14.2 : The total estimated catch from Sultangang to Lalgola stretch of the Ganga river system was 366.93 t during the year. Catch estimates from two new centres, Sahibganj and Farakka, were found to be 133.69 t forming 26.73% of the total catch (500.08 t) from the lower stretch. In the river Ganga at Bhagalpur, the primary productivity ranged from 34.38 (September) to 133.33 mg $C/m^3/hr$ (May).

14.3 : Research completed in 1969.

14.4 : The total estimated landings from the Hooghly-Matlah estuarine system were 13,734.3 t. Drift-net among gears and hilsa mong species caught contributed the maximum ; i.e., 6,096.2 and 6,391.1 t respectively. The most remarkable feature of this year's fishery was the abundance of *H. ilisha* during the monsoon months.

14.5 : The total fish landings for the Pulicat like were 1,173.341 t which was 0.2% more than that of the previous year. Prawns (417.401 t) and clupeids (105.127 t) showed a decline by 26.32 and 16.28% respectively in their landings as compared to last year's. The contributions of mullets, perches and crabs in the catches were 297.988, 125.402 and 102.234 t respectively.

Project 15 : Kept in abeyance.

Project 16 :

16.1 : 2, 4, 5-T (40% amine salt) has been found to be as effective as 2, 4-D against water-hyacinth but cannot be recommended on account of its toxicity to warm blooded animals. Disintigeration of water-hyacinth by 2, 4-D increased the phosphate content of the water and fish production was nearly twice as high as in pools with the living weeds.

16.2 : Bloom of blue-green algae, *Microystis* sp. could be controlled in the field by Simazine (Tafazine-50) @ 0.3 ppm active ingredient.

16.3 : A new weedicide formulation, BV 201, was found effective against *Hydrilla* sp., but was very toxic to fish. Tok E 25 applied @ 20 Kg a.i./ha damaged leaves and stems of *Panicum* sp., but regeneration of the same was not checked.

16.4 : Aqueous ammonia applied on the foliage of *Pistia* sp. and *Salvania* sp. could kill the weeds. At a lower dose of 0.25%, mixing of wetting agent 'Surf' enhanced the effectiveness of ammonia.

16.5 : *Eichhornia* sp. when treated with 16% solution of superphosphate at a dose of 500-1,500 Kg/ha died completely ; but the effect was more pronounced at a higher dose of 1,500 Kg/ha.

Commercial copper sulphate, when sprinkled on *Eichhornia* sp., could kill them at a dose of 25-35 Kg/ha.

A small area of a canal at the Howrah Botanical Garden, thickly infested with *Eichhornia* sp. and having flowing water, was directly treated with copper sulphate in three intermittent doses @ 35 Kg/ha. Within a month, the plants died inspite of the flowing water.

16.6 : No progress.

Project 17 :

17.1 : Several sets of *Rana tigrina, R. crassa* and *R. hexadactyla* were bred with homo- and heteroplastic pituitary extract @ 10 mg/Kg body weight. Dry fertilization yielded 100% success. Fecundity varied according to size and species. Induced hybridization between *R. tigrina* ♀ and *R. crassa* ♂ very much reduced the cannibalistic tendency of the tadpoles as compared to those of *R. tigrina.*

17.2 : 8.4, 3.7 and 8.1 thousand tadpoles of *R. tigrina. R. hexadactyla* and *R. crassa* respectively in addition to 2.5 thousand hybrid tadpoles of *R.*

tigrina ♀ and *R. crassa* ♂ were produced. Tadpoles of *R. hexadactyla* showed survival of 87.8-89.4% in five weeks.

In mixed rearing of tadpoles and hybrid spawn of Indian major carps, no adverse effect on either forms was noticed.

17.3 : 772.6 Kg/ha of frogs (*R. hexadactyla*) were produced in one year in weed-infested ponds (0.04 ha).

17.4 : Small frogs (*R. hexadactyla*) have been stocked with fingerlings of Indian major carps and exotic carps and regular observation on the growth and survival are being made.

17.5 : No progress.

Project 18 : Kept in abeyance.

Project 19 :

19.1 : Observation on winter and post-monsoon spawning of hilsa indicated that post-monsoon breeding of hilsa commenced from mid-September and continued till about the mid-November. The catch/net/hr of postlarvae has indicated that hilsa spawning during the year was heavier as compared to that in 1970. Hilsa landings showed an unusual abundance during the year and a report on this aspect has been published.

19.2 : The total landings of hilsa from the lower stretch of the Ganga river system were recorded to be 146.49 t as against 122.45 t of the preceding year. The period from June to November, was responsible for the bulk of the catches from the whole stretch and has further revealed that the fishery in the entire stretch was supported by all the three sub-populations. Two seperate spawning seasons, one during the post-winter months (March and April) and the other during the monsoon months (July to October), were observed. The intensity of spawning was higher during post-winter months at all the centres of observation. The number per 1,000 m^3 water varied between 0.24 in May and 32.37 in April at Bhagalpur, between nil in March and 26.20 in May at Rajmahal and 15.84 in May and 173.25 in April at Dhulian. Low spawning activity was observed in monsoon months. The number of larvae per 1,000 m^3 water ranged between nil in August and 115.90 in July.

19.3 : Sampling for studies on length, weight, age-composition and maturity of H. *ilisha* was carried out at the Gautami estuary and in the freshwater stretch of the river Godavari at Dowleswaram. The fishery commenced late and the males in III group were dominant in catches throughout the season. Females in V group were poorly represented. Fecundity was found to vary between 2.68 and 18.10 lakh ova in the range of 65.0-255.0 gm of ovary weight. There was further decline in the average weight. 15 trials to induce breed hilsa were not successful.

19.4 : The spawning grounds of *H. ilisha* in a 25-Km stretch, between Dathrigram and Medgachi of the Hooghly were studied. Average catches/net/

hr of larvae were found to be 343.00, 566.32 and 495.10 at Kalna, Dathrigram and Medgachi centres respectively.

19.5 : Success was achieved in 6 out of the 9 experiments conducted for artificial fecundation of hilsa. In the riverine environment percentage of hatching fluctuated between 2 and 75, while in the isolated river pools it was between 15 and 60. An attempt has been made to correlate the physico-chemical features with the rate of hatching. Observations have shown that hatching was earlier in nylon *hapas* as compred to *markin hapas.* Studies on transport of hilsa spawn and rearing of hatchling in confined waters were continued. Experiments were conducted to determine the rate of oxygen consumption of hilsa hatchlings.

Project 20 :

20.1 : The survey and characteristics of different types of wastes poured into the Hooghly estuary have been completed. Studies on the physico-chemical characteristics of the wastes, and plankton were made regularly. The pollution loads during the different seasons were also estimated.

7. Personnel

Retirement : Shri S. M. Banerjea, Fishery Scientist of this Institute retired from service in the afternoon of December 31, 1971.

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

Senior Clerk

Shri A. K. Das	:	Promoted as Head Clerk
Shri M. L. Biswas	:	Promoted as Head Clerk
Shri A. K. Sengupta	:	Promoted as Accountant

Junior Clerk

Shri M. Prasad	:	Promoted as Senior Clerk
Shri S. K. Singh	:	Promoted as Senior Clerk
Shri D. K. Banerjee	:	Promoted as Senior Clerk
Shri M. M. Neogi	:	Promoted as Senior Clerk
Smt. S. Das	:	Promoted as Senior Clerk
Shri D. C. Bose	:	Promoted as Senior Clerk
Shri N. Baidya	:	Promoted as Senior Clerk
Sk. A. Halim	:	Promoted as Senior Clerk
Km. N. Choudhuri	:	Promoted as Senior Clerk
Shri C. C. Das	:	Promoted as Senior Clerk

Gestetner Operator

Shri S. C. Bhowmick	:	Promoted as Senior Gestetner Operator

Book Binder

Shri M. M. Das	:	Promoted as Senior Book Binder

Watchman

Shri D. Bahadur	:	Promoted as Laboratory Boy
Shri Harke Bahadur	:	Promoted as Fieldman
Shri Hari Bahadur	:	Promoted as Fieldman

Fisherman

Shri H. K. Samal	:	Promoted as Laboratory-cum-Fieldman

Mali

Shri N. Jena	:	Promoted as Fieldman

Laskar

Shri K. Gopal	:	Promoted as Fieldman

Sweeper

Shri L. R. Balmiki	:	Promoted as Fieldman

Transfers : The following transfers were made during the year under report :

Senior Fishery Scientist

Shri A. V. Natarajan	:	From Hazaribagh to Nagarjunasagar

Junior Fishery Scientist

Shri G. K. Bhatnagar	:	From Rewa to Nagarjunasagar
Shri Ch. Gopalakrishnayya	:	From Madras to Bhavanisagar
Dr. A. G. Jhingran	:	From Allahabad to Rihand
Shri R. M. Rao	:	From Bangalore to Kurnool
Shri B. V. Gobind	:	From Hazaribagh to Bhavanisagar
Shri K. N. Krishnamurthy	:	From Madras to Karnal
Shri S. P. Ayyar	:	From Hazaribagh to Bhadra
Shri R. N. Pal	:	From Barrackpore to Gauhati
Shri K. V. Rao	:	From Bhagalpur to Gauhati
Shri M. Y. Kamal	:	From Allahabad to Patna

Senior Research Assistant

Shri R. D. Prasadam	:	From Madras to Nagarjunasagar
Shri S. R. Ghosh	:	From Kakdwip to Nagarjunasagar
Shri C. Selvaraj	:	From Panna to Bhavanisagar
Shri D. P. Chakraborty	:	From Cuttack to Barrackpore
Shri M. K. Banerjee	:	From Calcutta to Barrackpore
Dr. P. U. Verghese	:	From Barrackpore to Bhavanisagar
Shri J. B. Rao	:	From Rewa to Karnal
Shri G. V. Kawtal	:	From Cuttack to Poona
Shri N. K. Das	:	From Kakdwip to Darbhanga
Shri A. V. P. Rao	:	From Madras to Bhadra
Shri A. K. Ghosh	:	From Barrackpore to Gauhati

Research Assistant

Shri R. K. Dwivedi	:	From Kulgarhi to Allahabad
Shri A. C. Nandy	:	From Cuttack to Allahabad
Shri M. M. Bagchi	:	From Cuttack to Barrackpore
Shri G. R. M. Rao	:	From Rajahmundry to Madras
Shri H. S. Mazumder	:	From Kakdwip to Kolaghat
Shri P. B. Das	:	From Kolaghat to Kakdwip

Junior Survey Assistant

Shri B. D. Saroj	:	From Allahabad to Buxar
Shri K. Gopinathan	:	From Pulicat to Madras

Junior Clerk

Shri Jagadish Rai	:	From Allahabad to Karnal
Shri T. K. Sreedharan	:	From Rewa to Allahabad & then to Bhavanisagar

Laboratory-cum-Fieldman

Shri H. K. Samal	:	From Cuttack to Rihand

Fieldman

Shri K. Gopal	:	From Madras to Bhadra
Shri Hari Bahadur	:	From Kakdwip to Patna
Shri K. Prasad	:	From Loni to Shankargarh

Fisherman

Shri R. C. Biswas	:	From Kakdwip to Barrackpore
Shri G. C. Mandal	:	From Rewa to Barrackpore
Shri N. K. Barman	:	From Rewa to Patna

Peon

Shri C. R. Halder	:	From Kakdwip to Barrackpore

Watchman

Shri Ram Bahadur	:	From Allahabad to Barrackpore

Staff : The following staff rendered their services to the Institute during the year under report :

Director

DR. V. G. JHINGRAN

1 Freshwater Fish Culture Division (Cuttack)

1.1 Central Inland Fisheries Research Substation, Cuttack (Orissa)

Senior Fishery Scientist	:	Dr. H. Chaudhuri
Fishery Scientist	:	Dr. M. T. Philipose, Dr. A. K. Mondal and Shri V. Ramachandran
Junior Fishery Scientist	:	Sarvashri S. P. Singh, R. D. Chakraborty, M. A. V. Lakshmanan and R. M. Bhowmick

Assistant Fishery Scientist	:	Sarvashri K. Raman, K. H. Ibrahim (on other service under Tanzanian Govt.), S. Patnaik, G. N. Saha, P. R. Sen, T. Ramaprabhu and D. S. Murthy
Senior Research Assistant	:	Shri A. K. Banerjee
Research Assistant	:	Sarvashri D. K. Chatterjee, M. D. Rout, R. K. Jana, P. V. G. K. Reddy, P. C. Chakrabarty (upto 17.5.1971) and P. Gopalkrishna (upto 7.10.1970)
Accountant	:	Shri P. C. Kanungo
Head Clerk	:	Shri A. K. Das

and others

2 Riverine and Lacustrine Fisheries Division (Allahabad)

2.1 Central Inland Fisheries Research Substation, Allahabad (Uttar Predesh)

Deputy Director	:	Dr. Y. R. Tripathi
Fishery Scientist	:	Shri J. C. Malhotra
Assistant Fishery Scientist	:	Sarvashri Ravish Chandra and D. V. Pahwa
Senior Research Assistant	:	Sarvashri V. R. Desai, S. N. Mehrotra, P. K. Mathur, S. P. Singh and S. Jana
Research Assistant	:	Sarvashri M. R. Sinha, S. D. Gupta, S. C. Pathak, B. Singh, S. K. Das, P. N. Jaitly, P. M. Mathew, A. C. Nandy, R. K. Sexena, S. K. Wishard, G. N. Srivastava, N. K. Srivastava and A. G. Godbole (upto 18.5.1971)
Head Clerk	:	Shri K. B. Rajani

and others

2.2 Central Inland Fisheries Research Unit, Bhagalpur (Bihar)

Junior Fishery Scientist	:	Dr. G. N. Mukherjee
Research Assistant	:	Sarvashri B. L. Pandey, R. N. Seth, S. N. Sar and R. C. Singh

and others

2.3 Small Reservoir Unit, Rewa (Madhya Pradesh)

Junior Fishery Scientist	:	Shri S. J. Karamchandani
Senior Research Assistant	:	Shri K. P. Srivastava
Research Assistant	:	Sarvashri D. N. Misra, H. C. Joshi, Shri Prakash, M. D. Pisolkar and R. K. Dwivedi

and others

2.4 Krishna Godavari Unit, Rajahmundry (Andhra Pradesh)

Junior Fishery Scientist	:	Smt. T. Rajyalakshmi
Assistant Fishery Scientist	:	Shri Y. Rama Rao (on unauthorised leave)
Research Assistant	:	Sarvashri P. L. N. Rao, G. R. M. Rao, L. H. Rao and T. S. Ramaraju

and others

2.5 Reservoir Fisheries Research Unit, Hazaribagh (Bihar)

Research Assistant	:	Sarvashri S. K. Sarkar, M. Ramakrishnaiah, M. A. Khan, B. Roy, B. K. Banerjee and S. L. Kar

and others

2.6 Tank Fisheries Research Unit, Bangalore (Mysore)

Fishery Scientist	:	Dr. A. David
Research Assistant	:	Shri S. Lakshmiraghaban

2.7 Coldwater Fisheries Research Unit, Srinagar (Kashmir)

Junior Fishery Scientist	:	Shri K. L. Sehgal
Assistant Fishery Scientist	:	Shri K. V. Ramakrishna
Senior Research Assistant	:	Shri M. J. Bhagat
Research Assistant	:	Sarvashri K. L. Shah, C. B. Joshi, Kuldip Kumar and Shyam Sundar

and others

3 Estuarine Fisheries Division (Barackpore)

3.1 Estuarine Fisheries Research Substation, Barrackpore (West Bengal)

Senior Fishery Scientist	:	Dr. V. Gopalakrishnan
Fishery Scientist	:	Dr. V. R. Pantulu (on ECAFE service)
Junior Fishery Scientist	:	Shri P. Datta, Dr. M. Subrahmanyam and C. D. Saha
Assistant Fishery Scientist	:	Sarvashri P. Ray and A. Ghosh
Senior Research Assistant	:	Sarvashri S. B. Saha (on long leave), B. B. Ghosh, S. N. Datta (on long leave) and A. Choudhury
Research Assistant	:	Sarvashri N. K. Thakur (on long leave), K. K. Bhanot, S. K. Mukhopadhyaya, G. C. Laha, P. R. Das, M. M. Bagchi, D. D. Halder, B. K. Saha, R. N. De, A. R. Chaudhury, R. K. Chakraborty, D. K. De, H. S. Mazumder and P. M. Mitra. Mrs. K.K. Bhanot
Head Clerk	:	Shri M. L. Biswas

and others

3.2 Estuarine Fisheries Research Unit, Kakdwip (West Bengal)

Junior Fishery Scientist	:	Shri A. N. Ghosh
Research Assistant	:	Sarvashri P. K. Pandit, M. K. Mukhopadhyay, L. K. Das (upto 25.5.1971) and P. B. Das

and others

3.3 Pulicat Lake Unit, Madras (Tamil Nadu)

Research Assistant	:	Sarvashri S. Radhakrishnan, C. P. Rangaswamy, M. Kaliyamurthy, K. J. Rao, S. Srinivasagam, K. S Rao, D. R. Rao and H. Srikant (upto 28.4.1970)

3.4 Sunderbans Survey Unit, Kakdwip (West Bengal)

Fishery Scientist	:	Shri B. B. Pakrasi
Junior Fishery Scientist	:	Shri A. Sengupta
		Shri A. B Mukherjee

Senior Research Assistant	:	Shri N. C. Basu
Overseer	:	Shri P. N. Bhattacherjee

and others

4 Units under direct control of the Director

4.1 Soil Chemistry and Weed Control Unit, Calcutta (West Bengal)

Fishery Scientist	:	Shri S. M. Banerjea (upto 31.12.1971)
Junior Fishery Scientist	:	Dr. (Miss) E. Mitra and Dr. R. S. Panwar
Senior Research Assistant	:	Sarvashri S. C Banerjee, S. C. Thakurta, A. C. Banerjee and R. K. Banerjee

and others

4.2 Fishery Economics Unit

Junior Fishery Scientist	:	Shri M. Randhir

4.3 Library and Documentation Unit, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri B. N. Saigal
Research Assistant	:	Sarvashri P. K Chakrabarti and R. R. Khan (upto 11.6.1971).
Librarian	:	Miss Anjali Ghosh
Senior Artist	:	Shri J. Ghosh
Artist Photographer	:	Shri A. R. Mazumdar

and others

4.4 Administrative Section, Barrackpore (West Bengal)

Administative Officer	:	Shri H. N. Mukherjee
Superintendent	:	Sarvashri S. N. Chakravarti and P. K. Sthanapati
PA-cum-Stenographer	:	Shri G Lahiri
Accountant		Shri A K. Sengupta

and others

4.5 Stores Section, Barrackpore (West Bengal)

Superintendent	:	Shri S. K. Chatterjee
Senior Store Keeper	:	Shri K. C. Roy

and others

4.6 Accounts and Audit Section, Barrackpore (West Bengal)

Accounts Officer	:	Shri B. N. Das

and others

5 Institute Based Co-ordinated Projects

5.1 Co-ordinated Project on Reservoir Fisheries

5.1.1 Main Centre, Nagarjunasagar (Andhra Pradesh)

Senior Fishery Scientist	:	Shri A. V. Natarajan
Junior Fishery Scientist	:	Shri K. Alagaraja

and others

5.1.2 Sub-centre, Nagarjunasagar (Andhra Pradesh)

Junior Fishery Scientist : Shri G. K. Bhatnagar
Senior Research Assistant : Sarvashri R. D. Prasadam and S. R Ghosh and others

5.1.3 Sub-centre, Bhavanisagar, (Tamil Nadu)

Junior Fishery Scientist : Shri Ch. Gopalakrishnayya
Senior Research Assistant : Shri C. Selvaraj and others

5.1.4 Sub-centre, Rihand (Uttar Pradesh)

Junior Fishery Scientist : Dr. A G. Jhingran and others

5.2 Co-ordinated Project on Composite Fish Culture

5.2.1 Main Centre, Barrackpore (West Bengal)

Senior Fishery Scientist : Dr. V. R. P. Sinha
Junior Fishery Scientist : Shri H. A. Khan
Senior Research Assistant : Shri D. P. Chakraboarty and others

5.2.2 Sub-centre, Barrackpore (West Bengal)

Junior Fishery Scientist : Shri M. V. Gupta
Senior Research Assistant : Shri M. K. Banerjee and others

5.2.3 Sub-centre, Kurnool (Andhra Pradesh)

Junior Fishery Scientist : Shri R. M. Rao and others

5.2.4 Sub-centre, Bhavanisagar (Tamil Nadu)

Junior Fishery Scientist : Shri B. V. Govind
Senior Research Assistant : Shri P. U. Verghese and others

5.2.5 Sub-centre, Jaunpur (Uttar Pradesh)

Junior Fishery Scientist : Shri K. K. Sukumaran

5.2.6 Sub-centre, Karnal (Haryana)

Junior Fishery Scientist : Shri K. N. Krishnamurthy
Senior Research Assistant : Shri J. B. Rao and others

5.2.7 Sub-centre, Poona (Maharashtra)

Junior Fishery Scientist : Dr. K. P. P. Nambair
Senior Research Assistant : Shri G. V. Kowtal and others

5.3 Co-ordinated Project on Air Breathing Fish Culture

5.3.1 Main Centre, Durbhanga (Bihar)

Senior Fishery Scientist	:	Dr. P. V. Dehadrai
Senior Research Assistant	:	N. K. Das

5.3.2 Sub-centres, Bhadra (Mysore)

Junior Fishery Scientist	:	Shri S. P. Ayyar
Senior Research Assistant	:	Shri A. V. P. Rao

and others

5.3.3 Sub-centre, Gauhati (Assam)

Junior Fishery Scientist	:	Shri R. N. Pal
Senior Research Assistant	:	Shri A. K. Ghosh

and others

5.4 Co-ordinated Project on Spawn Prospecting

5.4.1 Main Centre, Allahabad (Uttar Pradesh)

Senior Fishery Scientist	:	Shri H. P. C. Shetty (upto 9.12.1971)
Junior Fishery Scientist	:	Shri K. K. Ghosh

and others

5.4.2 Sub-centre, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri P. Das

and others

5.4.3 Sub-centre, Gauhati (Assam)

Junior Fishery Scientist	:	Shri K. V. Rao

5.4.4 Sub-centre, Patna (Bihar)

Junior Fishery Scientist	:	Shri M. Y. Kamal

and others