1975

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE BARRACKPORE

ANNUAL REPORT

ANNUAL REPORT

for the year

1975

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

CREDITS

Edited by: Shri B. N. Saigal

Compiled by: Shri B. N. Saigal
Mrs. Kuljeet K Bhanot
Shri Amitabha Ghosh
Shri K. S. Banerjee
Shri P. K. Chakraborty
Mrs. Anjali De
Mrs S. Das

Photographs by: Shri J. Ghosh
Shri A. R. Mazumdar

Secretarial Assistants: Shri S. K. Pramanick
Shri H. B. Sutar
Shri Dipankar Chatterjee
Shri B. K. Ghosh
Miss. N Chaudhury

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Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute,
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Photograph 1. A view of the buildings of the Central Inland Fisheries Research Institute, Barrackpore, West Bengal.

ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES RESEARCH INSTITUTE, BARRACKPORE, 1975

1. DIRECTOR'S INTRODUCTION

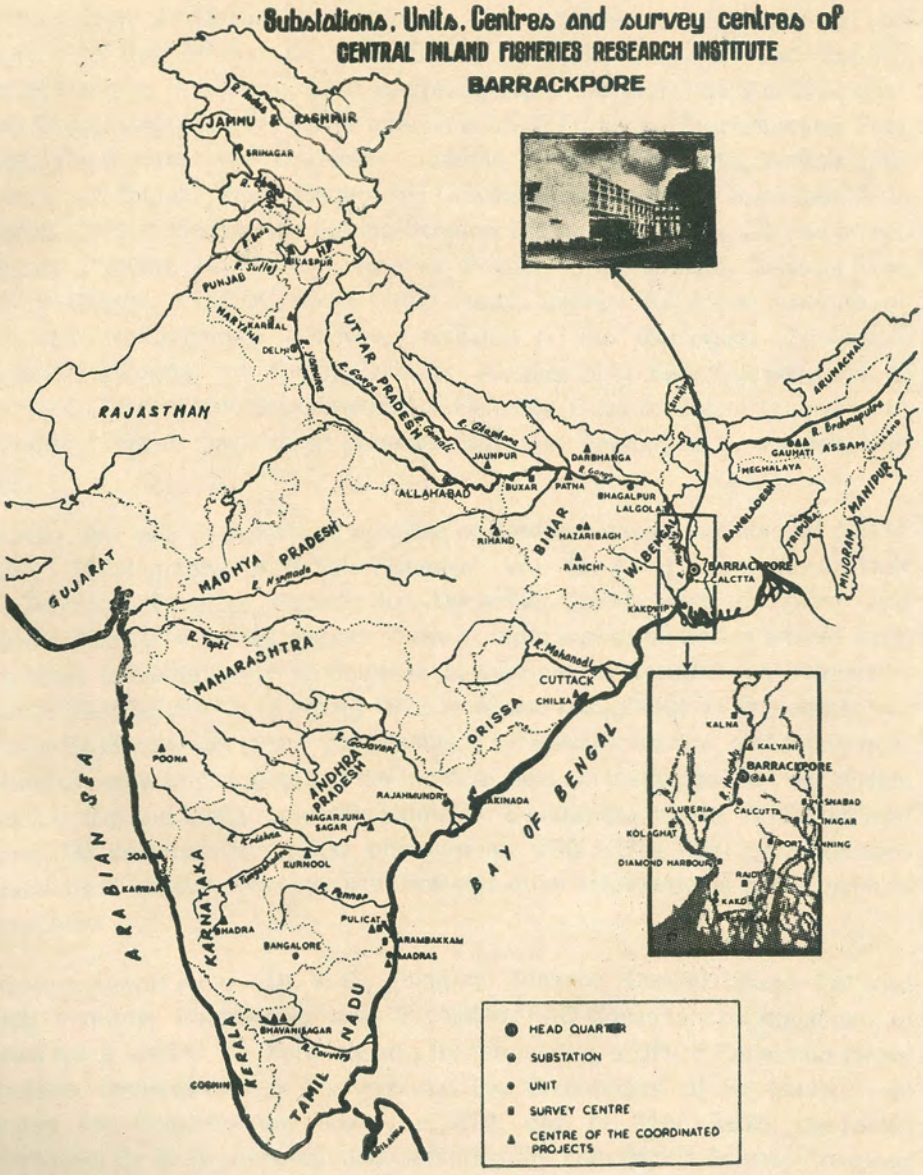
History : The Central Inland Fisheries Research Institute was formally established in March, 1947 under the Ministry of Food and Agriculture, Government of India for the purpose of conducting Scientific studies on Inland Fisheries of the Country. The Institute is since June, 1959, housed in its own buildings at Barrackpore on the left bank of the river Hooghly on an area covering about 5.2 ha. It came under the administrative control of the Indian Council of Agricultural Research on October 1, 1967.

Object : The principal objective of the investigations conducted at the Institute is to study and elucidate the scientific principles which can be applied in the utilisation of all available inland waters of the country for maximising fish production. Such an objective entails evolving sound fish husbandry techniques along modern concepts of aquaculture ; acquiring understanding of the biology of food fishes ; conducting investigations on hydrology and ecology of different types of fishery waters ; performing research on population dynamics of fish in natural capture fishery waters like those of rivers, lakes, reservoirs, estuaries etc, besides developing fishery mangement techniques relating to both fresh - and brackishwater environments. While the investigations are continued on long range research projects that are of a continuing nature, in consideration of the ever increasing consumer demand of fish in the country, due emphasis has also been laid on short term production oriented research projects, the solutions of which are apt to lead to rapid development of inland fisheries, specially in the field of aquaculture in rural areas of the country where both perennial and seasonal water bodies abound and which can be effectively utilised for fish production through pisciculture. With a view to achieving these objectives, three major divisions *viz.*, Freshwater Fish

Culture Division, Riverine and Lacustrine Division and Estuarine Fisheries Division were established at Cuttack, Allahabad and Barrackpore respectively to deal with the research problems of freshwater pond culture, riverine and lacustrine fisheries and estuarine culture and capture fisheries.

Organisational structure : The above stated three divisions of the Institute, with their units *viz.*, Tank Fisheries unit at Bangalore, Lower Ganga unit at Bhagalpur Cold water Fisheries Unit at Srinagar, Krishna-Godavari Unit at Rajahmundry, Brahmaputra Survey Unit at Gauhati, Brackishwater Experimental Fish Farming Unit at Kakdwip, Pulicat Lake Fisheries Unit in Tamil Nadu, Macrobrachium Breeding Unit at Kakinada and Sewage-fed Fish Culture Unit at Barrackpore have continued to function during the year. Soil Chemistry and Weed Control Unit at Calcutta, Library and Documentation Unit, Fisheries Extension Unit, Statistical Unit, Fisheries Economics Unit, Administrative & Accounts, Audit and Stores Sections continued to function at Barrackpore under the direct supervision of the Director. Besides, Frog Culture Unit at Kalyani, Operational Research Project in Composite Fish Culture at Krishnanagar also functioned under the direct control of the Director. Institute based All India Coordinated Research Projects *viz.*, (1) Ecology and Fisheries of Freshwater Reservoirs (with main centre at Hazaribagh and sub-centres at Bhavanisagar, Nagarjunasagar, Rihand, Ranchi and Bilaspur), (2) Composite Fish Culture and Fish Seed Production of Indian and Exotic Fishes (with main centre at Barrackpore and subcentres at Badampudi, Bhavanisagar, Kalyani, Jaunpur, Karnal, Ranchi, Gauhati and Poona), (3) Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps (with main centre at Barrackpore and sub-centres at Darbhanga, Bangalore and Gauhati) and (4) Brackishwater Fish Farming with main centre at Kakdwip and two state sponsored sub-centres at Keshpur (Orissa) and Adyar (Tamil Nadu) continued to function during the year. Diagramatic representation of the organisation of the Institute is presented in Organisational Chart below and photograph No. 2.

Library and Documentation : During the year under report 218 books, 103 reprints, 65 miscellaneous publications and 1,322 issues of periodicals were added to the library of the Institute. 47 foreign and 44 Indian journals were continued to be subscribed. The library obtained either as free gift or in exchange, additional 179 Indian and foreign journals. The present library holdings, inclusive of the year's arrivals, comprise 3,259 books, 3,393 reprints and 1,624 miscellaneous publications excluding the stock of loose issues of journals, pamphlets, maps, departmental publications etc. Besides maintaining exchange relationship with 316 Institutions and Organizations, 29 new exchange relationships were established during the year. Accession lists for the period December, 1974, January to October, 1975 and



Photograph 2. Substations, Units, Centres and Survey Centres of the Central Inland Fisheries Resarch Institute, Barrackpore, West Bengal.

"Current Awareness" lists January-September, 1975 were broughtout and circulated for the benefit of the Scientists of the Institute.

61 Technical and non-technical enqueries from India and abroad were attended to by the Library & Documentation Unit. The Institute supplied a number of publications to the Curator, Botanical Survey of India, Calcutta ; the Deputy Director of Fisheries (Statistics), Govt. of West Bengal, Calcutta ; the Sub Divisional Fisheries Officer, Mazaffarpur ; the Deputy Director of Fisheries (Brackishwater Fish Farming), Tamil Nadu ; the University Librarian, Andhra University, Waltair ; the Head, Dept. of Zoology, North Eastern Hill University, Shillong ; the Superintendent of Fisheries, Coastal Mechanised Fishing Scheme, Diamond Harbour, 24-Parganas ; the Deputy Director, Exploratory Fisheries Project, Govt. of India, Calcutta ; the Scientist-in-Charge, INSDOC, Delhi ; the Hony. General Secretary, Institute of Library and Information Services, Calcutta ; the Zoologist, Zoological Survey of India, Poona ; the Deputy Director, Air-breathing Fish Culture, Govt. of West Bengal, Kalyani ; the Superintedent of Fisheries, Govt. of Gujarat, Gujarat and the Director, Central Institute of Fisheries Education, Bombay on inter-library loan service.

During the year 64 reports on progress of Research were compiled and sent to the ICAR. "Bibliography of Indian Fisheries" Vol. **13** (2-4), 1974 and the Half yearly Technical Progress Report July-December, 1974 were compiled and broughtout. The 1974 Annual Report of the Institute was published in printed form. Lecture notes delivered to the participants of the Summer Institute on "Intensive Freshwater Fish Culture" held during 1975 were also broughtout in mimeographed book form for distribution to the participants. 47 scientific papers emanating from the results of research conducted at the Institute were communicated for publication in various Indian and foreign scientific journals. Besides the above, 550 sketches/ diagrams, 50 posters/charts, 1,400 photographs, 250 slides, 250 miscellaneous reproductions of various research activities and other achievements of the Institute were prepared.

Honours, Awards etc. : Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Barrackpore was appointed FAO Consultant on Aquacultre to Sri Lanka for a period of eight months for formulating a UNDP Project on Inland Aquaculture Development & Training for the Government of Sri Lanka. He proceeded for Colombo via Rome on 24th day of May, 1975. As Indian representative, Dr. V. G. Jhingran also attended the 13th Pacific Science Congress, organised by the University of British Columbia, from 18-30 August in Vancouver, BC, Canada and presented a scientific paper entitled "Systems of Polyculture of fishes in the inland waters of India". Dr. V. G. Jhingran is also the Project

Director of CIFRI/IDRC Project on Rural Aquaculture in India since its initiation in February, 1975.

Dr. H. Chaudhuri, Senior Fishery Scientist was invited to attend the 13th Pacific Science Congress in Vancouver, BC. Canada where he presented a scientific paper entitled "Use of hormones in induced spawning of carps". Dr. Chaudhuri was sent on deputation to Malacca for a period of one month as a consultant on IDRC Carps Project (Malaysia). He also served as Project Leader for the CIFRI/IDRC Project on Rural Aquaculture in India (in the States of Orissa and West Bengal) from February, 1975.

Dr. V. R. P. Sinha, Project Coordinator, Composite Fish Culture and Fish Seed Production was awarded the 1973 Hooker Award jointly with Dr. V. S. Mathur of the IARI, for his outstanding contributions in the field of fish culture in India.

Dr. V. R. P. Sinha, Senior Fishery Scientist & Project Coordinator was deputed to Bangkok, Thailand to attend the 2nd Regional Workshop on Aquaculture Development and Planning held during October 1-15, 1975.

Shri K. Raman, Fishery Scientist participated in the Internatianal Conference on Prawn Farming held during March 31, 1975 to April 4, 1975 at Vung Taul (Viet-Nam).

Sarvashri K. K. Sukumaran and S. P. Ayyar, Junior Fishery Scientists, have been deputed to Indonesia and Mauritius, respectively on FAO assignment during July, 1975.

Shri D. S. Murty, Junior Fishery Scientist, was selected by the Government of India as Senior Research Officer to take up the assignment as Grass Carp Expert with the Government of Fiji.

Shri S. B. Singh, Fishery Scientist; Shri M. Peer Mohamed, Junior Fishery Scientist; Shri S, P. Ayyar, Junior Fishery Scientist ; Shri A. Mathew, Senior Research Assistant ; and Shri Syed A. K. Naser, Senior Research Assistant ; were awarded Ph. D. degrees during the year.

Shri M. Y. Kamal, Junior Fishery Scientist, has also been awarded M. Phil degree during the year.

Shri P. Ray, Junior Fishery Scientist, and Shri B. B. Ghosh, Assistant Fishery Scientist, proceeded to Stockholam, Sweden for training in "Aquatic Pollution in Relation to Protection of Living Resources" under FAO Programme.

The following scientific personnel of the Institute were permitted to proceed for higher studies leading to the award of the M. Sc. degree and the training at the

Central Institute of Fisheries Education, Bombay.

Shri M. J. Bhagat, S.R.A.
Shri P. K. Pandit, R.A.
Shri M. D. Pisolkar, R.A.
Shri B. K. Banerjee, R.A.
Shri N. N. Sarkar, J.S.A.
Shri A. K. Ekka. J.S.A.
Shri N. Sarangi, L.F.A
Shri S. K. Sarker, R.A.
Shri H. S. Mazumdar, R.A.
Shri G. P. Bhattacharya, J.S.A.

Distinguished visitors : The following scientists and distinguished persons visited the Institute and its various establishments during the year under report.

Mr. M. Ahmed	Director of Fisheries, Gauhati, Assam.
Mr. S. K. Das Gupta	Special Officer, Planning Department of Fisheries, Assam.
Mr. B. R. Gupta	Chief Secretary, Government of West Bengal.
Mr. P. V. Senoi	Secretary to the Government of West Bengal, Department of Fisheries, Calcutta.
Mr. K. P. Srivastava	Deputy Director, Export Inspection Council, Government of India, Cochin-5, Kerala.
Mr. N. K. Anant Rao	Deputy Director-General (Education), I. C. A. R., New Delhi.
Dr. S. B. Chattopadhyay	Vice-Chancellor, Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani, West Bengal.
Mr. Sukhdev Singh	Deputy Director General (Crop Sciences), I.C.A.R. New Delhi.
Mr. P. Kandasamy	Secretary, Government of Tamil Nadu, Department of Forest and Fisheries, Madras, Tamil Nadu.
Mr. M. Mayilvahanan	Director of Fisheries, Madras, Tamil Nadu.
Mr. Narayan Singh	Hon'ble Minister of Co-operative, Animal Husbandry and Fisheries, Lucknow, Uttar Pradesh.
Mr. S. S. Jayarao	Director of Fisheries, Andhra Pradesh.
Dr. Y. R. Tripathi	Director of Fisheries, Lucknow, Uttar Pradesh.
Mr. F. Biean Wavy	University of British Coloumbia, Vancouver, BC, Canada.

Mr. Eric G. Watts Mrs. Susan F. Watts	Freshwater Fisheries Research Station, Batu Berendam, Malacca. West Malaysia.
Mr. Malcolm P. Gordon	Department of Biology, University of California, Los Angeles, California, U.S.A.
Mr. Paul De Kimpe	Nogent, France.
Dr. W. Herbert L. Allsopp	IDRC, Vancouver, BC, Canada.
Mr. S. C. Datta	Deputy Secretary, Department of Agricultural Research and Education, New Delhi.
Dr. Aubrey Gorbman	University of Washington, Seattle, U.S.A.
Dr. John Halver	College of Fisheries, Washington, Seattle, U.S.A.
Mr. Herben C. Lampe	Agricultural Development Council and University of Rhode Island, U.S.A.
Mr. D. R. Marah	Hon'ble Minister of Fisheries, Government of Meghalaya, Shillong, Meghalaya.
Mr. M. N. Kar	Trade Adviser and Director of Movements, Shillong, Meghalaya.
Mr. M. S. Lyngdoh	Fisheries Superintendent, Shillong, Meghalaya.
Dr. H. Swarup	Prof. of Zoology, Vikram University, Ujjain, Madhya Pradesh.
Dr. D. R. Bhumbla	Deputy Director General (S.A.E.), I. C. A. R., New Delhi.
Mr. A. R. Wani	Director, Games and Fisheries, Jammu and Kashmir.
Dr. B. K. Soni	Deputy Director-General (AS), ICAR, New Delhi.
Dr. R. Raghu Prasad	Assistant Director-General (F), ICAR, New Delhi.
Prof. P. C. George	Joint Commissioner (F), Govt. of India, Ministry of Agriculture and Irrigation, New Delhi.
Miss S. Chauhan	Additional Secretary, Indian Council of Agricultural Research, New Delhi.
Mr. J. G. Lawrence	British Council, British High Commission, New Delhi.
Dr. A. G. Cassidy	British Council Division, Calcutta, West Bengal
Dr. C. S. Shephard and Mr. Frank Lowenstun	World Bank, Washington, DC, U.S.A.
Mr. Pirier	Vice-President, Canadian International Development Agency, Ottawa, Canada.
Dr. Kampy	FAO, Fisheries Expert, Central African Republic.
Dr. A. G. K. Menon	Deputy Director, Zoological Survey of India, Regional Centre, Madras, Tamil Nadu.

Dr. Joshi	Director, Agriculture and Fisheries, Arunachal Pradesh.
Mr. T. Narayanan	Director, (A.H.), Planning Commission, New Delhi.
Mr. Falguni Sen	Administrator Administrative Staff College of India, Hyderabad.

Important events of the year : Significant events and achievements during the year 1975 were :

Important events :

Shri Falguni Kumar Sen, Administrator of the Administrative Staff College of India, Hyderabad visited the Institute on December 10, 1975 with a view to studying its organisation, management and planning of research activities. Dealing with the objectives and functions of the ICAR institutes in his report, Shri Sen pointed out that a proper distinction between the objectives and functions in most of the ICAR institute is rarely seen, however, notable exceptions do exist as is the case with the Central Inland Fisheries Research Institute, Barrackpore, where the investigations are carried out with a view to studying and elucidating the specific scientific principles towards maximising the utilization of inland waters available for optimum fish production for food. The specific functions which would help in the achievement of these objectives have been identified and the same has helped the Institute in identifying and elaborating a linkage with the environment. He has further observed that none of the scientists in this Institute expressed dissatisfaction either about the relevance of the various functions or about the relative importance given to each.

Expressing his views on the planning of the activities of the research projects, Shri Sen observed that at the CIFRI the project problems are properly 'decomposed' or broken down into a number of small independent tasks e. g. in the project entitled "Comparative study of the efficiency and economics of available fish poisons and their residual effects on the fish pond ecosystem" the problem is 'decomposed' as : (i) to build up sufficient stock of ammonia, Mahua oilcake, *Barringtonia* and other vegetable poisons ; (ii) the selected individual ponds are to be treated with the necessary doses of individual poisons on a comparative basis ; (iii) the species of fish killed, their sizes and time taken for this and revivability in freshwater to be noted ; (iv) the effect of treatment on plankton and bottom biota before and after the treatment to be studied and (v) water and soil quality before and after the treatment to be observed. In another project entitled "Studies on detection of digestive enzymes complex of freshwater culturable food fishes", the decomposition observed is the detection of enzymes in live specimens acclimatized to laboratory conditions in different stages of the life

cycle, *viz.*, fry, fingerlings and adults. Variations of enzyme complex with respect to seasons also to be studied like-wise. He observed that once the problem has been decomposed into various activities, it is essential to phase such activities and sequence the work.

Important achievements :

Composite fish culture :

Experiments on composite fish culture of Indian and exotic species *viz.*, *Catla catla; Labeo rohita; Cirrhinus mrigala;* silver carp, *Hypophthalmichthys molitrix;* grass carp, *Ctenopharyngodon idella* and common carp, *Cyprinus carpio* were conducted at the Freshwater Fish Culture Substation of the Institute at Cuttack. The six species combination was stocked @ 10,000 fingerlings/ha in the ratio of C 1 : R 2 : M 1 : Sc 2.5 : Gc 1.5 : Cc 2 and the excitingly high gross and net productions of 8,866/8,495 kg/ha/yr were achieved. Netting operation of carps from a pond under composite fish culture at Killa Fish Farm, Cuttack is shown in photograph No. 3.

Similar experiments on composite fish culture of Indian and exotic fishes were carried out at various centres of the All India coordinated Research Project on Composite Fish Culture and Fish Seed Production under different agroclimatic conditions with encouraging results. The six species combination of *C. catla* 1 : *L. rohita* 1 : *C. mrigala* 1 : *H. molitrix* 3 : *C. idella* 1.5 : *C. carpio* 2.5 when stocked @ 6,000 fingerlings/ha gave a net production of 5,160 kg/ha/6½ months at Poona. Net production up to 7,284 kg/ha/8 months was obtained at Karnal centre when a stocking density of 4,750 fingerlings/ha in the ratio of catla 1 : rohu 1 : mrigal 1 : silver carp 2.5 : grass carp 2.0 : common carp 2.5 was adopted.

Raising Indian major carps alone to marketable size :

In recent trials at the Fresh Water Fish Culture Division, Cuttack on rearing of Indian major carps to marketable size in two ponds, stocked at 6, 000 fingerlings/ha in the ratio of *C. catla* 3 : *L. rohita* 4 : *C. mrigala* 3, the productions obtained ranged from 3,100 to 4,000 kg/ha/yr. Similarly under National Demonstration Programme also, a high production of 5,153 kg/ha/15½ months was obtained when Indian major carps were stocked @ 7,500 fingerlings/ha in a 0.32 ha pond at JARI, Nilgunj near Barrackpore. This indicates the potentiality of culturing Indian major carps to the exclusion of exotic carps in areas where the availability of the seed of exotic carps is difficult.

Record fish production through pond fertilisation alone :

Productions to the tune of 4,000 kg/ha/yr could be obtained in composite fish culture by fertilisation of the pond with chemical fertilisers @ 280-100-30 kg

Photograph 3. A haul of carps from a pond under composite fish culture at Killa Fish Farm, Cuttack, Orissa.

N-P-K/yr. The pond was stocked with 5 species combination (silver carp, catla, rohu, mrigal and common carp) @ 7,500/ha. Silver carp attained 1 kg in 9-10 months time only.

Commercial production of carps in large sized ponds :

Three large sized ponds of 2.25, 1.0 and 0.67 ha in area were stocked with fingerlings of silver carp, grass carp, common carp and the Indian major carps catla, rohu and mrigal. The rate of stocking being 7,500 fingerlings/ha. Marketable fish weighing about 1 kg and above per specimen were periodically harvested. Fish yields ranging 5,628 kg/2.25 ha, 3,178 kg/ha and 2,057 kg/0.67 ha were obtained during 27, 19 and 16 netting days respectively by operating gill nets and drag nets. This accounted for only 20.9, 32.1 and 45.5% removal of the stocked fish. The gross average weights of harvested fish in the above mentioned ponds were 1. 19, 1. 76 and 0.96 kg respectively. The average weights attained by different species were ; silver carp (1. 321-2.676 kg), grass carp (1.29-2.056 kg), catla (0.890-1.794 kg), common carp (0.613-1.350 kg), mrigal (0.667-1.005 kg) and rohu (0.577-1.10 kg). These figures tend to suggest that in larger bodies of water with moderate depth, lower stocking rate would facilitates faster growth and continuous removal of marketable sized fishes will be an added advantage.

Culture of Tilapia mossambica in Sewage-fed ponds :

An experiment on the culture of *T. mossambica*, conducted in a sludge pond (0.076 ha) of the Titagarh Sewage Treatment Plant, Rahara, West Bengal from August 1974 to July 1975 gave an estimated gross production of 9,350 kg/ha in one year.

The experimental pond was initially fertilised with 1,67,200 l of sewage effluents having high concentrations of phosphate (1.2-26.4 ppm) and ammoniacal nitrogen (4.2-26.4 ppm) with BOD values ranging from 120 to 360 ppm. *T. mossamdica* fingerlings (average size/weight : 94.0 mm/14. 3 g) were stocked at at the rate of 17,000/ha in a combination of 6 males : 4 females in August 1974. Except for sewage water there was no other input. No special management measures were adopted either. The pond was supplied with sewage effluent @ 49,500 to 5,94,000 litres/month and harvesting was done at periodic intervals.

Induced Fish Breeding—Record seed production of silver carp, Hypophthalmychthys molitrix :

A record production of about 1.06 million spawn of silver crap, *H. molitrix* was achieved during the year by experiments conducted for commercial production of

seed of exotic carps by hypophysation technique. Though the weather conditions were erratic till August and several breeders lost condition, however, under cloudy weather and occasional showers from the second week of August, the response of the breeders was encouraging both in ponds and in *hapas* fixed in the river Mahanadi, and a high percentage of fertilisation (over 80%) resulted. The doses of pituitary hormones used were 10-16 mg/kg body weight for females and 2-4 mg/kg for males. The donor fish were Indian major carps and exotic carps.

Use of Salmon gonadotropin :

Results on the use of Salmon gonadotropin in inducing spawning in Indian major carps were very encouraging. A consignment of Salmon gonadotropin weighing 200mg received from IDRC, Canada, was utilised in inducing spawning in 45 sets of rohu (*L. rohita*), catla (*C. catla*) and mrigal (*C. mrigala*) with suitable controls injected with carp pituitary extract. The dosage ranged from 4-15 mg/kg of brood fish and 80% of the fish responded. Practically no difference in potency between salmon gonadotropin and carp pituitary extract in inducing spawning in major carps was observed.

Induced breeding of Mugil cephalus :

Significant results were achieved in the induced breeding experiments on mullets. Of the 7 sets of *M. cephalus* injected with homoplastic pituitary gland extract at Chilka lake-mouth, 4 sets gave positive resulte yielding 26,000 hatchlings which were reared successfully for a period of 10 days but thereafter very few survived and were acclimatized to freshwater and one of them was reared up to 325 days.

Mass culture of phytoplankton :

Observations on the mass culture of phytoplankton in glass jars/polythene bags indicated that the diatoms, *viz., Nitzschia ; closterium* and *Navicula cryptocephala* could be grown in culture solution containing N-P-K at 100 : 10 : 5. The maximum cell density of 3.5 million/ml was obtained within 5 days.

Rearing of Macrobrachium rosenbergii :

The Prawn-Breeding Unit of the Central Inland Fisheries Research Institute, at Kakinada, has succeeded in rearing the larvae of the giant freshwater prawn *Macrobrachium rosenbergii* under controlled conditions in the laboratory. All the larval stages could be reared and one of the postlarvae has been reared for over 165 days from the time of its hatching and has attained a length of about 40 mm. The postlarva undergoes 10 moultings before acquiring the adult characters. The early larval stages were fed with *Artemia*, the basic larval diet, and subsequent stages were fed upon other locally available diets.

Fish pathology :

Benzene hexachloride applied in the water at a concentration of 0.5 ppm eliminated heavy *Argulus* infection on fish without affecting the fish or fish food organisms adversely. By giving the fish a bath in 1-2 ppm BHC in water before transferring them from an *Argulus* infested pond to a non-infested one and by periodically destroying the *Argulus* eggs by getting them deposited on suspended substrates in the pond, the density of infestation couid be reduced.

Weed control :

With a view to obtaining a slow release of herbicide material for prolonged action and its absorption by roots of the rooted emergent and submerged weeds like *lilies, Limnophila, Ipomoea* spp. *Hydrilla, Najas, Ottelia, Nechamendra* etc., brick pellets soaked in 2,4-D ester herbicide @ 10 kg a. i./ha were installed in weed choked ponds in several field trials giving successful results.

Frog farming—Natural breeding of Rana hexadactyla :

In yard and field experiments, *R, hexadactyla* bred naturally. Frogs were found to breed continuously for 3 months in rainy or cloudy weather. 100% hatching of eggs was obtained and a total of 3,000 tadpoles were produced. Provision of *Hydrilla verticillata* and *Lemna polyrhiza* gave a high growth rate and survival. Growing tadpoles fed voraciously on *Hydrilla* leaves. A survival of 90% metamorphosed juveniles could be obtained. Early juveniles were fed with termites and other in ects and have attained a size range of 15 mm/0.5g to 59 mm/3·5g.

Induced breeding of frogs :

7,000 hatchlings of *Rana tigrina* were obtained by induced breeding. Cannibalism among the tadpoles could be checked by provision of artificial feed, like fish meal, minced frog meat and chopped earthworms. A survival of 70% up to 2 legged stage and 50% upto 4 legged stage could be obtained. Reduction of water column with the progressive growth of the tadpoles hastened the metamorphosis.

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

Through a net work of centres under the Institute based All India Coordinated Research Project on Composite Fish Culture of Indian and Exotic Fishes and Fish Seed Production, operating in different agro-climatic conditions, the State Governments continued to have assistance in the joint investigations on Composite Fish Culture and Fish Seed Production. Experiments on composite fish culture were

continued at Poona (Maharashtra), Kalyani (West Bengal), Bhavanisagar (Tamil Nadu), Jaunpur (Uttar Pradesh), Badampudi (Andhra Pradesh) and Karnal (Haryana) centres.

At Poona centre, the six species combination, i. e., catla 1: rohu 1 : mrigal 1 : silver carp 3 : grass carp 1.5 : common carp 2.5 at a stocking density of 6,000 fingerlings/ha gave a net production of 5,160 kg/ha/6½ months. The four species combination of catla 4 : rohu 1 : mrigal 1.5 : common carp 3.5 at the same stocking density yielded 2,460 kg/ha/8 months. Similarly six species combination, i.e., catla 1 : rohu 1 : mrigal 1.5 : silver carp 2.5 : grass carp 1 5 : common carp 2.5 at a stocking rate of 6,000/ha at Jaunpur centre gave net productions of 5,535-7,748 kg/ha/18 months, whereas, the four species combination of catla 3.5 : rohu 1.5 : mrigal 2.0 : common carp 3.0 with the same stocking density, yielded 5,350 kg/ha/18 months. At Kalyani centre, the net production obtained with stocking density of 7,000 fingerlings/ha in the ratio of catla 1 : rohu 0.5 : mrigal 1.5 : silver carp 2.5 : grass carp 2.0 : common carp 2.5 was 5,074 kg/ha/yr at a stocking density of 6,000 fingerlings/ha. Net productions up to 7,284 kg/ha/8 months have been obtained at Karnal centre with a stocking density of 4,750 fingerlings/ha in the ratio of catla 1 : rohu 1 : mrigal 1 : silver carp 2.5 : grass carp 2.0 : common carp 2.5.

Fish seed production was taken up at all the centres of the project. Silver carp (*H. molitrix*) in Assam and Tamil Nadu and grass carp (*C. idella*) in Maharashtra were bred for the first time at these centres. 4·44 million spawn of Indian and exotic fishes was produced at the different centres which included 2.10 million spawn of common carp, 1·74 million spawn of Indian major carps, 0. 45 million spawn of silver carp and 0. 15 million spawn of grass carp.

Under the project, five centrally sponsored centres *viz.*, two in the state of Gujarat at Anand and Rajpipla, one each in Tamil Nadu (Coimbatore), Orissa (Jeypore) and Madhya Pradesh (Durg) were established

The All India Coordinated Research Project on Air-breathing fishes in its joint investigations formulated with the State Fisheries Departments at different centres continued to tackle several production oriented schemes. In Bihar, the mixed culture of *Clarias batrachus, Heteropneustes fossilis* and *Anabas testudineus* stocked in a derelict swampy pond @ 25,000/ha yielded a gross production of 1,200 kg/ha in 7 months without fertilisation and supplementary feeding (Photograph 4). In Karnataka, a production of 3,159 kg/ha/8 months was obtained in the monoculture of *Channa marulius* stocked at 10,000/ha in a swampy pond. Dried marine trash fish was used as a supplementary feed. These achievements significantly pin-point the possibilities of exploitation of derelict and swampy water bodies through controlled culture of air-breathing fishes.

Photograph 4. A part of the harvest from mixed culture of magur *(Clarias batrachus)*, singhi *(Heteropneustes fossilis)* and koi *(Anabas testudineus)* from a derelict pond in Bihar.

In Assam, cage culture experiments have yielded gross production of 35,000 to 50,000 kg/ha/200 days when computed over the production per cage area. It should be possible to achieve the target of 10 kg per square meter area of cage per year for which the efforts are already under way.

Success was achieved in inducing *C. batrachus* to breed in specially designed paddy fields (3.5 X 3.0 m) with 15 to 20 cm of water depth, by administering pituitary extract injection of Indian major carps @ 80-90 mg/kg body weight of the recipient fish. The number of fry produced was estimated to be 1,200/pair of breeder. The Fry attained a size of 1.5-2.5 cm within three weeks of rearing under field conditions without any supplementary feed. Techniques based on these results are being developed for mass production of the stocking material of the species in paddy fields.

Supplementary feeding with animal organisms or products of animal origin is an expensive factor in the culture of *C. batrachus*. Detection of cellulase and significantly high amylase activity in the digestive tract of this species, studied under the All India Coordinated Project on Air Breathing fishes in collaboration with the Biochemistry Department of Calcutta University, however, suggests that the feeding of the fish could be rested on carbohydrate-rich diet from plant source in cage or culture ponds. The alkaline phosphatase activity which was observed to be higher than the acid phosphatase activity also indicates a high rate of carbohydrate and lipid metabolism.

Two centrally sponsored centres one each at Kalyani, West Bengal and Palair, Andhra Pradesh were established under the Project.

The All India Coordinated Research Project on Ecology and Fisheries of Freshwater reservoirs in collaboration with the State Fisheries Departments continued its various research activities on the physico-chemical characteristics of soil and water, organic production, fish food resources, fish yield and dynamics of fish stocks in Bhavanisagar, Nagarjunasagar, Rihand, Getalsud and Govindasagar reservoirs. It has been observed that the inflow from the catchment area largely determines the water quality of the impoundment rather than the reservoir's soil.

The estimated fish yield in 1975 was of the order of 208 t in Bhavanisagar, 111 t in Nagarjunasagar, 242 t in Rihand and 475 t in Gobindsagar. An increase of 68% of fishing effort (from 1971-72 level) in Bhavanisagar has improved the catch by 121·4%. In Rihand for an increase of 116·4% effort, the increase in catch of catla was about 58%. In Govindsagar, 101% increase (from 1972-73) in the catch was brought about largely due to increase in mesh size. In this reservoir, Gangetic major carps contributed to the catch significantly unlike previ-

ous years. In Nagarjunasagar, and Gobindsagar bays were found to be more productive while in Bhavanisagar, lotic zones were more productive. Natural breeding and recruitment were noted in respect of *C. catla* and *C. mrigala* in Rihand, *L. calbasu* and *C. mirgala* in Bhavanisagar, *L. fimbriatus* and some catfishes in Nagarjunasagar. Breeding grounds of commercial fishes were also located in Gobindsagar. In Rihand three sub-species of *C. catla* were identified. One of the subspecies showed indications of food preference towards *Microcystis*. In Getalsud reservoir, the stocked exotic silver carp (*H. molitrix*) registered a growth of 1·7-2·1 kg in 17 months.

Two centrally sponsored centres one each in the state of Gujarat (Ukai) and West Bengal (Kangsabati reservoir) were established under the project.

The All India Coordinated Research Project on Brackishwater Fish Farming with its main centre at Kakdwip and two centrally sponsored subcentres one each in Orissa and Tamil Nadu continued investigations during the year. Four new centrally sponsored centres, one each at Kakinada, Andhra Pradesh ; Cochin, Kerala ; Goa and Maharashtra are being established.

Culture of Mugil tade :

Culture of *M. tade* conducted at the Brackishwater Experimental Fish Farm, Kakdwip under the All India Coordinated Research Project on Brackishwater Fish Farming in a 0·08 ha pond, with stocking material collected from the adjoining estuary, has shown encouraging results, when fed with maize powder, wheat bran and mustard oilcake at the rate of 10% of the body weight initially for 5 months and 5% of the body weight for the rest of the culture period. In $1\frac{1}{2}$ years of rearing, the standing biomass of *M. tade* was estimated at 2,238·4/ha.

Culture of Penaeus monodon :

Experiments on the culture of *Penaeus monodon*, being carried out at the Brackishwater Experimental Fish Farm, Kakdwip under the All India Coordinated Research Project on Brackishwater Fish Farming, have shown encouraging results. In a 0·02 ha pond, *P. monodon* fry (average length : 30·85 mm) stocked at 40,000 /ha at the end of June 1975, recorded an average length/weight increment of 49·35 mm/4·41 g by August 1975 with almost cent percent survival. The stock was then removed to a bigger pond with a stocking density of 25,000/ha. Towards the beginning of November, the growth achieved was 110 mm/14·69 g. The standing crop at the end of 1975 was estimated to be 543·3 kg/ha/6 months.

Research collaboration at international level with FAO, Ford Foundation etc. :

Outstanding results of the investigation on culture fisheries conducted at this Institute were regularly communicated to the Food and Agricultural Organisation of the UN, Rome, for publication in the "FAO Aquaculture Bulletin."

In order to further strengthen exchange of research publications, new exchange relationships at international level were established with 12 organisations *viz.*, Bureau of Fisheries and Aquatic Resources of the Government of the Philippines, Regional Office No. 10, Cagayan de Orocity, Philippines ; National Inland Fisheries Institute, P. O. Box. 9-28, Bangkok 9, Thailand ; Agricultural Research Organisation, Fish and Agriculture Research Station, Ministry of Agriculture, Dor D. N. Hof-HACARMEL, Israel ; The Trade Information Service, Department of commerce, Flat 31, 2nd Floor, Galle Face Court 2, Colombo 3, Srilanka, Ceylon ; South-China Sea Programme, Box 1864, Manila, Philippines ; Southest Asian Fisheries Development Centre (SEAFDEC), Suite 401, Kalayaan Building, De La Rosa Corner, Salcedo sts, Makati, Philipphines ; Institut National De La Research Agronomique, Station D Hydrobiologie, Boite Postale 79,64,200 Biarritz, France ; Kenyatta University College, P. O. Box 43844, Nairobi, Kenya. The Hebrew University of Jerusalem, Department of Genetics, Jerusalem, Israel ; Secretaria de Agriculturee, Abastecimento do Estado do Rio de Janeiro, Departmemto de Cooperativismo, Divisao de Organizacao Rural, Alameda sao Boaventura 770-Fonsaca, CEP : 24,000-Niteroi-Rj-Brazil ; Universiti. Pertanian Malaysia, Division of Fisheries and Marine Science, P. O. Box 203, Sungei Besi, Selangor, Malaysia and Central Luzon State University, Nueva Ecija, Philippines 2320 during the year.

In collaboration with the International Development Research Centre, Canada, a project on rural aquaculture was initiated in the month of February, 1975 with two centres each in Orissa and West Bengal. The two centres in Orissa are located in the Ganjam and Puri districts with headquarters at Aska and Puri respectively. 11 ponds with a water area of 5·82 ha in Ganjam district and 18 ponds covering 5·64 ha in Puri district are being covered under this project. All the ponds in Ganjam district and 4 ponds in Puri district are under the control of the village bodies, the rest of the ponds being private ones. The necessary pond preparations were done on scientific lines and the seed of six species of major Indian and exotic carps was stocked. The fishes are growing satisfactorily and some of them have already attained a weight of about 1 kg. The villagers have all through shown great enthusiasm in extending full cooperation and taken part in the Rural Aquaculture Project Programme.

The Project in West Bengal was started with the selection of three villages (Hanspukur-Bishnupur Complex) in District 24-Parganas (Photograph No; 5)

and a single village *viz.*, Harishchandrapur in District Malda. 17 small ponds and 10 large ponds were selected in the Hanspukur-Bishnupur Complex covering an area of 5·26 ha while 18 ponds covering 5·6 ha were selected in Harischandrapur. Excepting for three ponds in the Hanspukur-Bishnupur Complex, which belong to the educational institutions, the remaining ponds are privately owned. The small ponds were initially used for spawn rearing and are now being utilised for growing table-size fish. The farmers have already made an income ranging from Rs. 100/- to 400/- by the the sale of fingerlings from these ponds. The fishes in large ponds are growing well both in the Hanspukur-Bishnupur Complex as well as Harischandrapur. Some fish, over 1 kg in weight, have already been harvested from the ponds at Harishchandrapur and handed over to the pond owners. The exotic carps have attained a weight of about 1 to 1·5 kg in the Hanspukur-Bishnupur Complex.

Research Associations : The scientists and the technical staff took active interest in the organisation and mangement of the "Inland Fisheries Society of India". Vol. **7** of the journal was published by the Society.

The Institute continued to have institutional membership of the following societies and associations :

Indian :

1. The Asiatic Society, Calcutta
2. Indian Association of Water and Water Pollution Control, Nagpur
3. Indian Science Congress Association, Calcutta
4. Inland Fisheries Society of India, Barrackpore
5. Marine Biological Association of India, Cochin
6. Indian Fisheries Association, Bombay
7. Indian Society of Ichthyologists, ZSI, Madras

Foregin :

1. The Fisheries Society of the British Isles, Huntingdon, England
2. Societas Internationalis Limnologiae, Michigan, U. S. A.

Advisory services received and provided :

Information on different aspects of Inland Fisheries Research *viz.*, techniques of composite fish culture, fish breeding, glass jar hatchery complex, cultivability of different fish species in varied ecological conditions, effects of pollution on fishes, collection techniques and analysis of plankton, control of aquatic weeds, frog farming etc. were communicated to various scientific personnel and to a number of Institutions in private and public sector in India and abroad.

Photograph 5. Villagers participating in a netting operation in a village pond at Hanspukur, 24-Parganas, West Bengal. The pond is under the management of the IDRC Rural Aquaculture Project of the Institute.

Technical know-how relating to glass hatchery complex developed by the Instiute, its operational techniques, etc. were furnished to the Joint Commissioner of Fisheries, Ministry of Agriculture, Government of India. Various State Fisheries Departments were also informed about the glass jar hatchery complex by the Cuttack Sub-station of the Institute.

Besides, apprising Dr. T. A. Mammen, Deputy Commissioner (FP), Ministry of Agriculture and Irrigation, Government of India, about the techniques, potential and scope of utilisation of air-breathing fishes in the derelict water bodies of the country, the Assistant Commissioner (FP) was also informed on the tolerance limit of fishes to various pollutants and the introduction of *Tilapia* sp. in some reservoirs of Uttar Pradesh.

Literature on 'Collection technique and methods of analysis of plankton' ; 'Breeding of grass carp' and information on the 'Effect of water hyacinth growth on fish culture' were made available to the Field Director, The Sunderbans Tiger Reserve Project, Gosaba (West Bengal) ; The Fisheries Project Officer, Rana Pratap Sagar and Rawat Bhata, Rajasthan ; and Shri S. Bhowmic, Advisor (Agriculture), North Hill Council, respectively.

Suggestion regarding introduction of various food fishes in ponds having different salinity levels was given to Dr. H. S. Mann, Director, Central Arid Zone Research Institute, Jodhpur, whereas technical advices were given to the State Fisheries Department, Government of Orissa on the prepatation of a detailed scheme on semi-intensive fish culture in the State and to the Special Officer (Fisheries), Kerala Agricultural University, on the culture of fishes in some ponds.

Information on larvicidal fishes for the biological control of mosquito larvae was communicated to the Assistant Director, Dandyakaranya Development Authority, Madhya Pradesh.

A brief write-up on the important achievements of the Institute was sent to Dr. M. S. Swaminathan, F. R. S., Director-General, Indian Council of Agricultral Research, New Delhi and The Institute of Economic Growth, University of Delhi was supplied with a note on the 'Employment Potential of Freshwater Fisheries in India.'

Smt. Rita Bhatia, Head, Technical Information Service (Action for Food Production), New Delhi and Shri J. B. Srivastava, Senior Scientific Officer, Regional Research Laboratory, Jammu Tawi, were supplied with lists of refererences on *Tilapia* sp. and "Breeding behaviour of palaemonid prawns", respectively.

Mr. Byron Cirlin, Ministry of Agriculture, Agricultural Research Organisation Israel, was informed about the sources of availability of Indian carps *viz., Cirrhinus mrigala* and *C. reba* ; Brazilian Embassy, New Delhi, was supplied with the infor-

mation on frog farming. Comprehensive lists of literature on" Fish breeding and reproduction," "Fish disease and transport of fish" and literature on benthic macrofauna were sent to Dr. E. M. Donaldson, Research Scientist, Environment Canada Canada ; Documental Center, Agricultural Economics, Bahia Balanca, Argentina ; and to Mr. Shahadat Ali, Assistant Professor, Department of Zoology, Dacca University, Dacca, Bangladesh, respectively.

A dully filled in proforma containing informationon shrimp and prawn culture was sent to Mr. J.F. Wiekns, Ministry of Agriculture, Fisheries and Food, Fisheries Experimental Station, Conwy, Caernavonshire.

Extension and Nation building activity : Dr. V. G. Jhingran, presiding over the Aquaculture Session of the Third All India Symposium on Estuarine Biology held during 4th to 6th February, '75 at Cochin, delivered a special lecture on "Some Aspects of Brackishwater Aquaculture in India." Narrating the achievements on mono- and polyculture of brackishwater fishes and prawns, he emphasised on the tremendous possibilities of expanding brackishwater fish culture in India.

At a Symposium on "Pollutional problems of major cities in India with particular reference to Calcutta," jointly organised by the Guha Institute of Biochemistry and the Department of Bio-chemistry, University of Calcutta, in collaboration with different organisations, held on 1st March, 1975 at Ramakrishna Mission Institute, Calcutta, Dr. V. G. Jhingran delivered an illuminating talk on "Effects of Pollution on Fisheries." The talk was illustrated with slides and Dr. V. G. Jhingran, during his talk, emphasised that it was essential to evolve and standardise methods for disposal of wastes from factories of each industrial commodity and also to lay down water quality standards for abatement of pollution with a view to saving public health and fisheries wealth. He suggested the need for establishing a system for regular water quality monitoring for determination of pesticides, radio activity, etc.

While delivering the inaugural address of the H. K. Mookherjee Academy on 4th August, '75 at the department of Zoology, University of Calcutta, Dr. H. Chaudhuri, Senior Fisheries Scientist, highlighted the recent advances made by the Central Inland Fisheries Research Institute in fish culture techniques.

For dissimination of results of practical value emerging from the research activities of the Institute, an extension pamphlet entitled "Glass jar hatchery for carps" developed and prepared by the Freshwater Fish Culture Division of the Institute, Cuttack has been published for distribution to the enterprising fish farmer's for their use.

Photograph 6. Carps being harvested under Operational Research Project at Krishnanagar Fish Farm, Nadia, West Bengal, suggesting "Aquaplosion".

Operational Research on Rural Aquaculture :

The Institute undertook composite fish culture programme in three large ponds measuring 2·15, 1·48 and 1·93 ha in area under the Operational Research Project at Krishnanagar Fish Farm, District Nadia, West Bengal. Necessary facilities in terms of inputs, such as feed, fertilisers, fingerlings, etc. were provided by the Department of Fisheries, Government of West Bengal.

A total production of 20,232·23 kg from 5·56 ha of water area was obtained during 1974-75. Gross and net productions from the three ponds were 2,654 & 2,514 ; 4,290 & 4,143 and 4,184 & 4,062 kg/ha/yr from the water areas of 2·15, 1·48 and 1·93 ha respectively.

Fish production from these water areas has been maximised to about 8 times. Three years before, the rate of production was 460 kg/ha/yr only. But in the present experiment, the production from these ponds roughly came to over 3,637 kg/ha/yr. A netting operation at the Krishanagar Fish Farm leading to the suggestion "Aquaplosion" is depicted in photograph No. 6.

Besides the above quantities of fish harvested, 4·2 million spawn of common carp, 0·008 million fingerlings of the same species and 0·85 million spawn of Indian major carps were also produced incidental to the field experiments under the Operational Research Project.

A total of Rs. 59,570·00 have been spent to produce 20,232 kg of fish, 50'5 lakhs of spawn of Indian major carps and common carp and 8,000 fingerlings of common carp.

Operational research programme on rural aquaculture (in collaboration with the C. R. R. I., ICAR, Cuttack) in fish culture has shown the profitability of fish culture in two selected villages *viz.*, Gohala and Jagannathpur where the scheme was launched by the Fish Culture Division of the Institute, Cuttack. · From these ponds of 0·02 to 0·035 ha in area, net profits of Rs. 200-300/- by way of sale proceeds of about 32-52 kg of fish during 6-7 months were obtained when the inputs ranged from Rs. 10-20/- only. Besidas the above, fry rearing in well prepared small village ponds yielded 5,000-8,000 fry in about a month and a half with an average financial return of Rs. 100-160/- per 0·01 ha of water area.

National Demonstration :

National Demonstration Centre, at Nilgunj in the District of 24-Parganas, West Bengal was established for demonstrating the practicability of fish culture as a sound commercial proposition. The pond at Nilgunj was stocked with the Indian major carps *Catla catla, Labeo rohita* and *Cirrhinus mrigala* @ 7,500 fingerlings/ha. Several demonstrations of various aspects of preparatian of pond and

management of fish culture techniques were arranged for the fish farmers at this centre. Periodic harvesting yielded a production of 1,711·86 kg of fish giving an estimated net production of 5,153 kg/ha/15½ months. Though the rearing of fish was continued for 15½ months duration, the feeds and fertilisers were provided only for a duration of 12 months.

The pond culture and weed control sections of the Freshwater Fish Culture Division, Cuttack have carried out extension work on the Operational Research and Rural Aquaculture projects of the Government of Orissa by rendering assistance in fish stocking operations, control of *Ipomoea carnea*, an abnoxious water plant and by supplying the seed of exotic carps for stocking in village ponds.

A specialised training in "Induced Breeding" of Indian major carps and exotic fishes was organised at the Freshwater Fish Culture Division of the Institute at Cuttack and the following personnel were trained.

1. Mr. Ahmed Tajuddin, S. P. I. A. T. (MADRI), Malacca, Malaysia
2. Sri Lakshmi Lal Sharma, Udaipur University.
3. Dr. A. G. K. Menon, Deputy Director, Zoological Survey of India, Madras Unit.
4. Shri P. Das, Research Scholar, Bangladesh.
5. Fishery Officers of the Government of Nepal.
6. Private Fish Culturists.

Comprehensive training on different aspects of inland fish culture was imparted to different batches of fishery trainees from (i) Central Institute of Fisheries Education, Bombay ; (ii) Inland Fisheries Training Unit of the Central Institue of Fisheries Education, Barrackpore ; (iii) Regional Training Centre of Fisheries Operatives, Agra ; (iv) Regional Training Centre for Fisheries Extension Workers, Hydrabad ; (v) Fisheries College, Mangalore ; (vi) North-Eastern Hill University, Shillong and (vii) Fish Farmers, Dhamtari, Raipur.

Laboratory and Library facilities were extended to the trainees and the participants of the Summer Institute, 1975. Fish seed of Indian and Chinees carps were distributed to a large number of organisations, individuals and state fisheries departments in pursuit of the objective of popularising acquaculture in a big way. The details of spawn, fry, fingerlings and table sized carps supplied are given in table 1.

Table 1. *Spawn, fry and fingerlings supplied to various agencies in 1975*

		Indian major Carps		Exotic Carps			
		Spawn (lakh)	Fingerlings	Silver carp fingerlings	Grass carp fingerlings	Common carp spawn (lakh)	Fingerlings
1)	IDRC	34·05	35,115	33,931	16,672	-	10,000
2)	Orissa Fisheries Department	4·6	-	21,020	1,000	-	-
3)	Operational Research Project	2.0	2,900	293	138	-	181
4)	Air Force, Barrackpore	-	-	2,904	500	-	-
5)	Government of Arunachal Pradesh	-	-	1,000	-	-	-
6)	Fish Farmers Development Agency, Raipur District	-	-	10,150	-	-	-
7)	FCI Sindhri	-	-	4,000	-	-	-
8)	Nagaland State Fisheries	-	-	625	-	-	-
9)	Bongaon Fisheries Corpn., West Bengal	-	-	5,000	-	-	-
10)	CIFRS	23·08	20,050	7,330	1,145	-	2,065
11)	Private party	4.8	19,836	10,932	2,670	1·0	-
	Total	68.53	77,901	97,185	22,125	1.0	12,244

Finance : The provision of funds for the Institute for the financial year April, 1975 to March, 1976 was

Non-Plan	Rs. 51,45,000
Plan	Rs. 41,42,350
Total	Rs. 92,87,350

Against the above provision, the expenditure during April, 1975 to December 31, 1975 was as follows :

Non-Plan	Rs. 38,41,950
Plan	Rs. 19,74,484
Total	Rs. 58,16,434

2. PROGRESS OF RESEARCH

Research investigations on 23 projects and under the Institute based All India Coordinated Research Projects were continued as per the Project Programmes for the year 1975. Each project has several problems to be worked out on priority basis. Project No. 21 "Fisheries of River Basins" remained suspended during the year.

(a) *Research completed :*

Since the Institute embarked on time bound project programmes in 1967, investigations on 63 problems have so far been completed. Six problems have been completed during the year under report. Their brief summary is given below.

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

Problem : 1·18 Role of some trace elements in pond productivity
Personnel : G. N. Saha, D. K. Chatterjee and C. Selvaraj
Duration : Five years

The effects of boron, cobalt, zinc and molybdenum in relation to primary productivity, plankton densitiy and spawn/fry survival and growth of fish in laboratory and yard experiments with different pond soils in combination with fertilizers/organic manures or without them indicated that primary productivity and plankton picked up after the treatments and fry production was better in cobalt and zinc treatments. The effect of trace elements was remarkable when applied in combination with fertilizers. A detailed report is being finalised.

Project 5 : Brackishwater fish farming

Problem : 5.1 Productive potential of polyculture in Lower Sunderbans and behaviour of pond dykes
Personnel : A. V. P. Rao, B. B. Pakrasi, A. Sengupta, P. Ray and P. K. Ghosh
Duration : Six years

Water salinity in a 0.25 ha stocking pond gradually decreased from 20·12% in July, 1968 to 3·20% in December, 1970. Subsequently the salinity of water has further gone down, with a range of 0·77-2.70%, in 1972, thus making polyculture of Indian and exotic carps, mullets and prawns a successful enterprise as envisaged under this project.

Species cultured :

Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Cyprinus carpio var. communis, Ctenopharyngodon idella, Mugil cephalus, Mugil parsia, Mugil tade, Chanos chanos & *Penaeus monodon* were the species cultured in the different experiments, *C. idella* could not thrive as the transient ecosystem with changing salinity could not support any weeds. So in later experiments, this species was eliminated. As stocking material of *C. chanos* and *M. cephalus* was very limited, their culture too was restricted to years of availability only.

Stocking density, stocking ratios and yield :

In K-pond during the period 1972-75, three stocking densities were tried *viz.*, 10,220/ha in 1972-73, 12,136/ha in 1973-74 and 6,140/ha in 1975. The representation of freshwater species, brackishwater fishes and prawn was 48.2%, 33·5% & 18.3% respectively in 1972-73, 39·8%, 47·4% & 12·8% respectively in 1973-74 and 69·6%, 23·8% & 6·6% respectively in 1975. The percentage contribution was 83·7 to 88·5 by freshwater fishes, 10·7 to 15·9 by brackishwater fishes and 0·22 to 0.80 by prawns. With fertilization (NP in the ratio 3:2 @ 600 kg/ha/year and raw cattle dung @ 10,000 kg/ha) and supplementary feeding (Mustard oilcake and Maize/Rice bran (1 : 1) @ 1% body weight of fish) a net production of 1,686kg/ha/8 months, 1,472 kg/ha/year and 1,630 kg/ha/year were obtained respectively at the above three stocking densities. In R- pond with the same inputs, the net production at a stocking density of 9,200/ha was 1,035 kg/ha/year in 1973-74.

Survival of mullets :

While the percentage of survival of *M. cephalus* was as high as 100 and that of *M. tade* was between 71.2 and 81.7, in the case of *M. parsia* it was very low being only 22·7 and 23·2 during 1972-73 and 1973-74 respectively. By eliminating, therefore, *M. parsia* during the 1975 experiment from the stocking, the overall survival of mullets increased to 82·4% as compared to 33·5% and 26·0% in the years when *M. parsia* was included in stock.

Based on the findings under this project a follow up project "Stock manipulation in polyculture of Indian and exotic carps, mullets, *Chanos* and prawns in low saline ponds in the Sunderbans" is proposed to be taken up in 1976.

Factors affecting production :

A sustained turbidity in the stock ponds observed during 1973-75 adversely affected the development of plankton, benthos and growth of fishes (especially of silver carp), inspite of pond fertilisation. Treatment with mahua oilcake @ 200

ppm followed by pumping in saline water to raise the salinity to 2·0 ppt controlled the turbidity for a period of 3 to 4 months. Therefore, to identify the causative factors and to evolve suitable methods to control turbidity in low saline ponds, a separate project "Flocculating colloidal soil suspensions in impounded waters of low salinity" is proposed to be initiated in 1976.

Problem : 5.8 Induced breeding of *Mugil cephalus*
Personnel ; H. Chaudhuri, R. M. Bhowmick, G. V. Kowtal, R. K. Jana and S. D. Gupta
Duration : Six years

Experiments on induced breeding of *M. cephalus* by pituitary injections were carried out during 1969-74, near the Chilka lake. Spawners migrating to the sea from the ake were used for the experiments. Male and female spawners varied in size from 0·3-0·75 kg and 0·7-2.1 kg respectively. Homoplastic pituitary glands were generally used and the effective doses varied from 2-8 glands/fish. Generally two injections were administered to females at an interval of 6-8 hrs and they ovulated within 4½-8 hrs after the second injection. Males were given only one injection at the time of the second injection to females. Matured males, without injection, were also successfully used. Dry method of stripping was followed. During 1969-74, out of 50 sets of injected fishes 31 responded and eight spawners yielded 26,000 hatchlings. The embryonic and larval developments were studied. Majority of them died within 3-4 days. A few thousands could be reared up to 10 days but thereafter very few survived. On several occasions they were transported in sea water in oxygen packed polythene bags to Cuttack. They were gradually acclimatised to freshwater and one was reared for 325 days. Fluctuations and sudden fall of water temperature and lack of proper food appeared to be responsible for high mortality of youngs. The seived plankters fed to youngs consisted of trochophores, rotifers, nauplii of copepods and cladocerans. The experiments demonstrated the possibility of large scale production of mullet seed by hypophysation.

Problem : 5.13 Selective culture of *Mugil parsia* and *Mugil tade*
Personnel : A. N. Ghosh, K. M. Das and G. N. Chatterjee
Duration : Three years

Experiments on stocking density :

In nursery management studies, the fry of *M. tade* @ 1,92,300/ha (av. size : 22 mm), 1,53,840/ha (av. size : 20 mm) and 76,920/ha (av. size : 21 mm) were

stocked in different morphometrically identical nursery ponds. They were fed daily with powdered mustard oilcake and maize powder mixed together in equal proportion @ $\frac{1}{16}$ of the total weight of the fish population. In 90 days of rearing they attained an average size of 54 mm/2.6 g, 63 mm/4.6 g and 72 mm/4.9 g respectively indicating the relation between density and growth under identical condition.

In a yard experiment with water depths of 40, 60, 70, 105, and 130 cm the survival and growth of *M. tade* (av. size : 22 mm and stocking density 5,00,000/ha) were recorded to be 70.78% & 0.473 g, 84 57% & 0.567 g, 86.28% & 0·493 g, 87% & 0·545 g and 92·86% & 0·722 g respectively indicating that deeper water bodies can sustain better survival and growth at a stocking density of 5,00,000/ha.

Selective culture of advanced fry of *M. tade* was done at two stocking densities i. e. , 40,000/ha (av. size : 67 mm) and 30,000/ha (av. size : 53 mm). Supplementary feeding with a mixture of rice bran and fish meal (1 : 1) @ $\frac{1}{10}$ body weight of stocked fish was done on alternate days. The length I weight achieved in 180 days were 141 mm/26·36 g and 151 mm/30·0 g respectively.

In culture operations at a stocking density of 4,000/ha (av. size : 149 mm/ 32·5 g), the fish recorded a growth of 184 mm/73·7 g in 150 days when fed with a mixture ot mustard oilcake and maize powder in the proportion of 1 : 1·5 given daily @ 16% of the total weight of the fish in single stocking and single harvesting experiment.

Experiments on fertilisatian and supplementary feeding :

Different feed mixtures, rice bran + fish meal (1 : 1) ; rice bran + mustard oilcake + fish meal (4 : 3 : 3) ; rice bran and silkworm pupae (1 : 1) and rice bran + mustard oilcake + silkworm pupae (4 : 3 : 3) were fed to *M. parsia* fry in a statistically designed laboratory experiment to find out the most efficient feed mixture, both in terms of survival and conversion ratio into fish flesh. The last mixture was found to be significantly different from the others at 1% level, with the survival ratio as 0·700 and conversion ratio as 3·62 : 1. The crude protein and carbohydrate contents of the mixture were 36·60 and 37·15% respectively. With the same feed mixture a low conversion of 14·5 : 1 was obtained at low temparature (ranged 23° -24·4°C) and at salinity range of 6·91-10‰. Addition of minerals and cobalt chloride with the feed, however, increased the conversion to 4·773 : 1 at the same low temperature and salinity.

The relative efficiency of (1) fertilization, (2) fertilization & supplementary feeding and (3) fertilization, supplementary feeding & periodic replenish-

ment of impounded water with the tidal water to increase the survival and growth rate of the fish in the nursery ponds was investigated. The ponds were fertilized with superphosphate and cow dung @ 100 kg and 1,000 kg/ha respectively and were stocked with *M. parsia* @ 12,500/ha (av. size : 17 mm). The feeding was done @ 16% of the total weight of the fish population. The third method was found to be the most efficient. During 90 days of rearing, the average net gain in weight per fry was 5·815 g with more than 82% survival.

Growth of *M. parsia* was studied in three ponds (1) fertilized with inorganic fertilizer (superphosphate @ 100 kg/ha), (2) with inorganic fertizer (superphosphate @ 50 kg/ha) combined with organic manure (cow dung @ 1,000 kg/ha) and (3) without any fertilizer (control), each stocked @ 5,000/ha. The supplementary feeding was done @ $\frac{1}{16}$th of the body weight of the fish population. It was observed that the maximum growth was attained in the pond fertilized with superphosphate, being 15 g in 120 days. The control exhibited a growth of 11·4 g during the same period.

The monospecies culture of *M. parsia* (40,000/ha) yielded an estimated production of 480 kg/ha per 180 days without any supplementary feed as against 750 kg/ha per 180 days with supplementary feed containing 21·68% of protein of vegetable origin (rice bran + mustard oilcake fed @ $\frac{1}{10}$th of body weight) and 800 kg/ha per 140 days with supplementary feed having 26·25% of protein from vegetable and animal origin (rice polish + vegetable peelings + mustard oilcake + fish meal) fed at the same rate

Rearing experiment on intensive culture of *M. tade* has shown that the growth is better when the salinity range lies between 10 and 25‰ as indicated by high conversion ratio of food given (3. 62 : 1).

Mixed culture of mullet and prawn on principles of multiple stocking and repeated partial harvesting :

By judicious stock manipulation through repeated stocking and partial harvesting, an estimated net production of 2, 670·92 kg/ha/year could be obtained in selective culture of *M. parsia* and prawn. While a total of 32,500 nos/ha of *M. parsia* were stocked, the prawn seed was let in with the tidal water after straining it through a closely woven bamboo grating.

Based on the results of this project, a follow up project "Stock manipulation in intensive farming for mullets in monoculture and in association with penaeid prawns" has been proposed.

Problem : 5·14 Culture of *Penaeus monodon*

Personnel : P. U. Verghese, Haridial Singh, A. N. Ghosh, G. N. Chatterjee and H. C. Karmakar

Duration : Three years

The investigations on *Penaeus monodon* were taken up to evaluate the possibilities of commercial farming of the species in the brackishwater ponds. The studies have shown that the seed of the species (postlarval stage, 10-15 mm) is available in the Muriganga estuary in abundance throughout the year except during November, December and January. The peak period of availability is during the months of March-May (300-3,000 postlarvae/net/hr). Effective techniques have been developed for collection and nursery rearing of the postlarvae under controlled conditions and artificial-cum-natural feeding. The rate of survival during this period was as high as 80%. The postlarvae attained a stockable size of 40-50 mm/0·5 g. Artificial feeds were prepared with ingredients like fish meal, slaughter-house waste, powdered algae and wheat flour with different growth promoting chemicals that gave good growth with high rate of conversion of 3·4 : 1 to 2 : 1. Under laboratoryconditions when fed on artificial feed alone, the highest growth rate of 27 mm/0·8 g/month was obtained.

Studies on moulting and growth have shown that in the laboratory, 10 mm postlarvae undergo about 28 moults during 140 days and attain a length of 100 mm.

19 stocking experiments undertaken in 0·02 ha ponds with different stocking densities ranging from 10,000 to 50,000/ha, the stocking material being in the size range of 35-80 mm, have indicated that at stocking densities varying between 15,000 and 30,000/ha, the survival, growth and production are good. Under the above experiments, productions varied from 334 to 543 kg/ha/6 months. Introduction of non-predatory mullets and *C. chanos* were found to enhance the total production from prawn ponds and an over-all production up to 846 kg/ha/6 months could be obtained. The abundance of the bottom faunalike gammarids, and polychaetes was found to be correlated with the growth and survival of *P. monodon* under culture. So the reverse resulted during heavy mortality and poor growth of prawn. The sudden change in the ecology of the brackishwater pond due to heavy rains also affects the bottom fauna and prawns adversely.

A new type of cage for rearing prawns has been developed with PVC sleeving, reinforced with split bamboos, that can last longer in saline waters than traditional bamboo cages.

From the cage culture experiments, it has been found that 600 g/m^2 of marketable prawns (20 g average weight) could be raised in 3 months when the

cages were stocked with prawns (initial weight, 5 g) @ 50 nos/m^2. Based on the findings, a new project "Collection and rearing of *Penaeus monodon* seed for stocking and supply" is proposed to be taken up during 1976.

Problem : 5·15 Culture of *Penaeus indicus*
Personnel : A. N. Ghosh, P. C. Mohanta, H. C. Karmakar and G. N. Chatteriee
Duration : Three years

In order to study the growth pattern of different size groups under similar ecological conditions an experiment was taken up with three different size groups, 60-80, 81-100 and 101-140 mm. The stocking density for the smallest group was kept at 50,000/ha which was decreased to 40,000 and 30,000/ha with increasing larger size groups. Within 50 days, respective length/weight increments were 39·04 mm/4·38 g, 19-23 mm/4·57 g and 11·41 mm/6·60 g. The salinity, temperature and dissolved oxygen varied from 17·01-28·20‰, 30·6° to 33·0°C and 6·3-9·24 ppm respectively during the period of culture.

Effect of season on the growth of *P. indicus* was studied. At the same stocking density of 5,00,000/ha, the average growth achieved was 1.01 mm/day during monsoon and 0·50-0·54 mm/day during winter. The initial average size of the postlarvae was 30 mm in each case.

Experiments on short term cage culture (before stocking in nursery) of the postlarvae (20·35 mm) gave a survival of 80-90%. Experiments were also carried out with juveniles (size : 73 mm) at the stocking densities of 3-9 prawns/m^3 and 5 prawns/m^3 of water with the result that 3-9 prawns/m^3 of water gave 80% survival with an average growth of 0·58 mm/day while total mortality occured in the second case.

Stock manipulation experiments carried out with early fry of average size of 16·0 mm at two stocking densities of 200 prawns/m^3 and 133 prawns/m^3 of water indicated that it is possible to maintain the growth at higher stocking densities by periodic thinning. The average length I weight attained in 160 days was 108mm/9·6 g. Without manipulation of the stock in lower stocking density, the average size attained after 167 days of rearing was only 88·0 mm/5·9 g during the same period of rearing.

In monoculture experiment in a pond of 0·02 ha without and with supplementary feed at a stocking density of 40,000/ha, average growth of 0.94 mm/day and 1·06 mm/day were attained during summer months and 0·63 mm/day and 0·64 mm/day during monsoon months respectively,

In laboratory experments, it was observed that feed pellets made of ingredients from animal and vegetable origin are readily consumed by the prawns. Such artificial diets (rich in protein and carbohydrate) were prepared out of cockle-meat, maize powder, sagu and shell powder in the proportion of 4 : 4 : 1·5 : 0·5 and fed to the postlarvae (size : 31·0 mm) along with plankton and periphyton. An average growth of 12·0 mm/43 days with a survival of over 50% was achieved.

The factors for large scale mortality in the culture of penaeid prawns at the postlarvale stage are largely due to sudden change in the environmental condition from lotic to lentic and differences in the salinity and temperature between the river and the pond. Lifting out of water for a short period and transportation for a short distance in head load also result in high mortality. Several trial experiments with different sizes for stocking in bigger pond showed that postlarvae in the advance stage (60 mm and above) are best suited for stocking and have given satisfactory survival rate of 60%.

Based on the results obtained a new project "Intensive culture of *Penaeus indicus* in association with other penaeid prawns" is proposed to be initiated in 1976.

(b) *Research in hand*

Research on 23 projects were continued during the year under report. The progress achieved under each project, during 1975, is outlined in the following pages.

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

Problem : 1·1 Composite culture of Indian and exotic species

Personnel : H. Chaudhuri, R. D. Chakraborty, P. R. Sen, D. S. Murty, N. G. S. Rao, S. N. Dutta, S. Jana, C. Selvaraj, S. R. Ghosh, K. J. Ram, R. K. Dey, B. Dash, S. L. Kar and P. V. G. K. Reddy

Duration : Continuing

Fry of Indian major carps *C. catla*, *L. rohita* and *C. mrigala* were stocked in the ratio of C 1 : R 1 : M 1 @ 50,000/ha. After about 1½ months rearing, the fingerlings on an average attained a size of 44, 33 and 25 g in case of *C. catla*, *C. mrigala* and *L. rohita* respectively. Field experiments on 3-6 months duration on rearing of silver carp (*H. molitrix*), grass carp (*C. idella*), rohu (*L. rohita*), mrigal (*C. mrigala*) and common carp (*C. carpio*) in two 0.08 ha ponds

were initiated in September, 1974 @ 2·5 lakhs fry/ha and in the species ratio of Sc 4 : Gc 2 : R 2 : Cc 2 in one pond and @ 3·5 lakhs fry/ha with species ratio of Sc 4 : Gc 2 : M 4 in other pond. The average survival and growth of silver carp, grass carp, rohu and common carp in the first pond were 74·5% & 82·94 mm/5·5 g ; 68·97% & 66·86 mm/3·0 g ; 94·72% & 111·8 mm/17·0 g and 47·95% & 95.86 mm/19·0 g respectively and in the other pond where the experiment was concluded after six months ; the average growth was silver carp, 110 mm/12·0 g ; grass carp, 93·98 mm/19·5 g and mrigal, 121 mm/18·5 g. The survival of fingerlings was, however, poor probably due to unavoidable delay in harvesting and also due to poaching. No fresh experiment could be initiated during 1975 for want of sufficient number of ponds.

In experiments conducted in two of the experimental farm ponds on intensive fish farming, gross productions obtained were 8,867 and 7,503 kg/ha/yr. The species cultivated were the Indian major carps and exotic carps stocked in the ratio of Sc 2.5 : C 1 : R 2 : Gc 1·5 : M 1 : Cc 2 at a combined density of 10,000 fingerlings/ha. A few prawns, *Macrobrachium rosenbergii* and the feather-back, *Notopterus chitla* were also added in each pond and these also recorded marketable weights. While the aggregate survival of the stocked carps was 91% in the smaller pond of 0·4 ha area (referred to pond -1 hereafter), it was 84% in other pond of 0·5 ha (pond 2) due to loss of silver carp during culture. The conversion of feed to fish flesh was approximately 2 : 1 in these experiments.

In terms of average weights attained, silver carp, grass carp and common carp performed the best in pond 1, being over 1 kg and mrigal was on an average over 800 g. For the other pond, the pattern was the same with the addition that catla also attained an average weight of over 800 g. The management measures involved were the provisions of fertilizers (organic manure and inorganic fertilizers) and feed (ground-nut oilcake + rice polish) and the weeds, mostly *Spirodela* sp for feeding grass carp. Lime was added periodically and the pond bottom was raked.

In other two experiments which are in progress, on intensive fish farming employing the technology of composite culture, productions so far estimated are about 1,345 kg/ha/3 months and 951 kg/ha/3 months The ponds were stocked @ 10,000 fingerling/ha in the ratio of Sc 2 : C 1 : R 2.5 : M 1·5 : Cc 1·5 : Gc 1·5. A few numbers of chitala were also introduced in each pond. In both the ponds, catla has performed the best and in one of the pond, its average weight has exceeded 0·5 kg in three months.

Intensive culture of the Indian major carps : *C. catla, L. rohita* and *C. mrigala* was undertaken in two ponds at the Killa Experimental Farm, Cuttack. Fingerlings

of the three species were stocked in two ponds @ 6,000/ha in the ratio of catla 3 : rohu 4 : mrigal 3. The ponds were fertilised with organic manure and chemical fertilisers. Supplementary feeding with a mixture of ground nut oilcake and de-oiled rice polish in equal proportions by weight was also done. The ponds, harvested after a year, recorded gross productions of 3,930 kg/ha/yr and 3,017 kg/ha/yr. The best average gain in weight of around 800 g was obtained in *C. catla* despite the high survival of the species in both the ponds. It was possible to determine the sex of the majority of the harvested fish by external examination. Productions as obtained in these experiments indicate that such high productions can be obtained from ponds by intensive culture of Indian major carps alone in areas where exotic carp seed is not available.

In an experiment on composite culture of Indian and exotic carps to raise marketable fish by fertilization (both organic manure and inorganic fertilisers) and supply of weeds (for grass carp) but without any supplementary feeding, the production estimated (at 80% survival) was about 3,065 kg/ha/10 months. The pond was stocked @ 6,000/ha in the species ratio of Sc 2·5 : C 1 : R 2·5 : Gc 1·5 : M 1·5 : Cc 1·0. The silver carp attained the marketable size of 1 kg and except common carp all the other species were around 0·5 kg on an average.

Both organic manures and chemical fertilizer were being used for fertilization and only a small quantity of aquatic weeds was provided.

The results obtained are promising particularly in the context of low production cost as the major inputs in terms of money for the artificial feeds have not been used at all.

Problem : 1·21 Carp fry rearing for optimum survival and growth under high stocking density
Personnel : P R. Sen and D. K. Chatterjee
Duration : Three years

The field trials under this project could not be conducted during the year.

Problem : 1·22 Biology of fish food organisms -Cladocera (Water fleas)
Personnel : R. D. Chakraborty, S, Jena, Kanaujia and B. Dash
Duration : Four years

Samples of Cladocera (*Moina* sp.) were inoculated in three media i. e., cow dung, poultry manure and mahua oilcake added to water that had been

filtered in Nylo-bolt cloth. Doses of each manure tried in the first 2 sets were 400, 600 and 750 ppm. Pond soil was used as base.

Satisfactory growth of *Moina* sp. was not observed in the first 2 sets. However, in the 3rd set tried with doses of 300, 500 and 750 ppm of the manure, the results appeared to be better. Poultry manure proved to be better at 700 ppm. With the 300 and 500 ppm doses, Cladocera were not observed. With mahua oilcake at 700 ppm no satisfactory result was observed.

At the time of inoculation in November, some Cladocera were observed with eggs. Young ones of *Moina* sp. were observed on the 15th day after inoculation in some of the jars. During the trials, the water temperature varied from 21° to 28°C in winter and 28° to 34°C in summer.

Problem : 1·23 Evolving efficient method for capture of bottom dwelling fishes in ponds
Personnel : M. Rout, M. A. V. Lakshmanan and D. R. Kanaujia
Duration : Four years

A net was designed with a view to collect representative number of both surface and bottom feeders simulateneouly for sampling and harvesting. Trials were made in water bodies ranging in area from 0·15 to 2.25 ha and it was observed that the catch per haul increased by 10-15% with the newly designed net than with the conventional drag-nets. Twines of different diameters were braided for gill-nets and by trials of these nets in ponds, it was revealed that the catch efficiency decreased with increasing diameter of the twine. Average catch of bottom dwelling fishes was calculated as 30% of the total catch. Relative vulnerability for capture of fishes was calculated to be 0·95, 1·00, 1·25 and 1·4 kg for 100, 112, 125 and 137 mm mesh respectively. Optimum mesh size for removal of fish of minimum 1 kg size was found to be 120-130 mm. Hanging coefficient was kept between 50-60% to catch fish by gilling as well as entanglement.

Problem : 1·24 Studies on the effect of chemical fertilisers in relation to pond productivity
Personnel ; G. N. Saha, D. K. Chatterjee, C. Selvaraj and N. N. Mazumdar
Duration : Five years

Fertilizers— triple superphosphate, ureaform and postassium chloride were applied at two rates, 25 and 50 kg of N, P_2O_5 and K_2O/ha in slightly acid soil in laboratory. Each treatment was replicated thrice. 10 rohu spawn in each

jar were reared for 18 days. The survival of spawn of rohu was 80% with urea-form at 25 kg N/ha as against 60% in control. At higher rate triple super-phosphate gave 70% survival. The rate of 25 kg/ha of fertilizer was tried in yard using the same soil type. Though the survival of fry was higher with potassium chloride (90%) the growth of fry recorded was better with urea-form application as fertiliser.

Encouraging result was achieved in increasing fish production using fertilisers alone. Two fertiliser combinations tried in two ponds (0·25 ha each)— one treated with only chemical fertiliser (@ 280-100-30 kg N-P-K/ha/yr) and the other with both chemical + organic manure (cow dung 10,000 kg/ha/yr) almost at the same rate of nutrient ratio. The stocking of ponds was done with fry of Indian and exotic carps @ 7.500/ha with 5 species combination (silver carp, catla, rohu, mrigal and common carp). In both the cases, the growth of fishes was good. Silver carp attained 1 kg in 9-10 months. The net production was 4,220·82 kg/ha/yr with chemical fertilisers alone and 3,275·78 kg/ha/yr with both chemical and organic fertilisers. In latter case, the production was low mainly due to poaching.

Problem :	1·25	Mass Culture of phyto- and zooplankton in field to feed fish
Personnel ;		K. K. Bhanot, A. C. Nandy, N, N. Sarkar, and G. P. Bhattacharjee
Duration :		Three years

Mass culture of *Chlorella vulgaris*, using N : P : K fertilisers, with urea, single superphosphate and muriate of potash, were continued. Experiments in laboratory and yard gave sustained growth of diatoms *viz*,, *Nitzschia closterium* and *Navicula cryptocephala*. Mass culture of these species could be obtained by using urea, single superphosphate and sodium silicate in 100 : 10 : 5 ratio. The maximum cell density observed was 1·5 million cells/ml in 5 days. Both the species are maintained on agar plates slants for stock culture.

Culture of *Scenedesmus obliquus* was made in laboratory in 1 l round bottom flask at a constant temperature 20± °C. The cell density increased exponentially from the 7th day after the inoculation and the cell count reached to a maximum of 57 X 10^3/ml by the 20th day. Thereafter the cell density indicated a decline and was observed to be 38 X 10^3/ml by the time the experiment was closed on the 28th day. The culture was done in Bristol's solution.

Zooplankton culture in glass jars has indicated that ground-nut oilcake alone or in combination with poultry excreta @ 740 ppm resulted in quick growth of *Brachionus* sp. within 10 days. With an initial innoculum of 1,042 units/l the maximum population obtained was 57,659/l in 10 days.

Mass culture of *Moina* sp. was also attempted in field conditions using freshly cultured *C. vulgaris* and *S. obliquus* as feed. Spawning periodicity of *Moina* sp. was also observed and it was found that an individual bred about 8 times during 9 days.

Problem : 1·26 Nutritional requirements of fry and fingerlings of carps
Personnel : P. R. Sen, N. G. S. Rao and S. R. Ghosh
Duration : Four years

Five test diets were prepared with protein and carbohydrate at 0, 15, 30, 45 and 60% levels and tested with common carp spawn and fry. The results obtained in the experiments confirmed the earlier findings that growth was maximum with the test diet having 45% protein and 25% carbohydrate, whereafter it was not significant. Further confirmatory experiments with 9 test diets with protein and carbohydrate levels of 0, 15, 30, 40, 45, 50, 55, 60 and 70% were conducted with rohu fry. The results indicated that growfh progressively increased with increase in protein in the test diets up to 45% with a corresponding decrease in carbohydrate up to 30-25% levels and almost indentical results were obtained in diets having 40% and 45% of protein, with carbohydrate at 30% and 25% levels, whereafter the increment was not significant.

Problem : 1·27 Comparative study of the structure of the gill apparatus of the Indian major carps catla, rohu and mrigal and its development with age and correlation with feeding
Personnel : R. D. Chakraborty, S. N. Dutta and B. Das
Duration : Three years

More closely arranged long filamentous gill rakers of *C. catla* suggest its better seiving ability than the other two species. The ratio of gill rakers and gill filaments within a gill arch in catla is about 1 : 1. The same in *L. rohita* and *C. mrigala* are about 1 : 2·5 to 3 and 1 : 1·5 to 2 respectively, showing less prominence of the rakers in these two species. The average number of rakers in harvestable size of catla was about 280 whereas it was 80 and 85 in rohu and mrigal respectively. In fingerlings, the numbers were 180, 55 and 65 and in smaller fingerlings 120, 40 and 40 respectively in the three species.

Analysis of the gut contents of *C. catla* revealed the predominance of zooplankton, comprising copepod, rotifers, etc. In *L. rohita*, phytoplankters were more abundant, consisting of unicellular and colonial green algae like, *Scenedesmus*, *Pediastrum* and some euglenoids (*Phacus* and *Euglena*). Diatoms and desmids were dominating in the gut contents of *C. mrigala*, abundant forms being *Closterium*, *Cosmarium* and *Navicula*. Rotifers and remains of leaf fragments along with sand particles were also encountered. In general, it was observed in these carps that some of the filamentous green and blue-green algae and colonial blue-green algae were present all along the gut, suggesting that these were undigestible. Many zooplankton, desmids and unicellular green algae found in the fore and mid gut were not encountered among items observed in the hind gut, suggesting their digestibility.

Other items encountered in the hind gut of the three carps, were fragments of copepods and insect larvae in *L. rohita*, bits of leafy vegetation in *C. catla* and insect parts and sand particles in *C. mrigala*.

Problem	: 1·28	Commercial production of carps through composite culture in large sized ponds
Personnel	:	M. A. V. Lakshmanan, N. G. S. Rao, M. Rout, D. K, Chatterjee, D. R. Kanaujia and C. Selvaraj
Duration	:	Three years

Periodic removal of marketable sized fishes of 1 kg and above was continued by using gill-nets and drag-nets. Fish of 5,628·6 kg/2·25 ha, 3,718·8 kg/ha and 2,057·1 kg/0·67 ha were harvested, so far in 27, 19 and 16 net days respectively. This accounted for only 20.9, 32·1 and 45·5% removal of the fish stock. The gross average weights of harvested fishes in the above mentioned order of ponds were 1·19, 1·76 and 0·96 kg respectively. The average weights attained by individual species in the descending order were silver carp (1·321-2·676 kg), grass carp (1·292-2·056 kg), catla (0·890-1·794 kg), common carp (0·613-1·350 kg), mrigal (0·667-1·005 kg) and rohu (0·577-1·10 kg).

Plankton production in the ponds remained poor during the year (negligible to 0·2 cc/45 l of pond water). Bottom fauna consisted mainly of *Limnodrilus*, *Branchidrilus* and *Pentaneura*, the density ranged from 495 to 4,080/m^2 in the three ponds. Except dissolved nutrients and total alkalinity, the average water quality of first two ponds remained uniform. Dissolved phosphorus (0·086 ppm) and NH_3—N (0·22 ppm) were slightly more in the second pond than in the first pond whereas the first pond showed slightly higher alkalinity (82 ppm) than the former (71 ppm).

Problem ; 1·29 Comparative study of the efficacy and economics of available fish poisons and their residual effects on the fish pond ecosystem

Personnel ; H. Chaudhuri, V. Ramachandran and S. Jena

Duration : Two years

A few sets of jar experiments were conducted with Tamarind seed-husk and Karanja oilcake. Tamarind seed-husk is giving encouraging results in killing fish at 8-10 ppm within two hours. The time is shortened by one hour when the dose is increased to 15-20 ppm. The test fishes used were *Tilapia mossambica* and *C. carpio* of 40-50 mm sizes. However, no response was noticed even at 30 ppm dose with Karanja oilcake.

Problem : 1·30 Operational research on fish culture

Personnel : M. A. V. Lakshmanan, N. G. S. Rao, N. K. Tripathy and D. R. Kanaujia

Duration : Two years

Culture experiments were initiated in 2 ponds in Gohala village and in 8 ponds in Jagannathpur village belonging to individuals and was continued till May-June, 1975 when the fishes were harvested due to low water level in ponds. Ponds ranging from 0·02 to 0·035 ha (with the exception of one Panchayat pond 0·09 ha) yielded 32 to 54 kg (190 kg in the 0·09 ha pond) i. e., at the rates of 1,000-2,100 kg/ha in 6-7 months. The villagers earned income ranging from Rs. 200-1,000 (i. e. Rs 1,500-13,400/ha). The relatively low rate of production was due to improper and casual attention given by the pond owners in feeding the fish and attending to the pond fertilisation scheme.

5 of the above 10 ponds were selected and prepared for demonstrating fry rearing techniques. Quality spawn of *L. rohita* and *C. mrigala* obtained by induced breeding at Cuttack were stocked and harvested with financial returns of Rs. 100-160 from 0·01 ha water area.

Problem : 1·31 Use of anaesthetics, in transport of fry and fingerling under oxygen packing

Personnel : S. N. Dutta, K. Janaki Ram and A. N. Mohanty

Duration : Three years

A consignment of fingerlings of *L. rohita* transported from Cuttack to Puri, a distance of about 100 km, packed under oxygen + Chloral hydrate at 300 ppm recorded better survival over those containers charged with oxygen only.

Problem : 1·32 Bionomics and culture of Tendipedid larvae a favoured fish food organism

Personnel : N. G. S. Rao

Duration : Two years

Larvae of two species of tendipedid belonging to sub-family Chironominae were commonly encountered in the selected environments examined. Observations on the life cycle of tendipedids revealed that adults lay eggs within 2-3 days after their emergence. The cases are tubular gelatinous masses containing 400-420 eggs in each. The larval stages usually exist for 20-35 days depending upon temperature.

Natural spawning method of propagation was experimented upon. In one series of experiments conducted in enamel trays, milk powder, urea and triple superphosphte were used as media in progressively increasing concentrations (·85 to 425 ppm and in the other series cow dung and chicken droppings were added in small quantities (200 g each time in 0·56 m^3 of water) on alternate days in plastic pools with and without soil base. The production of tendipedid larvae remained poor (maximum of about 1,000/m^2) even with introduction of larvae and pupae in both the series.

Problem : 1·33 · Studies on detection of digestive enzyme complex of freshwater culturable food fishes

Personnel : B. N. Saigal, A. K. Datta (up to May, 1975) and Amitabha Ghosh

Duration : Four years

Preliminary observations have indicated that amylase and invertase are present in the intestine, intestional bulb and liver of *C. mrigaia* (size : 16-17·5 cm) and *L. rohita* (size : 8-12 cm). Lipase was detected throughout the digestive tract of *Heteropneustes fossils* and in the intestine, intestinal bulb and liver of *L. rohita* (size : 5-12 cm) and *C. mrigala* (size : 15·0-17·4 cm). Detection of these and other enzymes in larger size groups of maior carps and other food fishes are in progress.

Project 2 : Induced fish breeding

Problem : 2·1 (Research completed in 1970)

Problem : 2·2 Use of various hormones for inducing spawning in carps

Personnel : R. M. Bhowmick, G. V. Kowtal, R. K. Jana and S. D. Gupta

Duration : Nine years and six months

45 sets of Indian major carps injected @ 4-15 mg/kg of body weight with salmon gonadotropin gave over 80% success. The controls (nine sets) injected with carp pituitary extract also gave positive results indicating that whole pituitary extract is equally potent.

Labeo rohita injected with lutocyclin, LH and RH gave negative results. Clomiphine citrate when injected @ 8-28 mg/kg of body weight failed to induce spawning in rohu.

14,000 mg of pituirary glands, mostly from common carp specially reared in the Killa Fish Farm were collected. The collection was supplemented by glands obtained from other carps. To meet the pituitary gland requirement of 1976 rearing of 1,147 common carp fingerlings in a 0·3 ha pond is in progress.

Problem : 2·3 (Research completed in 1972)

Problem : 2·4 Hatching of eggs of major carps in newly designed hatching jars under controlled conditions

Personnel : R. M. Bhowmick, R. K. Jana and S. D. Gupta

Duration : Nine years and six months

15 sets of experiments carried out with the eggs of major carps (catla, rohu, mrigal) inside the Glass jar hatchery yielded 43·271 lakhs spawn. Better spawning of catla was observed inside the hatchery tank under a shower with running water facilities than in the *hapas* fixed in the stagnant waters in ponds.

Three experiments with eggs of silver carp (*H. molitrix*) and grass carp (*C. idella*) in the hatchery gave 4·8 lakhs seed of these exotic carps, even when percentage of fertilsation in all the experiments was poor.

Problem : 2·5 (Research completed in 1972)

Problem : 2·6 Production of multiple broods from the same individual of major carps in the course of one year

Personnel : R. M. Bhowmick, G. V. Kowtal, R. K. Jana and S. D. Gupta

Duration : Six years and 6 months

The monsoons were very much delayed and as a result only two sets of rohu and mrigal attained full maturity for the second time in the season at an

interval of about 5 weeks from the date of first breeding. They were successfully induced bred for the second time and this resulted in increasing the production of spawn by an additional quantity of 3·8 lakhs.

Problem : 2·7 Isolation of fish gonadotropin for hypophysation of carps in large scale.
Personnel : V. R. P. Sinha
Duration : Three years

Due to non availability of U. V. cord record and lypholizer no progress could be made during the year.

Problem : 2·8 Induced breeding of important cultivated fishes (other than carps)
Personnel : R. M. Bhowmick, G. V. Kowtal, R. K. Jana and S. D. Gupta
Duration : Five years

Distinguishing characters of male and female *Notopterus chitala* have been determined. Some of the specimens of *N. chitala* matured in a rearing pond and two were selected for hypophysation. When the males and females were injected with homoplastic pituitary extract, the females released eggs on stripping. The eggs could not be fertilised as the males were not in proper stage of maturity.

Problem : 2·9 Studies of the process of maturation, ovulation and resorption of gonads in Indian major carps
Personnel : G. V. Kowtal, R. M. Bhowmick, R. K. Jana and S. D. Gupta
Duration : Five years

Gonads of Indian major carps were collected and preserved for histological examination of the gonadial tissue.

Project 3 : Reservoir Fisheries

Problem : 3·1 (Research completed in 1972)
Problem : 3·2 (Research completed in 1972)
Problem : 3·3 (Research completed in 1972)
Problem : 3·4 (Research completed in 1972)
Problem : 3·5 (Research completed in 1972)

Problem : 3·6 Fisheries of Peninsular tanks : Assessment of biological productive potentialities

Personnel : B. V. Govind, P. K. Sukumaran, S. L. Raghavan and M. F. Rahman

Duration : Three years

Composite fish culture in 2 ha tanks with a stocking density of 5,000/ha of Indian and exotic carps showed weight increments with reference to *C. catla L. rohita, C. mrigala* as 223 g, 39·01 g and 54·4 g respectively in 104 days of rearing. In another tank stocked at the same rate, common carp *(C. carpio)* and silver carp *(H. molitrix)* showed an increment of 79·2 and 43·2 g respectively in 54 days only.

Problem : 3·7 (Research completed in 1970)

Problem : 3·8 Fisheries of Peninsular tanks : Introduction and propagation of cultivable species

Personnel : B. V. Govind, P. K. Sukumaran, S. L. Raghavan and M. F. Rahman

Duration : Three years

Four hundred and fifty advanced fry of *Puntius pulchellus* (size range : 18-34 mm) were stocked in ASC Centre and Bilvardhalli tanks respectively. These were collected from the Tunga and Bhadra river drainages during December, 1975.

Ten and one hundred advanced fry of mahseer (size range : 19-32 mm) were stocked in ASC and Bilvardhalli tanks respectively for follow up studies.

Milting males of *P. pulchellus* were noticed in the Vanivilas Sagar Fish Farm from August onwards till December, 1975 while females were unripe.

Problem : 3·9 Development of Fisheries of Loni Reservoir

Personnel : A. G. Jhingran, K. L. Saha, S. N Mehrotra, K. P. Srivastava, M. D. Pisolkar and R. K. Saxena

Duration : Three years

Studies on the breeding of major carps in the reservoir and the escapement of eggs and spawn down the waste weir : Detailed observations on the natural breeding of major carps in the Loni reservoir and the intensity of escapement of the resultant eggs and spawn down the waste weir were made from 12.7.75 to 22. 7. 75. The reservoir attained full level (290 ft) in the evening of 19. 7. 75. With the overflow of the waste weir, the breeding commenced first above the waste weir in the shallower areas. Hectic movement of breeders started and the local villagers barricated the breeding area and resorted

to mass killing of the breeders by speares and bamboo poles. Examination of 28 specimens thus captured revealed that one was rohu (♀ spent) and the rest were mrigal (12 ♀ spent and 15 ♂ oozing).

Six Midnapore type of 1/8" meshed shooting nets were operated first above the waste weir and a total of 50,000 eggs and 19 ml (9,500 nos.) of spawn were collected. Only two shooting nets could be operated about 1 km below the waste weir and 70 ml (35,000 nos.) of spawn were collected. The catch/net/hour of spawn collected above and below the waste weir was estimated to be 0·39 ml and 9·47 ml respectively indicating that out of the spawn colleted, about 96% came from below the waste weir thus indicating heavy escapement. The percentage of major carp in the collection, as determined by nursary rearings, was found to be 78·9 and that by microscopical examination as 85%.

Fishing operations, stocking programme : 60,030 fingerlings of Indian major carps were stocked in the reservoir till 21. 11. 75. The fingerlings for stocking were procured from various sources *viz.* , salvaged from below the waste weir of the Loni reservoir, collected from the river Ganga and its adjoining nullahs at Allahabad, procured from Cuttack Sub-station of the Institute and received from State Fisheries Department, Rewa (M. P.). Stocking progromme will be intensified further.

Experimental fishing : No fishing was done till March, from April onwards experimental gill-nets were operated. Fishing was done with the help of multi-meshed nylon gill-nets (length 28·94 to 52·51 m, breadth 2·00 to 2·80 m), the mesh size varying between 4 and 10 cm bar. Two pieces of drag nets and one cast-net were also operated. The gill-net catches comprised *C. mrigala, C. catla, L. rohita* and *L. calbasu* amongst major carps ; *M. seenghala* and *Wallago attu* amongst catfishes ; *Labeo bata, Puntius sarana, Labeo gonius* and *L. pangusia* amongst minor carps ; and *Notopterus notopterus* amongst feather-backs. The meagre catches by drag-nets and cast-net comprised minor carps (*P. sarana, C. reba, Osteobagrus* sp. and *Puntius* spp.), clupeoids (*Gudusia chapra and Setipinna phasa*), perches (*Chanda* spp,) murrels (*Channa* spp.), and feather-backs (*N. notopterus*).

During 15 days of fishing, spread over the year, 222 numbers of fish of various species weighing 147·170 kg were captured with the gill-nets. Table-2 gives the species composition of the gill-net catches by weight and by numbers in parentheses.

Table 2. *Species composition of the gill-net catches by weight (Kg.),number in parentheses and size (mm)*

Months	No. of fishing days	C. mrigala	C. catla	L. calbasu	L. rohita	M. seenghala	W. attu	L. bata	P. sarana	L. gonius	L. pangusia	N. notopterus	Total
April	4	7·880	-	5·190	12·250	11·550	-	1·350	7·750	1·220	0·870	1·210	49·070
		(15)		(9)	(10)	(9)		(3)	(22)	(3)	(2)	(7)	(80)
		354-426		315-430	405-486	400-742		624-355	242-312	316-342	341-350	260-305	
May	2	8·820	-	1·750	1,000	6·990	-	0·700	3·640	0·300	1·000	1·410	25·520
		(13)		(2)	(1)	(4)		(2)	(11)	(1)	(2)	(4)	(43)
		375-556		315-446	445	642-734		328-345	241-312	302	302-391	270-320	
June	2	8·950	4·000	4 350	4·440	4·000	-	0·750	1·050	-	-	1·400	28·400
		(13)	(1)	(5)	(3)	(3)		(1)	(3)			(8)	(37)
		361-443	635	331-446	480-495	500-710		310	270-285			260-316	
July	2	10·170	-	8·950	6.300	-	1,930	0,250	1·210	1·930	-	0·150	30-530
		(14)		(13)	(4)		(1)	(1)	(3)	(4)	-	(1)	(41)
		375-486		332-442	502-520		690	290	290-291	314-344		262	
August	2	-	1·750	-	1·300	4·500	-	-	1,200	-	-	0,570	9·320
			(1)		(1)	(1)			(3)			(3)	(9)
			490		470	985			285-330			271-299	
September	1	0,410	-	-	1·110	-	-	-	0,270	-	-	0·4 0	2·520
		(1)			(1)				(2)			(2)	(6)
		405			471				254-262			282-300	
October	1	-	-	-	-	0·700	-	-	-	-	-	1,110	1·810
						(1)						(5)	(6)
						535						253-305	
November	1		-	-	-	-	-	-	-	-	-		Nil
Total	15	36,230	5·750	19·880	26·150	27·650	1.930	2·550	15·420	3·450	1·870	6·290	147·170
		(55)	(2)	(29)	(20)	(18)	(1)	(7)	(44)	(8)	(4)	(33)	(222)
		354-556	490-635	315-446	405-520	400-742	690	290-355	241-330	302-392	302-391	253-320	

Commercial fishing : Commercial fishing was conducted for a day in February, 1975. Subsequently it was started in September, 1975 with multimeshed nylon gill-nets of different dimensions. About 35-50 pieces of gill-nets were operated for a period of 41 days till the 22nd of November, 1975. 738·500 kg of fish comprising 175·00 kg major carps, 6·00 kg catfishes & murrels, and 557·50kg other fishes, were harvested. Details of commercial catches are presented in table 3.

Table 3. *Details of fish catch (kg) under commercial fishing in the Loni reservoir*

MONTHS	No. of fishing days	Major carps	Catfish & Murrels	Other fish	Total
February	1	4·60	-	11·00	15·50
September	18	131·50	6·00	246·50	384·00
October	15	35·50	-	176·50	212·00
November	7	3·50	-	123·50	127·00
Total	41	175·00	6·00	557·50	738·50

Yield per hectare : Per hectare yield from the reservoir, based on commercial catches, was estimated to be 26·76 kg which is a definite improvement over that estimated for the years 1967-1970 (14·73 kg/ha). Heavy exploitation of the reservoir through commercial fishing has started from 1974 earlier to which protracted commercial fishing was never done in the reservoir as it did not prove to be remunerative to the fishermen.

Hydrology : The reservoir water was clear as evidenced by Sacchi disc readings (12·5-100·0 cm). Water temperature ranged between 20° and 31°C. The water was characterised by alkaline pH (7·6-8·4) with carbonate and bicarbonate ions ranging between 0-7 ppm and 54-110 ppm respectively. Free CO_2 ranged between 2·0 and 13·4 ppm and was present during monsoon months only. Ca ions ranged as 29·0-36·5 ppm. Mg ions showed values as 2·8-4·8 ppm. The concentration of dissolved oxygen was the maximum (8·4 ppm) in November against a minimum of 6·4 ppm. Organic matter showed the maximum concentration in August (7·2 ppm) and the minimum in April (3·0 ppm). The inorganic nutrients showed lower values from January to June and comparatively higher values from July to December. Nitrate ranged between 0·1 and 0·19 ppm, phosphate between 0·08 and 0·18 ppm, and silicate between 11 and 20 ppm.

Bottom biota : The macrobenthic fauna was dominated by oligochaetes and chironomid larvae. The other representatives were larvae of Coleoptera, Trichop-

tera & Diptera, odonate nymphs, bivalves (*P. favidens*) and gastropods (*Limnaea* sp. and *Gyrulus* sp.). The average number of organisms/m^2 ranged from 76 (in July) to 1,683 (in October).

Project 4 : Riverine carp spawn prospecting and collection technique

Problem	: 4·1 & 4·2	(The work is being done under a Coordinated Research Project.)
Problem	: 4·3	(Research completed in 1971)
Problem	: 4·4	(Research completed in 1973)
Problem	: 4·5	Yearly variation in quality and quantity of spawn in river Ganga
Personnel	:	K. L. Shah and G. N. Srivastava
Duration	:	Four years

Because of paucity of funds the project was suspended during the year.

Project 5 : Brackishwater fish farming

Problem	: 5·1	Productive potential of polyculture in lower Sunderbans and behaviour of pond dykes
Personnel	:	A. V. P. Rao, B. B. Pakrasi, A. Sengupta, P. Ray and P. K. Ghosh
Duration	:	Six years

A 0·25 ha low saline pond (K) was stocked with catla, rohu. mrigal, silver carp, common carp, *Mugil cephalus*, *M. tade* and *Penaeus monodon* @ 6,140/ha. The proportions of the different categories were : freshwater fishes 69·6%, brackishwater fishes 23·8% and prawns 6·6%. Fertilisation with inorganic fertilisers @ 600/kg/ha and cow dung @ 10,000 kg/ha was done. Supplementary feeding with mustard oilcake and maize powder @ 1·0 to 1·5% of the body weight was resorted to. Average sizes attained after one year of rearing were catla, from 160·0 to 879·2 g & from 42·9 to 468·8 g ; rohu, from 200·0 to 553·8 g & from 42·7 to 315 7 g ; mrigal, from 22·3 to 382·8 g ; *Mugil tade*, from 62·2 to 290·3 g & from 21·3 g to 171·0 g ; silver carp, from 2·0 to 366·0 g ; *M. cephalus*, from 184·5 to 750·0 g and *P. monodon*, from 2·0 to 75·0 g. Harvesting could not be completed but it is anticipated on the basis of the above growth rates that a gross production of 1,850 kg/ha and a net production of 1,650 kg/ha can be obtained from the said pond.

Constant low turbidity, high pH, lower ranges of phosphates and nitrates were recorded. The salinity range was 0·18 to 0·91‰ in the water phase. Moderate values of primary productivity (50-360 mg C/m³/hr), and lower concentration of phytoplankters (100 to 2,600 u/l) were a result of turbidity. In the R-pond (0·25 ha), the same species which were stocked @ 5,120/ha, had to be partially harvested in May, 1975 after rearing for 5 months, due to excessive evaporation of water. The estimated production was 745·5 kg/ha/5 months.

Problem : 5·2 (Research completed in 1973)
Problem : 5·3 (Work programme transferred to Brackishwater Experimental Fish Farm Unit, Kakdwip)
Problem : 5·4 (Research completed in 1972)
Problem : 5·5 (Research completed in 1972)
Problem : 5·6 (Research completed in 1972)
Problem : 5·7 (Research completed in 1973)
Problem : 5·8 (Research completed in 1975)
Problem : 5·9 (Research completed in 1973)
Problem : 5·10 (Research completed in 1975)
Problem : 5·11 (Research completed in 1974)

Problem : 5·12 Methods of silt control and experimental trials on sluices
Personnel : A. B. Mukherjee, A. Sengupta and B. Basak
Duration : Three years

A detailed design, drawing and estimate for an open top 6 m long ractangular box-type wooden sluice measuring 0·71 m X 1·81 m at the highest point with reducing sectional areas at both ends have been prepared. The construction for the same is being awaited.

Problem : 5·13 Selective culture of *Mugil parsia* and *Mugil tade*
Personnel : A. N. Ghosh, K. M. Das and G. N. Chatterjee
Duration : Three years

In the nursary management, it has been established that the stocking density of fish seed is directly proportional to the volume of water instead of surface area. In experiments with same surface area but with different volumes of water having 70 and 140 cm depths, it is found that at 87 nos/m² of water area with a depth of 140 cm, fish seed could be nursed successfully with a survival of more than 90%.

Stock manipulation experiment under monoculture of *Mugil tade* fingerlings in the size range between 59 and 89 mm indicated that the optimum stocking density for this size range is around 9,000 nos./ha. The respective survival rate at 25,000, 19,000 and 9,000/ha from an earlier stocking density of 34,000, 25,000 and 10,000/ha were 12·44%, 25·75% and 59·44% respectively. The average size attained by the fish at the highest survival rate was 151·85 mm/ 39·85 g.

Rearing experiments with two different size groups of *M. tade* (av. size : 145·76 mm/30·88 g @ 1,800/ha & 161·72 mm/50·68 g @ 300/ha) resulted in an average size of 211·91 mm/106·38 g in a period of five and half months.

In mixed culture, *M. parsia*, *M. tade*, and *Penaeus monodon* at the respective rate of stocking at 3,100, 1,200 and 1,900/ha with average size of 86·16 mm/ 7·86 g, 144·56 mm/30·98 g and 106·50 mm/8·90 g respectively, attained an average respective size of 115·76 mm/18·82 g and 196·27 mm/86·67 g for *M. parsia* and *M. tade* in a period of five and half months and 167·60 mm/40 g, for *P. monodon* in a period of three and half months.

At a very high stocking density of 60,000/ha the early fry of mullets could be successfully stunted with more than 90% survival rate in 70 days with an average size of 58·57 mm/2·78 g through proper fertilisation and artificial feeding programme. This experiment paved the way for provision of stocking material when natural seed is not avaiable and thus help in the year round farming of mullet.

Problem : 5·14 Culture of *Penaeus monodon*

Personnel : P. U. Verghese, Hardial Singh, A N. Ghosh, G. N. Chatterjee and H. C. Karmakar

Duration : Three years

Stocking experiments of *P. monodon* were conducted in small ponds of 0·02 ha employing different stocking rates 10,000 to 50,000 nos./ha for different duration that resulted in the productions of 78 75 kg/ha/yr and 331·0 kg/ha/6 months. By cultivating subsidiary crop of mullets and other prawns, additional productions of 690·5 kg/ha/yr and 23·0/kg/ha/6 months were obtained from the same ponds during the course of experiments.

The survival and growth were found better in short term culture especially during December to July. The highest survival observed under pond culture was 86·6% for 6 months with prawns growing to an average weight of 20·72 g

from initial stocking size of 0·5 g. Lower stocking rate of 10,000 to 20,000 nos./ha with40-50 mm sized seed gave better results than higher stocking with early juveniles of 20-30 mm.

Introduction of mullet mainly *M. parsia* has been observed to increaee the rate of production without causing considerable damage to the prawns. The abundance of the bottom fauna like, gammarid and tanaeid crustaceans and polychaetes was found to be correlated more to the salinity than to the organic carbon contents of pond soil. These forms dwindled and became negligible during monsoon and post-monsoon period inspite of manuring when the salinity registered a sharp fall from 28 to 4‰.

Studies on food requirement were undertaken for adult prawns in cages and it was found that pelleted feed containing 40-75% fish meal @ 10% body weight of prawn/day can bring about 4-5 g increase in weight/prawn/ month with 80-90% survival over a period of 2 months. Supplementary feed prepared without animal protein or with fish meal at the rate of less than 40% was found inadequate for normal growth. Postlarvae and early juveniles ingested 20 to 50% body weight of dry feed/day with the highest growth of 27 mm /0·8 g/month. High conversion rate (2 : 1) was obtained with a feed mixture containing 50% goat intestine powder. Experiments have further shown that *P. monodon* can be raised for over a period of 6 months completely on artificial feed under controlled conditions.

Problem : 5·15 Culture of *Penaeus indicus*
Personnel : A. N. Ghosh, P. C. Mohanta, H. C. Karmakar, N. K. Das and G. N. Chatterjee
Duration : Three years

Stock manipulation experiments carried out with early fry (approximate average length : 16·0 mm) at two stocking densities (200 and 133 prawns/m^3 of water), indicated that it is possible to maintain the growth at higher stocking densities by periodic thinning. The average length and weight attained in 160 days was 108 mm/9·6 g. Without manipulation of stock in ower stocking the average growth attained after 167 days of rearing was only 88 mm/5·9 g.

The optimal stocking density of juveniles of *P. indicus* (av. size : 73 mm) under monoculture was established to be arround 4 nos./m^3 of water. The higher stocking density resulted in heavy mortality. At this stocking density, the monthly pattern of growth under pond condition was found to be 4·9 mm/ 0·684 g during a culture period of 100 days.

Feeding experiment with pelleted food made of tapioca, maize powder, cocklemeat (dry) and shell powder in the proportion of 4 : 4 : 1·5 : 0·5 had given 60% survival of the postlarvae (av. size : 31 mm) alongwith natural planktonic food.

Problem : 5·16 Culture of *Lates calcarifer*
Personnel : A. N. Ghosh, P. K. Pandit and H. C. Karmakar
Duration : Three years

Collection techniques for procurement of Bhetki (*Lates calcarifer*) fry in large quantity have been standardised. It is now possible to collect early fry as small as 8 mm in length.

L. calcarifer and *M. tade* were found to be compatible in mixed culture in the ratio of 1 : 4. *Lates calcarifer* (35·85 mm/59 g) and *M. tade* (129·20 mm /21·75 g) grew to 256·42 mm/231·78 g and 196·50 mm/71·24 g respectively in a period of 360 days with the provision of trash fishes and prawn along with tidal ingress and supplementary feeding for mullets. Such a process also enables a subsidiary production of penaeid prawns raising thereby the total production of the pond.

Experiment on inducing gonadial maturity in *L. calcarifer* in captivity indicated that females of even 4 years age group did not show any sign of maturity. Hormone injection could induce maturity in the male but not so far in female.

Problem : 5·17 Brackishwater prawn culture in Madras region
Personnel : K. Raman, K. Gopinathan and S. K. Chowdhury
Duration : Five years

Penaeus monodon fry (53·0 mm/0·63 g) were stocked in plastic pools and fed on four artificial feed mixtures separately for a period of 45 days. Of these, two feeds : (1) rice bran + prawn powder + tapioca and (2) rice bran + gram + tapioca, gave percentage increments in weight by 330·7 aud 274·1 with 100% and 87·5% survival respectively. Though the increase in weight was encouraging, a stunted growth in length was noticed.

Postlarvae of prawns collected from Adyar and reared in plastic pools for a period of two months by giving artificial feed (rice bran + prawn powder + tapioca) had grown from an initial size of 10·0-20·0 mm to 30·0-45·0 mm. At this stage they were indentified and the species composition was : *P. indicus*, 25·0% ; *P. monodon*, 3·0% ; *Metapenaeus dobsoni*, 20·0% and *M. monoceros*, 30·0%. The remaining 22·0% were palaemonids. Due to closure of bar-mouths at Pulicat & Adyar and severe drought conditions during summer, prawn

fry were not available during summer months.

At Pulicat near the proposed farm site, juveniles of *P. indicus* were available in moderate number throughout the year but the postlarvae were negligible probably due to the prolonged closure of the lake-mouth. During the period when the lake-mouth was closed, there was some evidence of meagre recruitment of prawn and fish into the lake through Buckingham canal connecting many of the lagoons in the area.

Problem : 5·18 Culture of edible oysters in lake Pulicat
Personnel : K. V. Ramakrishna and R. Ganapathy
Duration : Five years

The oysters kept in trays, on strings and on asbestos sheets have grown to a size range of 64-121 mm, 48·78 mm and 53·78 mm in shell-heights respectively at the end of March, 1975. The fouling organisms and the settled silt were periodically removed. During April, all these oysters were found dead due to severe drought conditions. Oysters ranging from 18-85 mm in shell-heights were transplanted from Ennore to Pulicat during September and are under observation. Fresh cultch material (asbestos sheets and .dead oyster shells) has been set up for spat collection. No spat fall was noticed so far.

The ranges and average of various hydrological parameters of the lake area were as follows :-

	Minimum	*Maximum*	*Average*
Water temp (°C)	25·5 (Nov.)	32·0 (Apr.)	30·11
Depth (cm)	5·0 (Aug.)	190·0 (Nov.)	58·70
Transparency (cm)	5·0 (Aug.)	18·0 (Apr.)	13·50
Salinity (pp.)	22·0 (Nov.)	46·0 (Sept.)	36·80
D. O. (ppm)	4·6 (Jul.)	12·4 (Aug.)	8·94

Yard experiments in earthenware tubs and with oysters were initiated for studying the suitability of feed suspensions, but they were vitiated due to servere drought. However, fresh experiments were set up during September. The ranges of the shell-height, length and weight were 18-140 mm, 15-78 mm and 1·6-280·0 g respectively with averages of 45·55 mm ; 31·35 mm and 34·21 g. No oyster samples (for biological studies) and the associated fauna could be collected from the natural oyster beds near Pampupadu as all oysters were observed in dead condition probably due to drought.

Problem : 5·19 Work transferred to Project 5·26

Problem : 5·20 Use of compost as fertilizer in coastal fish ponds
Personnel : R. K. Banerjee, B. B. Pakrasi, S. C. Banerjee and N. C. Basu
Duration : Three years

Compost was charged @ 5,000 kg/ha. 1% inorganic N and P were added to the compost during the observational period. The hydrological features of the treated ponds were : pH, 7·3-8·4 ; salinity, 0·54-0·72‰ ; PO_4, 0·06-0·12 mg/l and NO_3, 2·0-28·0 mg/l. The phytoplankton production was as high as 58,300 u/l and zooplankton 2,600 u/l. The bottom biota was dominated by chironomid larvae and tubifex worms. Within 90 days of rearing, *C. catla*, *C. mrigala*, *C. carpio* and *M. parsia* attained a net increase by 111 mm/175 g ; 110 mm/147 g ; 156 mm/295 g and 90 mm/15 g respectively.

Observations have been made on six nursery ponds with compost as manure in different doses in order to determine a near optimal dose with and without artificial feeding.

Release of nutrients from different organic wastes by addition of little external agents has been tried and it has been found that though the available nitrogen is almost the same in sewage sludge and compost, the release of ammonical nitrogen and nitrate nitrogen is more in the case of sewage sludge than in the compost. As regards the poultry manure, it appears that the available nutrients are quite high. The addition of external agents does not help in the release of nutrients and the maximum nutrients are released only in the beginning when the poultry manure is put in the ponds.

Problem : 5·21 Fish and prawn seed resources of Pulicat lake
Personnel : K. Raman, K. V. Ramkrishna, R. D. Prasadam, G. R. M. Rao, S. Radhakrishnan, M. Kaliyamurthy, C. P. Rangaswamy, K. Gopinathan, R. Ganapathy, K. O. Joseph and Pranesh Kumar
Duration ; Five years

Due to prolonged closure of lake-mouth, observations on seasonal abundance and ingress of fish and prawn larvae into the lake could be carried out only during February, November and December. During February, among fish, post-larvae of *Sillago sihama* (175·6/net/hr) and *Elops saurus* (108·0/net/hr) were available in good numbers while *Gerres* spp. , *Megalops cyprinoides* and *Mugil* spp.

were available in small numbers only. Among prawns, *Penaeus indicus* (418·0 /net/hr) was the most abundant as usually being followed by *P. semisulcatus* (41·3/net/hr), *P. monodon* (21·3/net/hr), *Metapenaous monoceros* (13·7/net/hr) and *M. dobsonii* (9·0/net/hr. From March to the end of October, the lake-mouth remained closed and on reopening, the collections were rather poor in November.

Distribution and abundance of fish fry within the lake were studied from a few selected centres. Excepting the availability of *Hemiramphus* sp. among the weedy areas, collections from the other centres were very poor during dry period. Prior to the opening of the lake-mouth with the monsoon showers, a number of fresh-water fish species and prawns were encountered in the collections from most of the centres. With the opening of the lake-mouth, the entry and dispersion of marine species were also evident from the collections.

During the period when the lake-mouth was closed, it was found that fishes and prawns were getting into the lake through the Buckingham canal.

Problem	: 5·22	Rearing of fry of brackishwater fishes
Personnel	:	R. D. Prasadam, G. R. M. Rao, C. P. Rangaswamy, M. Kaliyamurthy, K. Gopinathan and R. Ganapathy
Duration	:	Five years

An increase in weight of mullet fry by 268% with yeast, 228% with iron sulphate, 195% with Vitamin B complex, 191% with Terramycin and 128% with cobalt chloride was obtained. Mullet fingerlings of 56-144 mm in length were fed in plastic pools with a mixture of tapioca + fish meal + weeds. Compost and lablab was provided in control. Fish actively fed upon the artificial feed and lablab. Due to *Caligus* infection all the fish became emaciated and subsequently died. Another lot of 80 fingerlings (40-57 mm in length) stocked in a pond and a third lot of 30 fingerlings in a plastic pool, are being fed with artificial feed. Fingerlings of *Chanos chanos* were fed for 160 days in 4 experiments with 3 artificial feed mixtures. Of these mixtures, the commercial feed + lablab gave better results. Fry of *Sillago sihama* (20-40 mm), *Gerres* spp, (11-23 mm) and *Scatophagus argus* (10-17 mm) were acclimatised to low saline and freshwaters without any mortality and were fed with a mixture of fish meal + wheat flour + yeast. The growth rates ot 3·5 mm/month in *S. sihama* and 2 mm/15 days in *Gerres* sp. were obtained. Fry of *Scatophaqus argus* were fed with a mixture of wheat flour + algal powder + yeast and a length increment of 2·61 mm/month with 47% survival was obtained. The same feed gave a growth of 3·33 mm/

month in case of *Etroplus suratensis* whereas fry of *S. sihama* and *Gerres* spp. did not survive for longer periods. *Therapon jarbua* gave higher growth rate in fresh-water than in sea water. Three feed mixtures were fed to *T. jarbua*. Of which, fish meal + wheat flour + yeast gave the best result regarding gain in weight and survival (*i. e.*, 16·7 mg/month and 60%).

Samples of *Hemirhamphus gaimardii* were collected and analysed for biological studies. The food of the species consisted of fish remains (15 to 45%), crustaceans (5 to 15%) and plant matter (25 to 30%). Morphometric measurements of fish of 101-138 mm length range were taken. *Nematalosa nasus* of 59-75 mm length range were fed in plastic troughs with a mixture of wheat flour + prawn powder + yeast + Streptomycin. Monthly growth rate of 6.2 mm and a survival of 40% were obtained, With another feed mixture (commercial feed + wheat flour) growth rate was 3·2 mm/month with a survival of 60% in case of *N. nasus* fingerlings of 35-42 mm length range.

Problem : 5·23 Experimental culture of brackishwater fish food organism in the laboratory and field

Personnel : A. C. Nandy, A. N. Ghosh, P. K. Mukherjee, Smt. K. K. Bhanot, H, Singh, G. P. Bhattacharjee and N. N. Sarkar

Duration : Three years

Isolation of a blue-green alga, *Oscillatoria limosa* could be achieved and the species could be grown in the laboratory in Bristol's solution and in brackishwater fertilised with N-P-K in the ratio of 15 : 5 ; 3. The pure culture is being maintained on agar plates in the isolation chamber.

Problem : 5·24 Effect of hormones on the growth and photosynthetic behaviour of plankton

Personnel : A. C. Nandy, Smt. K. K. Bhanot, and N. N. Sarkar

Duration : Three years

The effect of different concentrations of indol acetic acid and Gibberellic acid on the growth and photosynthetic behaviour of *Chlorella vulgaris*, *Nitzschia closterium* and *Scenedesmus obliquus*, was observed. A moderate increase of 5% after 15 days of treatment with indol acetic acid 15 ppm concentration was observed in *Chlorella* sp. and *Scenedesmus* sp. Gibberellic acid at 20 ppm concentration promoted growth of *Nitzschia closterium* in 20 days.

Problem : 5·25 Nutritional requirements of cultivable brackishwater fish and prawns

Personnel : A. N. Ghosh, P. K. Mukhopadhyay and A. K. Roy
Duration : Three years

(Studies could not be initiated due to limited staff and field facilities)

Problem : 5·26 Transformation of nitrogen and phosphorus in water logged saline soils relative to different grades of water salinity
Personnel : G. N. Chattopadhyay, A. N. Ghosh and P. C. Mohanta
Duration : Three years

Studies on transformations of both native and applied phosphorus under different water salinities in laboratory condition showed that the availability of phosphorus depends largely on salinity levels of water, thus suggesting that the water salinity level must be taken into account before application of phosphatic fertiliser in brackishwater fish ponds. Application of urea, superphosphate and cow dung in a single dose was found to increase the productivity of the brackishwater pond to a great extent as compared to that in the control pond. The plankton and soil flora concentration in the treated pond ranged from 40 to 1,268 nos./l and 21 to 980 nos./cm^2 respectively. For the control pond, those were 26 to 424 nos./l and nil to 109 nos./cm^2 only.

Problem : 5·27 Detailed contour survey of the Kakdwip Island for designing the Brackishwater Fish Farm
Personnel : P. N. Bhattacharya, A. N. Ghosh, A. Sengupta, G. N. Chatterjee and A. B. Mukherjee
Duration : One year

The tidal readings of the river Murigana were taken from the Kakdwip side regularly to correlate the same with possible amount of flooding of Kakdwip sand Island when the contour survey would be over. The work could not be started due to limited funds.

Problem : 5·28 Behaviour of lake-mouth bar and its bearing on the fishery of lake Pulicat
Personnel : K. Raman, K. V, Ramakrishna, S. Radhakarishnan, K. Gopinathan, R. Ganapathy, K. O. Joseph, Pranesh Kumar, S. Srinivasagam and P. M. Abdul Kadir
Duration : Four years

Hydrobiological observations have been made from the lake-mouth area and three other centres nearby. The lake-mouth remained closed from March to October. The total catch from the lake was estimated at 759·626 t showing a fall of about 22·65% from that of the previous year. With the closure of lake-mouth, a phenomenon which is reguarly observed is the shifting of abundance of fish from the southern to the northern sector. There is reduced fishing activity in the lake-mouth area consequent to the prolonged closure of the mouth and less concentration of fish in the southern sector. The closure of lake-mouth has become a regular feature since 1972. The period of closure has been increasing from year to year, resulting in steady fall in the total catch. During the months of severe drought all fishes congregate in the deep basins near Pulicat and are completely fished out by repeated shore seining. This has resulted in unduly high catches during certain months. The effect of the closure of the lake-mouth on the species composition, size composition of individual species and their appearence in the fishery are to be studied by comparison of these factors during the open condition of the lake-mouth.

The lake-mouth which has shifted to the northern most point (Sambassipalli) got closed in March this year. After the heavy rains during the monsoon when sufficient water accumulated in the lake, the mouth has been cut open by dredging and manual labour at a point about 1·5 km to the south of Sambassipalli. Now with the force of current, the mouth has widened to about 500 metres. The approximate width, depth and current speed are being obserserved regularly. During earlier years it was observed that the lake-mouth gets slowly shifted northwards during the course of the year by erosion of the northern edge and accretion at the southern edge.

During months of severe drought (May-July), cases of mortality of fish were also observed. These were probably due to high salinity and temperature. Fishes found dead were : *Triacanthus* sp. , *Gerres* sp. , *Tachysurus* sp. , *Brachirus* sp. , *Therapon* sp. , *Mugil* sp. and eels.

Problem	: 5·29	Role of silt load in the Hooghly estuary on nutrient balance of the environment and its effect on primary productivity
Personnel	:	P. Ray, B. B. Pakrasi and N. C. Basu
Duration	;	Two years

The important points noticed are that nutrient status in silt was low (av. nitrogen : 18·6 & 19 6 ; 17·0 & 19·6 ; 14·7 & 11·2 and av. P_2O_5. 2·98 & 1·88 ; 7·37 & 2·64 ; 45 & 9·99 mg/100 g) at Barrackpore, Kakdwip and Taldi

during summer and rains respectively where as the concentration of nitrogen and phosphorus in the water was moderately high. Nitrogen values were 1·08 & 0·32 ; 0·32 & 0·16 ; 0·11 & 0·24 ppm and phosphorus, 0·186 & 0·15 ; 0·135 & 0·229 ; 0·129 & 0·072 ppm at Barrackpore, Kakdwip and Taldi respectively during the two seasons.

Problem : 5·30 Shapes and structure of ponds, feeder canal and dykes relative to stability, water management and fish culture under brackishwater environment
Personnel : A. Sengupta, A. N. Ghosh, A. B. Mukherjee and P. N. Bhattacharji
Duration : Two years

Detailed design, drawing and estimate of earthern embankments having different cross section, feeder canal of different discharging capacity and different types of ponds have been prepared.

Problem : 5·31 Studies on the macrophytic flora in lake Pulicat with special reference to their utilisation as organic manure and artificial feed for fish
Personnel : S. Radhakrishnan
Duration : Three years

The growth of macrophytes in the lake was affected adversely by the severe drought condition prevailing during the major part of the year. However, filamentous algae were observed in large quantities after the premonsoon showers. The total biomass of filamentous algae (*Ulva* sp., *Enteromorpha* sp. and *Chaetomorpha* sp.) during the period ranged between 0·63 (November) and 15·63 kg (September).

Studies on the periphytic communities on different substrata, kept suspended at different levels in the lake water, were made. The forms commonly encountered on the glass slides were, *Pleurosigma* sp., *Nitzschia* sp., *Diploneis* sp., *Enteromorpha* sp., *Ulva* sp., *Lyngbya* sp., *Oscillatoria* sp., and tintinids. The density of periphytic organisms on glass slides ranged from 121 u/cm^2 (November) to 1,955 u/cm^2 (May).

An artificial feed was prepared using the brackishwater plants + filamentous algae + slaughter house waste + ground-nut oilcake in the ratio, 2 : 2 : 1 : 1. Fry of mullet fed on such feed mixture grew better than those fed with ground-nut oilcake and a commercial feed separately. Various feeds are being prepared using different algal species for testing their efficacy as fish feed.

Problem : 6·1 Freshwater prawn culture techniques
Personnel : H. Chaudhuri, K. Janaki Ram and S. R. Ghosh
Duration : Nine years

Juveniles of *Macrobrachium malcolmsonii* with an average weight of 3 g were collected from the river Mahanadi and stocked in two ponds of 0·04 ha area @ 20,000 and 5,300/ha respectively besides stocking in a fish pond of (0·4 ha) @ 4,750/ha. The prawns are being fed with a mixture of rice bran and groundnut oilcake (1 : 1). The prawns have grown to more than 20 g (average weight) within 3 months after stocking.

Berried prawns (from the Mahanadi river) were maintained in brackishwater (17 ± 2‰ salinity) in laboratory aquaria on a diet comprising minced fish and prawn meat. After hatching, the larvae were transferred to glass jars or wide mouthed earthern pots with brackishwater (salinity 17‰) having the provision of continuous aeration. The larvae were fed with egg-custurd and crushed cladoceran as diets. They could be reared up to the 20th day after hatching. It was observed that majority of larvae started dying after the 8th day of hatching. The larvae reared in earthern pots, however, showed better survival till the 20th day of hatching.

Young prawns *Macrobrachium rosenbergii* with an average size of 43·5 g were stocked in two ponds with an area of 0·5 and 0·4 ha @ 35 nos./pond along with Indian major carps and exotic carps (stocking density : 10,000 nos./ha). 31 prawns with an average size of 295·15 g from the first pond and 35 with an average size of 230·09 g from the second pond were harvested after one year.

Problem : 6·2 Propagation and culture of *M. malcolmsonii*
Personnel : K. V. Rao, T. S. Ramaraju and P. S. C. Bose
Duration : Five years

Experiments on the culture of *Macrobrachium malcolmsonii* were conducted for the first season in the four ponds at Badampudi fish farm in West Godavari district of Andhra Pradesh.

Stocking of juvenile prawns (size range : 16·0-37·0 mm), obtained from the riverine source at Godavari anicuts was done in four ponds during the last week of November, 1974. The average size at stocking was 22·2 mm/ 0·12 g and the stocking rate was 75,000/ha. Only monoculture experiments

were attempted. Thrice during the season, the ponds were fed with fresh water from the adjacent irrigation canal. Fertilization with cattle dung @ 10,000 kg/ha in equal doses at fortnightly intervals was carried out in all the ponds. Supplementary feeding with rice bran, broken rice, ground-nut oilcake and fish meal in 8 : 8 : 8 : 1 ratio and at a rate involving progressive increase of 5 to 25% of the anticipated body weight was resorted to on alternate days. Regular observations on plankton, dissolved oxygen and primary productivity were made.

Plankton, dissolved oxygen and primary productivity :

The plankton production in all the four ponds was very poor (less than 0·5 ml/50 l of water throughout the season). The number of plankters per litre varied from 10 in November to 79 in March in pond I, 3 in December to 70 in June in pond II, 6 in November to 40 in January in pond III and 4 in January to 228 in March in pond IV. Zooplankton dominated over phytoplankton and were represented mostly by crustacean larvae and ocassionally rotifers like, *Keratella* sp. and *Brachionus* sp. Copepods and daphnids were also observed. *Spirogyra* sp., *Microcystis* sp., *Oscillatoria* sp., *Cosmarium* sp., *Pediastrum* sp., *Closterium* sp., and *Euastrum* sp. were the chief phytoplankters encountered.

Dissolved oxygen varied between 5·0 and 13·1 ppm in all the ponds. The lowest primary production ranging between 125 and 250 mg $C/m^3/6$ hr was recorded in all the ponds during the month of July. The primary production in December, was high like, 938 mg $/C/m^3/6$ hr in pond I, 1,064 mg $/C/m^3/6$ hr in pond III and 1,563 mg $C/m^3/6$ ha in pond IV, excepting in pond II (188 mg $C/m^3/6$ hr).

Prawn production :

Harvesting of prawns was done during the third week of July after a growth period of $7\frac{1}{2}$ months by completely dewatering the ponds and hand picking of the prawns. Per hectare prawn production in the four ponds was of the order of 75·4 kg (pond I), 209·4 kg (pond II), 83·3 kg (pond III) and 96·8 kg (pond IV). The survival rate of prawns was observed to be 4·5% in pond I, 10.9% in pond II, 8·2% in pond III and 4·7% in pond IV. The size of harvested prawns ranged as 49-145 mm in pond I ; 45-157 mm in pond II ; 45-151 mm in pond III and 48-166 mm in pond IV. The average growth attained during the period was 99·9 mm/15·3 g (pond I), 112 2 mm/25·5 g (pond II), 83·3 mm/9·1 g (pond III) and 87·1 mm/11·9 g (pond IV). The maximum size of 166 mm/95 g was recorded from pond IV, though the highest average growth of 112·2 mm/25·5 g was obtained in pond II.

Problem : 6·3 Freshwater prawn fishery of the middle stretch of the Ganga

Personnel : J. C. Malhotra, R. N. Seth, Shree Prakash, R. K. Tyagi, Krishna Chandra and N. K. Srivastava

Duration : Five years

Berried specimens of *Macrobrachium birmanicum choprai* procured from commercial catches at Buxar were transported to Allahabad for rearing experiments. The larvae could be reared for 11 days in 10 l glass jars which were provided with 25 mm thick sterilised sand at the bottom and inoculated with traces of calcium, ascorbic acid, sodium chloride and soil extract.

Project 7 : Murrel and live fish culture :

(Work being conducted under a coordinated project)

Project 8 : Estuarine and brackishwater lake fisheries

Problem : 8·1 Brackishwater fish seed prospecting of the Hooghly-Matlah estuarine system

Personnel : K. K. Bhanot, D. D. Halder, A. Chowdhury. H. Singh, S. K. Mazumder, P. B. Das, P. K. Pandit, R. N. Dey, A. R. Choudhuri, H. S. Mazumder, N. D. Sarkar and A. R. Paul

Duration : Ten years

Brackishwater fish seed prospecting was conducted on the following estuarine centres :

1. Kakdwip, Uluberia, Monirampore and Kalna on the Hooghly estuary
2. Port Canning on the Matlah estuary
3. Geokhali and Kolaghat on the Roopnarayan estuary
4. Raidighi on the Thakuran estuary
5. Gosaba on the Bidya estuary

Three-day sampling, during each fortnight, was done with the help of standard spawn collection nets up to June. Later the frequency of observational days was reduced to one-day every fortnight due to the shortage of funds. This one-day observation was made during full-moon and new moon days. The major period of abundance of the commercially important species of fish seed at different centres is presented in table 4.

Table 4. The major period of abundance as per net per hour of fish seed of the commercially important species at different centres

Species	Kakdwip	Uluberia	Moniram-pore	Kalna	Port can-ing	Geokhali	Kola-ghat	Raidighi	Gosaba
E. tetradactylum	Aug (1,602) May (1,550) & Jul (2,072)	-	-	-	Jun (555) Sep (403)	-	Jun (320)	Jun (516)	-
I. elongata	Aug (240) Nov (295)	-	-	-	Aug (17) Sep (403)	-	-	Jun (145)	-
C. reynaldi	-	-	-	-	Aug (209) Sep (155)	-	-	Jun (1,883) Dec (1,092)	Nov (149)
S. argus	May (34)	-	-	-	Jun (24)	-	-	-	-
Sciaenids	Jun (14) Nov (16)	Aug (35)	-	-	-	-	May (39)	Dec (392)	Aug (18) Nov (32)
M, parsia	Jun (72)	-	-	-	-	July (12)	-	-	Oct (31)
M. tade	Aug (205)	-	-	-	-	-	-	-	-
E. saurus	Sep (40)	-	-	-	-	-	-	-	-
E. kammalensis	Oct (75)	-	-	-	-	-	-	-	-
S. taty	-	-	-	-	-	-	-	-	-
H. nehereus	-	-	-	-	-	-	-	-	Jul (27) Aug (25) Oct (21)
M. gulio	-	-	-	-	-	-	-	-	-
H, ilisha	-	Dec (19)	Dec (21)	May (551)	Sep (24)	-	Dec (14)	Oct (75)	Aug (93)
M. cephalus	-	-	-	-	-	-	-	-	-
S. phasa	-	-	-	-	Aug (35)	-	-	-	-
S. *panijus*	-	-	-	-	-	-	Jun (13)	-	-
C. lile	-	-	-	-	-	-	-	-	Sept (16)
C. fimbriatus	-	-	-	-	-	-	-	-	Sept (15)
H. toli	-	-	-	-	-	-	-	Sep (64)	-
P. paradiseus	-	-	-	-	-	-	-	-	-
M. corsula	-	-	-	Oct (432)	-	Aug (17)	Jun (12)	-	-
M. seenghala	-	-	-	-	-	-	-	-	-
G chapra	-	-	-	-	-	-	-	-	-

Problem : 8·2 and 8·3 (Research work completed in 1973).

Problem : 8·4 Brackishwater prawn seed prospecting of the Hooghly-Matlah and Rupnarayan estuarine system

Personnel : D. D. Halder, K. K. Bhanot, A. Chowdhury, S. K. Mazumder. P. B. Das, B. K. Saha. P. K. Pandit, R. N. Dey, A. R. Chowdhury, H. S. Mazumder, N. D. Sarkar, S. P. Ghosh, A. R. Paul and N. C. Mondal

Duration : Four years

Brackishwater prawn seed was collected around 10 centres of the Hooghly-Matlah and Rupnarayan estuarine system during the period May to December, 1975. The species recorded were : *P. monoaon, P. indicus M. brevicornis, M. monoceros, P. styliferus, P. tenuipes, Macrobrachium rude, M. mirabile, M. villosimanum, M. scabriculum, M. affinis, Caridina* sp. and *Acetes* sp.

The maximum abundance of *P. monodon* seed was observed at Geokhali (May, 304 and 514/net/hr in low and high tides respectively), followed by the abundances at Gossaba, Canning, Kakdwip, Tamluk, Raidhighi and Kolaghat. It has been observed that by the 2nd fortnight of June, the availability of *P. monodon* seed declined to nil except at Kakdwip (June, 9 and 48/net/hr in high and low tides respectively, September 27/net/hr in high tide, October 13/net/hr in low tide and December 2/net/hr in low tide only) and Gosaba (July, 12 and 10/net/hr in low and high tide, August 6/net/hr in low tide condition). It has been observed that abundance of *P. monodon* seed is more during high tides during full-moon period.

The highest abundance of *P. indicus* seed was recorded at Kakdwip (June, 10,360 and August, 13,904/net/hr), followed by the abundances at Gosaba, Raidighi, Geokhali and Tamluk. The seed was available throughout the collection period at Kakdwip and Gosaba. The abundance of the seed is more in low tide condition during new moon.

The maximum seed of *M. brevicornis* was available at Kakdwip (August, 504/net/hr), followed by Canning (August, 440/net/hr) and Gosaba (June, 204/net/hr). The seed was almost nil at other centres. The abundance of seed was related to new moon during hlgh tide condition.

M. monocerus seed was in abundance at Tamluk (May, 2,592/net/hr), Raidighi (May, 450/net/hr), Canning (July, 460/net/hr), Gosaba (May, 160/net/hr) and Geokhali (May, 554/net/hr). It was almost nil in other centres. The abundance was related to full-moon during low tide conditions.

Among palaemonid prawns, *P. styliferus* was recorded to be the highest in abundance at Kakdwip (August, 66,072/net/hr). The prawn was available at all the centres throughout the year. The abundance of *P. styliferus* seed was more during low tide conditions of new moon period.

Problem : 8·5 Rearing of the palaemonid prawn, *Macrobrachium rosenbergii*

Personnel : M. Subrahmanyam, K. Janardhan Rao, K. Subba Rao and D. Ramakrishna Rao

Duration : Three years

Altogether seventeen experiments were conducted. Seven experiments were conducted with aged sea water. In all the experiments, the zoea survived well and all the larval stages could be obtained within a period of 38-42 days. One postlarva, obtained in one of the experiments, is being grown in freshwater to the young stage.

The larval stages were fed upon *Artemia* nauplii. *Tubifex* worms, fish meal and a number of compounded diets of which *Artemia* nauplii and worms gave best results.

The larvae could be grown successfully in green water developed with organic materials without any supplementary diet. The maximum zoeal survival was found in salinities ranging from 15 to 25‰.

The protozoan infection was checked with copper sulphate, potassium permanganate or Acriflavin application.

Thirty-two adult prawns were kept in a plastic pool, exposed to artificial light and fed with feeds of both vegetable and animal origin. Among the feeds tapioca was found to be the best due to its low cost and preference by prawns. The water temperature ranged from 28·8° to 31·0°C and dissolved oxygen from 1·12 to 6·86 ml/l.

Problem : 8·6 Standardisation of Brackishwater seed prospecting collection and transporting techniques

Personnel : K. K. Ghosh, A. N. Ghosh, A. C. Nandy, K. K. Bhanot, D. D. Halder, A. R. Chowdhury, P. K. Pandit and G. P. Bhattacharjee

Duration : Two years

Experiments in glass jars were conducted to know the exact dose of Lignocaine and Xytotox (Chemical anaesthatics) required to be put in the water so as to anaesthetise commercial brackishwater fish species for transportation. Mullet or any other brackishwater species could not be procured at the time of starting the experiment. So, spawn of *Cyprinus carpio* was selected as test fish. It was found that 0·5% Lignocaine was sufficient to sedate hatchlings of *C. carpio* (8-10 mm) within ten minutes of their libration in jar. The fish were observed to be motionless. The fish again became active and swam freely after their transfer to freshwater within 20 minutes.

Problem : 8·7 Reproductive biology of cultivable brackishwater fishes

Personnel : K. K. Bhanot

Duration : Three yeare

Fortnightly, samples of *Sillago panijus* and *Polynemus indicus* were collected from the bag-net catches obtained at Raidhighi. The analyses of the samples are being done to study the fecundity and sex ratio of the species.

Project 9 : Selective breeding and hybridization

Problem : 9·1 (Research completed in 1973)

Problem : 9·2 (Research completed in 1972)

Problem : 9·3 (Research suspended)

Problem : 9·4 Selective breeding and hybridisation of carps and other cultivated fishes with special reference to cytogenetical features of the hybrids

Personnel : H. Chaudhuri, R. M. Bhowmick, R. K. Jana and S. D. Gupta

Duration : Five years

Selective breeding of *L. rohita* has been initiated.

A number of slides have been prepared for the study of chromosome numbers of catla x rohu hybrid with colchicine sodium citrate air drying method. The somatic chromosome number of this particular hybird has been found to be 50.

Biometrical studies revealed that the head length of catla-rohu hybrid is shorter than that of catla and body girth near the 1st dorsal fin is more than that of rohu. The gut content analysis revealed that the species mainly subsisted on copepods, rotifers and diatoms.

The maturation studies of F_1 hybrids have been initiated which are aimed at producing F_2 generation and conduct back cross tests.

Project 10 : Fish farm designing

Problem : 10.1 Designing fish farm under the soil conditions of Orissa.
Personnel : C. Saha, N. K. Tripathy, D. K. Chatterjee, M. D. Mantri and C. D. Sahoo
Duration : Four years

Survey and investigations with reference to soil type, water supply, topography, size, shape, water depth, dyke slopes, inlet and outlet facilities etc. have been conducted in fish farms at Badjor, Kathpal and Bethnoti of Mayurbhanj district in Orissa.

Badjor and Kathpal Fish Farms are having slopped topography whereas the Bethnoti Fish Farm is having a flat topography. The water retentivity of the soil of Badjor fish farm is poor and the nursery ponds dry up during summer. The retention of water in Bethnoti and Kathpal fish farm soil is better.

The sources of water supply to these ponds are rainfall and its run-off. Ponds of these three farms do not have any water inlet and outlet facilities. Almost all the ponds are rectangular in shape. The slopes of dykes vary from 1 : 1 to 3 : 1. In Badjor Fish Farm, the nursery ponds are about 0·18 ha in size while stocking ponds are 0·4 ha in size. Bethnoti Fish Farm comprises 10 nursery ponds of 0·04 to 0·16 ha in size.

Problem : 10·2 Studying seepage losses in ponds
Personnel : C. Saha, G. N. Saha, K. L. Srivastava, (Agri. Engr., Dry Land Agriculture Research Project, OUAT., Bhubaneswar), C. D. Sahoo and M. D. Mantri
Duration : Five years

A set of experients was conducted at Killa Fish Farm, Cuttack after excavating eight mini ponds of 2 m X 2 m size and 45 cm depth having side slopes

of $1\frac{1}{2}$: 1 ($1\frac{1}{2}$ horizontal : 1 vertical). Out of eight mini-ponds, two were kept as control, two ponds were treated with soil and cow dung mixture, two with soil and cement mixture, one with sodium carbonate and the remaining one with sodium chloride.

During observations, all the treated ponds showed improved water retention capacity than the control ponds, excepting one which was treated with sodium chloride.

Project 11 : Economics in fishery investigations

Problem	: 11·1 & 11·2	(Research work completed in 1974)
Problem	: 11·3	(Research work completad in 1973)
Problem	: 11·4	Assessment of marketable size for fish culture enterprises in West Bengal
Personnel	:	M. Ranadhir and H. K. Sen
Duration	:	Three years

Two fish farms in private sector were covered to gather information on sizes of fish harvested. The fish-market data in regard to prices were analysed for all the months for each fish-market. Higher price levels were observed during August to November. Prices showed a declining trend during March to May, while it showed an increasing trend from June, reaching its peak in September/ October. The higher price level, during these months might be an inducing factor for fish farmers to harvest even the lower sizes (less than 600 g), the fish being hardly 3 to 4 months old. The prices of even such lower size groups varied from Rs. 5·00 to 9·75/kg. The prices of other size groups such as 500 to 750 g and 750 to 1,000 g varied from Rs. 6·40 to 11·60 and Rs. 8·00 to 12·50 respectively. Price level for fishes weighing more than 1.000 g varied from Rs. 8·50 to 14·00 per kg. Large sized fishes were generally sold as cut pieces, the price range of which was usually between Rs. 12·00 and 16·00/kg and these were generally routed through Howrah wholesale fish-market, the supply of which comes mainly from other States. Such large size groups might also belong to capture fisheries. Suburban fish-markets might reflect the true image of harvestable sizes of culture fishery enterprises of West Bengal. The average size in the bulk of fish catches marketed in the suburban fish-markets was in the range of 600 to 800 g, whereas it ranged in the vicinity of higher size groups in Calcutta fish-markets. Moreover, the fish sizes harvested from private fish ponds were observed to be around 600 g.

In addition to the six fish-markets selected, Howrah and Chagalhata wholesale fish-market were also surveyed to know the system of wholesale fish-mar-

keting in Calcutta. The bulk of fish catches were in fhe large size groups, the wholesale prices of which varied from Rs. 8 to 11/kg. The wholesale price of smaller sized fishes weighing 750 to 1,000 g ranged between Rs. 6 and 8/kg.

Project 12 : Exotic fish culture

Problem : 12·1 & 12·2 (Research works completed in 1973)
Problem : 12·3 (Research work completed in 1972)
Problem : 12·4 Suitable supplementary feeds for grass carp fry and fingerling
Personnel : D. S. Murty, R. K. Dey and P. V. G. K. Reddy
Duration : Three years

Two sets of laboratory experiments of 15 days duration in glass jars, were conducted with fingerlings of grass carp (*Ctenopharyngodon idella*) of average lengths 46·1 mm (in the 1st expt.) and 63·12 mm (in the 2nd expt.). The feeds given were ground-nut oilcake, rice bran, ground-nut oilcake + rice bran, Wolffia sp. and plankton in the first experiment and *Hydrilla* sp. *Spirodela* sp. *Lemna* sp. *Enhydra* sp. and plankton in the second experiment. In the first experiment, ground-nut oilcake + rice bran followed by rice bran alone registered better growth. In the second experiment, there was marked loss in weight in all the treatments which might have been due to the limited space available for the fingerlings. However, all the feeds tried were accepted by the fish. It is proposed to repeat the experiment to assess the relative efficiency of the feeds by providing different quantities of the feeds and more space to the fingerlings.

Problem : 12·5 Techniques for commercial production of grass carp and silver carp seed
Personnel : H. Chaudhuri D. S. Murty, R. K. Dey and P. V. G. K. Reddy
Duration : Four years

The breeders of silver carp (*Hypophthalmichthys moilitrix*) and grass carp (*Ctenopharyngodon idella*) were well maintained in rearing and stocking ponds at a stocking density of 1,500-2,000 kg/ha. Experiments were conducted during June-August, 1975. Due to lack of regular monsoon rains throughtout the month of July and also due to high water temperature, the response of both silver carp and grass carp breeders was poor. Most of the breeders especially grass carp females were found to have lost their condition by the time when there was improvement in the weather condition in August. During the second

week of August when weather was cloudy with occasional showers, the response of silver carp was quite encouraging, more so when the *hapas* were fixed in the river Mahanadi. Under the improved weather conditions, the percentage of fertilization as well as hatching were observed to be 80 and above.

The doses of pituitary hormone administered were 10-16 mg/kg body weight for female breeders and 2-4 mg/kg body weight for males.

A record production of 10·6 lakhs silver carp and 65,000 grass carp spawn was acheived. Out of 11·25 lakhs of spawn produced, about 4·8 lakhs were obtained from the eggs kept for hatching in the glass jar hatchery.

From the spawn produced and reared to fry and fingerling size, supply of the seed were made to State Departments, Rural aquaculture centres under I. D. R. C. (Canada) Project, private bodies and private fish culturists.

Problem : 12·6 Compatibility and competition between silver carp and Indian major carps
Personnel : D. S. Murty, R. K. Dey and P. V. G. K. Reddy
Duration : Five years

A field experiment of six months duration to study the compatibility and competition between silver carp *(H. molitrix)* and Indian major carps, initiated in February, 1975 in four 0·08 ha ponds at a stocking density of 3,000 fingerlings/ha with species ratio of silver carp 2 : rohu 3 in two ponds and catla 2 : rohu 3 in two other ponds, was concluded in August, 1975. As the water level in the ponds was high, complete harvesting could not be done. The data obtained indicated the experiment to be inconclusive because in one set growth of rohu was higher in combination with silver carp as compared to catla whereas it was reverse in the other set of the experiment.

Project 13 : Cold water fish culture

Problem : 13·1 (Research work completed in 1970)
Problem : 13·2 Artificial feeds and trout nutrition
Personnel : K. L. Sehgal, Kuldip Kumar and Ghulam Nabi (State Fisheries)
Duration : Three years eight months

The trials with compound, dry and pelleted and feeds prepared in the laboratory, were continued. Two new formula (Table 5) were compounded. As

evident from the table, the two formulae are very close to each other in respect of crude protein content and hence formula IV was abandoned in the middle of the year. The remaining three formulae are being continued for trials. In all 11 field trials were carried out during January-November. The results of these trials have been summarised in table 6.

Table 5. *Showing details of feed prepared for feeding trials of trout during 1975*

Ingredients	*Formula III*	*Formula IV*	*Vitamin mixture added for 1 kg*	
Brown fish meal	600 g	700 g	Thiamine chloride	- 0·200 g
Soyabean	100 ,,	100 ,,	Riboflavin	- 0·200 ,,
Brewer's yeast	100 ,,	100 ,,	Pyridoxine hydro-chloride	- 0·400 ,,
Wheat starch	150 ,,	50 ,,	Choline Chloride	- 5·000 ,.
Feeding oil	30 ,,	30 ,,	Calcium pantothenate	- 0·600 ,,
Vitamin mixture	20 ,,	20 ,,	Inositol	- 0·500 ,,
			Ascorbic Acid	- 0·500 ,,
			Folic Acid	- 0·010 ,,
				7·410 ,,
			Skimmed milk powder as carrier	- 12·590 ,,
Total	1,000 ,,	1,000 ,,		- 20·000 ,,

Chemical composition	*Formula III*	*Formula IV*
Crude protein	39·16%	37·63%
Crude fibre	2·15%	0·76%
Ether extract	5·34%	5·34%
Nitrogen free extract	13·33%	6·13%
Ash	37·20%	43·82%
Moisture	2·82%	4·40%

In 11 field trials, with brown trout (*Salmo trutta fario*) the average conversion ratios for pelleted feeds containing crude protein at 26·4, 28·0, 35·0 and 39·0% levels were 2·9, 1·9, 2·0 and 1.4 respectively as against 5·1 for conventional feeds of silkworm pupae and 2·2 for partially boiled carp as feed. In case of rainbow trout (*Salmo gairdneri*), the average conversion ratios at 26·4. 28·0 35·0, 37·6 and 39·0% crude protein levels were 3·1, 1·4, 1·5, 2·1 and 1·7 respectively.

Table 6. *Results of feeding trials at Laribal and Harwan farms during 1975*

Pond No.	Crude protein content of the pellet %	STOCKED			REMOVED			Gain in weight (g)	Food consumption per kg of growth		Species of trout
		Dt.	No /kg.	weight (g.)	Dt.	No/kg	weight (g)		(g)	Conversion	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
N3	26·4	8. 11. 74	36	3,000	8. 5. 75	14	5,940	2,940	7,925	2·6	Brown
N1	28·0	,,	31	2,574	,,	11	5,998	3,424	6,754	1·9	.,
N5	35·0	,,	26	1,500	,,	20	3,050	1,550	3,547	2·2	,,
N6	Silkworm pupae	,,	27	3,300	,,	25	5,051	1,651	7,299	4·4	,,
Y3	26·4	,,	625	700	,,	300	1,863	1,163	3,678	3·1	Rainbow
Y1	35·0	,,	625	760	,,	285	2,428	1,668	4,210	2·3	,,
Y2	35·0	,,	250	420	,,	100	1,050	630	1,530	2·2	,,
N1	23·8	9. 5. 75	14	7,000	11. 7. 75	10	9,830	2,830	5,985	2·1	Brown
N3	26·4	.,	28	6,500	,,	20	8,724	2,224	4,329	1·9	,,
H2	28·0	31. 5. 75	70	1,000	18. 7. 75	30	1,500	500	1,274	2·5	,,
H4	35·0	,,	245	400	,,	136	763	363	882	2·1	,,
1	28·0	23. 8. 75	40	2,320	20.11.75	20	7,250	4,930	7,417	1·5	,,
2	35·0	,,	35	1,500	,,	20	3,000	1,500	3,072	2·0	,,
7	28·0	15. 9. 75	10	4,500	21.11.75	6	6,300	1,800	3,300	1.8	,,
9	35·0	,,	27	3,750	,,	12	7,100	3,350	4,752	1·4	,,
11	39·0	,,	25	800	,,	20	1,600	800	1,188	1·4	,,
8	Silkworm pupae	,,	72	3,000	,,	50	4,000	1,000	6,939	6.9	,,

Table 6. *Results of feeding trials at Laribal and Harwan farms during 1975*

Pond No.	Crude protein content of the pellet %	STOCKED			REMOVED			Gain in weight (g)	Food consumption per kg of growth		Species of trout
		Dt.	No /kg.	weight (g.)	Dt.	No/kg	weight (g)		(g)	Conversion	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
N3	26·4	8. 11. 74	36	3,000	8. 5. 75	14	5,940	2,940	7,925	2·6	Brown
N1	28·0	,,	31	2,574	,,	11	5,998	3,424	6,754	1·9	,,
N5	35·0	,,	26	1,500	,,	20	3,050	1,550	3,547	2·2	,,
N6	Silkworm pupae	,,	27	3,300	,,	25	5,051	1,651	7,299	4·4	,,
Y3	26·4	,,	625	700	,,	300	1,863	1,163	3,678	3·1	Rainbow
Y1	35·0	,,	625	760	,,	285	2,428	1,668	4,210	2·3	,,
Y2	35·0	,,	250	420	,,	100	1,050	630	1,530	2·2	,,
N1	23·8	9. 5. 75	14	7,000	11. 7. 75	10	9,830	2,830	5,985	2·1	Brown
N3	26·4	,,	28	6,500	,,	20	8,724	2,224	4,329	1·9	,,
H2	28·0	31. 5. 75	70	1,000	18. 7. 75	30	1,500	500	1,274	2·5	,,
H4	35·0	,,	245	400	,,	136	763	363	882	2·1	,,
1	28·0	23. 8. 75	40	2,320	20.11.75	20	7,250	4,930	7,417	1·5	,,
2	35·0	,,	35	1,500	,,	20	3,000	1,500	3,072	2·0	,,
7	28·0	15. 9. 75	10	4,500	21.11.75	6	6,300	1,800	3,300	1.8	,,
9	35·0	,,	27	3,750	,,	12	7,100	3,350	4,752	1·4	,,
11	39·0	,,	25	800	,,	20	1,600	800	1,188	1·4	,,
8	Silkworm pupae	,,	72	3,000	,,	50	4,000	1,000	6,939	6.9	,,

Table 6 contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
10	Silk worm pupae	15. 9. 75	31	3,000	21.11.75	21	4,000	1,000	4,158	4.1	Brown
12	Boiled fish	,,	25	2,000	,,	16	3,000	1,000	2,283	2·2	,,
N6	28·0	9. 5. 75	273	1,000	11.7.75	77	2,500	1,500	2,121	1·4	Rainbow
N5	35·0	,,	100	800	,,	35	2,000	1,200	1,365	1·1	,,
H1	37·6	31. 5. 75	2,000	140	18.7.75	1,065	350	210	450	2·1	,,
H3	39·0	,,	2,000	140	,,	1,060	350	210	450	2·1	,,
3	35·0	23. 8. 75	15	1,100	20.11.75	9	4,850	3,750	4,870	1·3	,,
5	35·0	,,	1.000	150	,,	200	850	700	840	1·2	,,
4	39·0	,,	2,000	200	,,	500	834	634	1,280	2·0	,,
6	39·0	,,	500	300	,,	100	930	630	1,075	1·7	,,
13	35·0	24. 8. 75	1,500	300	21.11.75	300	887	587	990	1·7	,,
16	35·0	,,	2,000	275	,,	500	750	475	566	1·2	,,
18	35·0	,,	350	400	,,	100	1,220	820	1,014	1·2	,,
14	39·0	,,	50	1,500	,,	24	3,060	1,560	2,824	1·3	,,
15	39·0	,,	1,430	300	,,	215	1.000	700	1,118	1·6	,,
17	39.0	,,	110	1,250	,,	25	2,740	1,490	2,142	1·4	,,

Problem : 13·3 (Research work completed in 1971)
Problem : 13·4 (Research work completed in 1970)
Problem : 13·5 (Research work completed in 1970)
Problem : 13·6 (Research work completed in 1972)
Problem : 13·7 (Research work completed in 1970)

Problem : 13·8 Standardisation of trout hatchery practices
Personnel : K. L. Sehgal, Seerajdin (State Fisheries), G. N. Gazi (State Fisheries) and R. K. Langer
Duration : Three years

Investigations on this project commenced in September, 1975 on the recommendations of the Cold Water Fisheries Research Committee of the Indian Council of Agricultural Research. The project replaces the old project entitled "Commercialisation of trout culture."

748 females and 400 males of brown trout *(Salmo trutta fario)* were segregated fn September. The spawners were fed @ 1·0% of body weight on deviscerated and partially boiled *C. carpio*. In control, 306 spawners of both the sexes were kept in the same pond and were fed @ 1·0% of body weight on raw pellets of *C. carpio* without deviscerating. The egg taking operation commenced from 6.11.75 and is continuing. The results obtained so far indicated that the segregated female of brown trout (average total length/weight : 328 mm/578 g) gave 1,049 green eggs against 740 green eggs in control (female having average length/weight : 315 mm/527 g). In all 1,86,700 green eggs from experimental fish and 82,000 from control fish have been kept for hatching. To control fungus, flushings of hatching trays with Malachite green in the ratio of 1 : 200,000 for 45 minutes are being done twice a week. Four hourly recording of water and air temperatures and water quality analysis are being done.

Problem : 13·9 (Research suspended)

Problem : 13·10 Food of *Salmo trutta fario* in natural streams
Personnel : K. L. Sehgal, Kuldip Kumar and Shyam Sunder
Duration : Three years

From the analysis of preferred food of brown trout *(Salmo trutta fario)* in the Lidder, Erin, Sind, Bringhi and Verinag streams during 1971-1974, the fish was found to be an unspecialised carnivore mainly feeding by sight. The main constituents of brown trout food in five streams, were development-

al stages of Trichoptera, Ephemeroptera and Diptera in order of their ranking as the first, second and third graded feeds. The brown trout showed an increasing trend to feed upon surface organisms like, aerial insects and fish with the increase in its size. In the size group of 101-200 mm trout, the fish and the aerial insects were in negligible percentage in the food but increased to 8·96 and 6·31% respectively in the size group of 301-400 mm.

The brown trout showed an ability to select and concentrate on certain animal genera. In all 10 genera of insects and crustaceans were found to be preferred. They were *Baetis, Epeorus, Heptagenia, Mystacides, Hydrosyche, Hydrophilus, Atherix, Tendipes, Simulium* and *Gammarus*.

Coefficient of accessibility or forage ratio was determined for the ten important genera forming preferred food. The CA value of 1·0 meant that the genera of invertebrates concerned were being consumed directly in accordance with its occurrence in the bottom fauna. In the present study *Epeorus* sp., *Baetish* sp., *Heptagenia* sp., *Mystacides* sp., *Atherix* sp. and *Tendipes* sp. had CA values of 1·41, 1·11, 1·15, 1·53, 1·00 and 1·37 respectively.

The available bottom organisms in the five streams were nymphs of Ephemeroptera (27·53%), nymphs of Plecoptera (1·35%), larvae of Trichoptera (33·97%), larvae of Diptera (8·87%), larvae & adults of Coleoptera (2·54%) *Gammarus pulex* (24·09%) and miscellaneous forms (1·45%). On the basis of wet weight of biomass in the stream, three grades of streams were recognised. The gradings (wet weight of biomass/m^2) are given below.

Grade	I	Wet weight of biomass	0·5-1·0 g/m^2 (Lidder, Erin and Bringhi streams)
Grade	II	,, ,, ,,	0·1-0·5 g/m^2 (Sind stream)
Grade	III	,, ,, ,,	less than 0·1 g/m^2 (Verinag stream)

Problem : 13·11 & 13·12 (Research suspended)

Problem : 13·13 Studies on the biological indicators in an eutrophic lake (Dal Lake)

Personnel : K. K. Vass, M. J. Bhagat, C. B. Joshi and R. K. Langer

Duration : Two Years

The transparency of water varied from season to season and station to station. The values were usually low at Dalgate (70-25 cm) and Hazaratbal (110-78 cm) as compared to Charchinari and Nishat. These observations indicate pollutional impact at various stations. The higher value of DO ranging between 10·0 and 13·5 ppm at

Hazratbal showed higher trophic status. The alkalinity (90-150 ppm) and dissolved organic matter at Dalgate and Hazratbal indicated that these two parts of the lake were more under the pollutional impact. This trend was further substantiated by higher primary production recorded at Dalgate (72·5-137·50 mg $C/m^3/hr$) while at other stations it ranged between 26·4-8·2 mg $C/m^3/hr$

The phytoplankton at various centres mainly belonged to Chlorophyceae, Bacillariophyceae and Myxophyceae. The group-wise representation of different centres was as under:

	Dalgate	Charchinari	Nishat	Hazaratbal
	%	%	%	%
Chlorophyceae	27·00-83·10	34·10-57·14	15·32-52·27	28·00-86·10
Bacillariophyceae	4·44-61·06	5·71-44·00	6·81-47.64	13·80-72·00
Myxophyceae	4·44-66·56	15·47-37·14	11·77-41·77	> 1

The maximum abundance of Myxophyceae (represented by *Spirulina* sp. and *Oscillatoria* sp.) was at Dalgate indicating pollutional impact in this region of the lake. Frequent blooms of *Euglena* sp. at Nishat and Charchinari centres accounted for pollution due to effluent from habitation at these centres. At Hazaratbal area which received effluents from Dargah township and floating gardens, the maximum diatom population (represented by *Fragillaria* sp. and *Gomphonema* sp.) gave strong indications of eutrophication,

The zooplankton population recorded at different stations was represented by rotifers. The main genera recorded were : *Keratella, Filinia, Brachionus* and *Polyarthra*. At Dalgate, *Keratella* sp. was dominant while at Hazaratbal, *Polyarthra* sp. was the dominant rotifer. Among crustaceans, mainly the copepod nauplii and adult forms were recorded while cladocerans were few in number. The benthic population recorded from different stations belonged to Tubificidae, Naididae among Oligochaeta, larvae of Chironomidae among Diptera and gastropod shells. The quantitative assessment of benthos revealed that Hazaratbal station invariably showed higher numbers ranging from 200 to $355/m^2$.

Problem : 13·14 Crude culture of fish-food organisms under temperate climate

Personnel : K. K. Vass, M. J. Bhagat and C. B. Joshi

Duration : Two years and six months

Zooplankton culture : Trials were made on the culture of *Daphnia*, sp. *Ceriodaphnia* sp. and *Cyclops* sp. under laboratory conditions. Different combinations

of organic nutrients such as cow dung extract, urea and urea in combination with cow dung extract were tried as nutrient media. The different concentrations tried were from 100 to 400 ppm @ 5-10% dose. In case of *Daphnia* sp., the culture was started with the animals ranging in body length between 0·5 and 0·6 mm. The animals attained a size of 1·0 to 1·35 mm in about 3-4 days. As the individuals reached a size range of 1·50-1·65 mm, they developed parthenogenetic eggs. The number of eggs ranged between 7 and 8/ batch. Normally it took 8-9 days for the development of eggs. It was observed that animals cultured in cow dung extract with urea in combination took only 5 days for egg development while it took 10 days in pure cow dung extract. The young ones were liberated within 24 hours of formation of eggs. Each female under experimental conditions produced parthenogenetic eggs six to seven times. On an average each animal had a life span of 50-60 days The individuals cultured in urea could not survive more than a week. In case of *Ceriodaphnia* sp. the initial body length of 0·15-0·16 mm increased to 0·25 0·38 mm in about 3 days. Within the following three days, the animals developed parthenogenetic eggs and on the seventh day, the young ones were liberated. Each female produced a batch of 3 to 4 young ones four to five times daily. Under laboratory conditions each animal had a life span of 25-30 days. The growth at low temperatures was unsatisfactory.

Young *Cyclops* individuals were cultured in laboratory giving cold cow dung extract (200 ppm concentration) @ 10% dose. It took 15 days for the individuals to attain maturity and develop the egg-sacs. The average size of egg-sacs ranged between 0·3 and 0·4 mm and the number of eggs produced per sac varied between 7 and 14. The size of each individual egg was between 0·06 and 0·08 mm. After the release of eggs each female took 3 to 5 days for the development of fresh egg-sacs. Under normal laboratory temperature (18-22° C) each female produced three broods within a period of 2 months.

Phytoplankton culture : Unicellular and useful species were tried for culture in the laboratory. A mixed culture of chlorophycean forms *Scenedesmus* and *Chlorococcum* was started in conical flasks using (a) Bristol's solution and (b) NPK fertiliser mixture. From the preliminary studies it was observed that NPK mixture gave better results. The different concentrations of NPK (100, 200, 300 and 400 ppm) @ 15% dose were tried. It took more than 25 days for culture in 200 ppm concentration to reach a density of 2,00,000 cells/ml from an initial of 4,000 cells/ml. The growth of cultures at 300 and 400 ppm was comparatively less.

Problem : 14·1 Fish catch statistics of the middle stretch of the Ganga River System

Personnel : R. K. Tyagi, G. N. Mukherjee, S. N. Mehrotra, G. N. Srivastava, B. C. Jha, R. A. Gupta and N. K. Srivastava

Duration : Continuing

The estimated fish landings at Sadiapur, Daraganj and Buxar were 83·78, 33·26 and 7·22 t respectively. The contribution of the different major fish groups at Sadiapur and Daraganj was as under :

	Major carps	Catfishes	*H. ilisha*	Misc.	Total
	(t)	(t)	(t)	(t)	(t)
Sadiapur	28·02	20·44	0·45	34·87	83·78
Daraganj	5·07	4·85	0·03	23·32	33·26

Scales of *L. rohita*, *C. catla* and *C. mrigala* have been collected to study the fluctuations in the relative abundance of the different age-groups in their population.

Primary productivity recorded in the Ganga ranged from 0 to 150 mg $C/m^3/hr$ and in the Yamuna it ranged from 12·5 to 125 mg $C/m^3/hr$.

Problem : 14·2 Fish catch statistics of the lower stretch of the Ganga River System

Personnel : S. K. Wishard, S. N. Sar, B. L. Pandey and R. C. Singh

Duration : Continuing

Fish catch statistics : The estimated fish production from the six assembly centres from the lower stretch of the Ganga River System was 328·66 t which indicated a decrease by 40·20% when compared with that of the corresponding period of 1974. The decrease was due to significant fall in the annual landing of *Hilsa ilisha* from the entire lower stretch covered by the sampling centres on the river Ganga and Lalgola on the river Padma.

The fish production at individual centres was estimated to be 67·41, 25·06, 32·80, 42·65, 55·32 and 105·42 t at Bhagalpur, Sahibganj, Rajmehal, Farakka, Dhulian and Lalgola respectively.

H. ilisha predominated among all other species contributing 42·69% to the total catch. This was followed by miscellaneous species (41·41%), *W. attu* (6·40%), *C. catla* (2·53%), *M. seenghala* (2·31%), *M. aor* (2·24%) *C. mrigala* (1·24%), *L. rohita* (0·81%) and *L. calbasu* (0·37%).

Percentage contribution of various species at different assembly centres is presented in table 7.

Table7. Centre-wise landing of various species (t). Figures in parentheses indicate their percentage contribution at the centres.

Species	Bhagalpur	Sahibganj	Rajmahal	Farakka	Dhulian	Lalgola
C. mrigala	2·16	0·77	0·37	0·27	0·50	-
	(3·20)	(3·07)	(1·13)	(0·63)	(0·90)	
C. catla	4·26	1·56	1·00	0·79	0·71	-
	(6·31)	(6·22)	(3·05)	(1·85)	(1·28)	-
L. rohita	1·35	0·48	0·39	0·18	0·27	-
	(2·00)	(1·92)	(1·19)	(0·42)	(0·49)	
L. calbasu	0·34	0·27	0·18	0·20	0·22	-
	(0·54)	(1·07)	(0·55)	(0·47)	(0·40)	
M. aor	2·35	1·23	0·74	0·90	2·15	-
	(3·48)	(4·91)	(2·26)	(2·11)	(3·89)	
M. seenghala	3·32	1·37	0·69	0·85	1·37	-
	(4·92)	(5·47)	(2·11)	(1·99)	(2·48)	
W. attu	10·29	2·46	2·25	2·40	3·64	-
	(15·25)	(9·82)	(6·85)	(5·63)	(6·58)	
H. ilisha	0·01	0·11	2·83	17·83	21·56	97·92
	(0·10)	(0·44)	(8·62)	(41·81)	(38·97)	(96·76)
Miscellaneous	43·33	16·81	24·35	19·23	24·90	7·50
	(64·20)	(67·08)	(74·24)	(45·09)	(45·01)	(3·24)
Total	67·41	25·06	32·80	42·65	55·32	105·42
	(20·55)	(7·62)	(9·98)	(12·95)	(16·83)	(32·07)

Primary productivity : Average carbon assimilation both gross & net, and respiration during the period were 68·00 & 45·67, and 25·85 mg C/m³/hr respectively, showing an increase by 63·54 & 73·45%, and 34·07% respectively over the values of the corresponding period of 1974.

The maximum gross carbon assimilation was recorded in April (189·07 mg C/m³/hr) and minimum in August (11·88 mg C/m³/hr). Net carbon assimilation was the maximum in April (165·00 mg C/m³/hr) and the minimum

in August (5·63 mg C/m³/hr). Respiration rate was the maximum in February (55·88 mg C/m³/hr) and the minimum in July (7·13 mg C/m³/hr).

The maximum DO was recorded in February (8·17 ppm) when air and water temperatures were 18·5° and 20·5°C respectively. The minimum DO was recorded in August (3·41 ppm) when air and water temperatures were 25·5° and 28·0°C respectively. The turbidity was the maximum in August (435·00 ppm) when DO was the minimum and while it was the minimum in February (32·5 ppm), DO was the maximum. The pH varied between 8·25 and 8·50 (January to November).

Plankton : The maximum abundance of phytoplankton was observed in May (8,826/l) while the minimum (105/l) was in September. An increase of production by 8·84% was recorded when compared with that of the preceding year. The dominant phytoplankton groups were Chlorophyceae represented by *Actinastrum* sp., *Ankistrodesmus* sp., *Scenedesmus* sp., *Pediastrum* sp.; Bacillariophyceae represented by *Navicula* sp., *Synedra* sp., *Nitzschia* sp., *Asterionella* sp., *Pleurosigma* sp.; Myxophyceae represented by *Microcystis* sp., *Merismopedia* sp., *Spirulina* sp., *Oscillatoria* sp., *Anabaena* sp. and Desmidiaceae represented by *Gonatozygon* sp.

The zooplankton population varied between the maximum of 36 organisms/l in September and the minimum of 3 organisms/l in May. The zooplankton registered a decrease by 20·41% when compared with that of the corresponding period of 1974.

The various zooplankton encountered were : rotifers represented by *Keratella* sp., *Notius* sp., *Brachionus* sp., *Polyarthra* sp., *Filina* sp., *Ploeosoma* sp. and *Trichocerca* sp.; cladocerans represented by *Ceriodaphnia* sp., *Sida* sp., *Bosmina* sp. and *Leptodora* sp.; and copepods represented by *Diaptomus* sp. *Cyclops* sp. and nauplii.

Problem : 14·3 (Research work completed in 1969)
Problem : 14·4 (Research work completed in 1971)
Problem : 14·5 (Research work completed in 1973)

Problem : 14·6 Effect of major environmental changes on the fisheries of commercially important stocks of the Hooghly-Matlah estuaries

Personnel : G. C. Laha, A. Chowdhuri, P. M. Mitra, A. R. Choudhuri, B. K. Saha, R. N. De, G. P. Bhattacharya, N. D. Sarkar, A. R. Paul. N. C. Mondal and A. K. Namasudra

Duration : Five years

1975

The data for November, 1974 to October, 1975 was processed. A total of 13,525·8 t of fishes were estimated to have landed from the Hooghly- Matlah estuarine system during this period, which is more than the total catch of the corresponding period, November 1973 to October, 1974, by 1,659·8 t. Zone III (i.e. lower Sunderbans) accounted for 80·1% of the total catch. The catches from the extensive fishing areas of this zone, however, cover the following main assembly centres : Namkhana, Kakdwip, Diamond Harbour, Raidighi, Hasnabad and Kalinagore. These centres were covered on total enumeration basis.

The species which dominated the catches were : *Harpodon nehereus* (3,541·2 t, 26·2% of the total catch), *Hilsa ilisha* (2,429·6 t, 18·0% of the total catch), prawns (1,543·5 t, 11·4% of the total catch), *Pama pama* (716·9 t, 5·3% of the total catch), *Setipinna phasa* & *S. taty* (713·6 t, 5·3% of the total catch) and *Trichiurus savala* & *T. haumela* (573·8 t, 4·2% of the total catch).

The gears which dominated the catches were : bag-net, large seines and drift nets. Bag-nets accounted for 8,332·5 t (61·6%) when large seines captured 2,556·6 t (18·9%) and drift-nets accounted for 1,305·5 t (10·0%) of the total catch.

To collect the statistics of catch and effort for winter migratory fishery a survey camp was opened at Freserganj in November 1974. Besides, additional seasonal landing centres at Falta and Haragram, Digha were also covered. Total estimated catch during the winter months (November, 1974 to January, 1975) from winter migratory fishery was 5,941.8 t only. In the winter fishery, major species encountered were : *H. nehereus*, *P. pama*, *S. phasa* & *S. taty* and *T. savala* & *T. haumela*. Among the gears, bag-net was the chief contributor.

Problem :	14·7	Survey of the fish and fisheries of the river Brahmaputra.
Personnel :		Ravish Chandra, H. P. Singh, M. Choudhury and V. Kolekar (from 18th April, 1975)
Duration :		Four years

Catch statistics : During the period under report, 241·4 t of fish were estimated to have landed at four observed centres *viz.*, Tezpur, Fancybazar (Gauhati), Uzanbazar (Gauhati) and Dhubri. The centre-wise break up being as under :

Centres			Fish landings (in t.)
Tezpur			59·406
Gauhati	(i)	Uzanbazar	57·359
	(ii)	Fancybazar	58·724
Dhubri			65·908
		Total	241·397

Centre-wise observations on the fish catch statistics were as under :

Tezpur : 59·4 t of fish were estimated to have landed at Tezpur. Catfishes (29·63%) dominated the landings, followed by miscellaneous fishes (25·13%), major carps (18·14%), minor carps (15·59%), prawns (5·98%) and hilsa (5·52%).

Gauhati : 116·1 t of fish were estimated to have landed at the two landing centres as compared to 167·1 t during the previous year, thereby showing a decline of 30·6% in the total catch. The maximun. landings were recorded during September and January and the minimum during July and August at the two centres.

The landings were dominated by miscellaneous fishes (34·78%), followed by minor carps (19·94%), catfishes (17·82%), major carps (13·87%), hilsa (9·03%) and prawns (4·56%) at Uzanbazar, whereas at Fancybazar, landings were dominated by miscellaneous (24·35%), followed by major carps (22·93%), catfishes (20·02%), hilsa (18·08%), minor carps (9·22%) and prawns (5·38%).

Dhubri : 65·9 t of fish were estimated to have landed at Dhubri centre. The catches were dominated by catfishes (29·99%), followed by miscellaneous (23·18%), major carps (14·93%), minor carps (14·07%), hilsa (11·55%) and prawns (6·27%).

Hydrological observations - Tezpur : The ranges of alkalinity, free CO_2, DO, nitrate and phosphate varied from 50·0 to 80·0 ppm, 2·0 to 4·0 ppm, 6·88 to 10·40 ppm, 0·025 to 0·05 ppm and 0·05 to 0·14 ppm, respectively, as compared to 68·0 to 200·0 ppm, 2·0 to 6·0 ppm, 6·24 to 8·64 ppm, 0·024 to 0·04 ppm and 0·06 to 0·32 ppm, respectively during the preceding year.

Gauhati : At Uzanbazar sampling centre, the ranges of surface water temperature pH, turbidity, alkalinity, free CO_2, DO, nitrate and phosphate ranged as 15·0 to 29·0°C., 7·4 to 8·0, 10·0 to 100·0 ppm, 54·0 to 82·0 ppm, 2·0 to 5·0 ppm, 6·4 to 10·08 ppm, 0·03 to 0·06 ppm and 0·05 to 0·14 ppm

respectively, as compared to 18·0° to 31·5°C., 7·4 to 7·6, 16·0 to 300·0 ppm, 70·0 to 220·0 ppm, 1·0 to 5·0 ppm, 4·0 to 8·8 ppm, 0·024 to 0·05 ppm and 0·05 to 0·2 ppm respectively during the year 1974. It is observed that there was a decrese in alkalinity but an increase in Do and pH of the water during the year.

Dhubri : The ranges of alkalinity, free CO_2, Do, nitrate and phosphate varied from 56·0 to 76·0 ppm and 4·5 to 8·0 ppm, 6·72 to 9·92 ppm, 0·03 to 0·66 ppm and 0·05 to 0·16 ppm, respectively, as compared to 64·0 — 240·0 ppm, 2·0-10·0 ppm, 5·8-8·64 ppm, 0·02-0·05 ppm and 0·07-0·3 ppm respectively during the preceding year.

Primary productivity : Gross primary productivity fluctuated between 24·58 and 31·25 mg $C/m^3/hr$ as compared to 19·50 and 31·25 mg $C/m^3/hr$ during the preceding year. The net production varied between 14·12 and 19·36 mg $C/m^3/hr$ as compared to 12.30 and 18·75 mg $C/m^3/hr$ during the year 1974.

Plankton :

Tezpur : The average monthly percentages of phyto- and zooplankton were 63·54 and 36·46 respectively. Bacillariophyceae (28·91%) formed the main group being the maximum (75·0%) in November and the minimum (9·38%) in August. Chlorophyceae, blue-green algae and Desmidiaceae accounted for 27·71, 8·07 and 1·85% respectively among the phytoplankters. The zooplankton comprised protozoans (21·84%), rotifers (9·25%), copepods (3·7%), miscellaneous (1·5%) and anostracans (0·17%). The common phytoplankton genera were : *Spirogyra, Zygnema, Mougeotia, Spirulina, Navicula. Gyrosigma* and *Diatoma* and the common zooplankters were : *Keratella, Cyclops, Asplanchna, Centrophyxis* and nauplii of copepods;

Gauhati : Monthly average phytoplankton was 81·25%, rest being the zooplankton. Among the phytoplankters, Bacillariophyceae accounted for 47·04%, being followed by Chlorophyceae (41·04%), blue-green algae (8·38%) and Desmidiaceae (3·54%). Among the zooplankters, rotifers formed 9·28%, being followed by protozoans (3·74%), miscellaneous (3·38%), copepods (1·67%) and cladocerans (0·68%) in the total plankton.

Dhubri : The average monthly phytoplankton and zooplankton were 78·65 and 21·35% respectively. Among the phytoplankters, Bacillariophyceae forming 47·43% was followed by Chlorophyceae (21·35%), blue-green algae (6·65%) and Desmidiaceae (3·22%). Among the zooplankters, rotifers (7·54%), copepods (7·54%), cladocerans (3·22%), protozoans (1·98%) and miscellaneous (1·07%) were encountered in the total bulk of the plankton.

Problem : 14·8 and 14·9 (Research suspended)

Problem : 14·10 Ecological changes in the Hooghly estuary in the context of freshwater release from Farkka Barrage into the system.

Personnel : A. C. Nandy, K. K. Ghosh, P. M. Mitra, H. Singh, S. K. Mazumder, B. K Saha, R. N. Dey R. K. Chakraborty, H. S. Majumder, G. P. Bhattacharjee, N. D. Sarkar, A. R. Paul and N. C. Mondal

Duration : Three years

The hydrological studies indicated the waters to be moderately alkaline. The pH of water in the entire stretch fluctuated from 7·9 to 8·4. Salinity was found to be the highest at Gosaba centre (7,581 to 30,250 ppm) and the lowest at Kalna centre (15 to 23 ppm). The specific conductivity was the maximum at Gosaba centre (10,436 to 17,998 mhos) and the minimum at Barrackpore (143 to 287 mhos). Total alkalinity and total suspended solids also showed a marked change from 548 ppm to 80 ppm and 6,60J ppm to 840 ppm respectively.

The plankton studies showed higher abundance of freshwater forms with phytoplankton dominating over the zooplankton in the estuary up to Geokhali. Marine forms were encountered from the lower estuary. The phyto plankton (68·38%) exhibited dominance over zooplankton (31·62%). Diatoms ond copepods were found to dominate the phytoplankton and zooplankton cycles respectively. Phytoplankton mainly belonged to two major groups with Bacillariophyceae having the maximum representation in terms of species (18) and being closely followed by Chlorophyceae (8) and the other groups with the least representation. *Coscinodicus excentricus* was the most abundant (an average of 96%) during the entire period of investigation at all the centres. There were several species recorded but the most common forms encountered in the samples were *Melosira granulata, Synedra ulna, Coscinodiscus* spp., *Navicula cryptocephala, Navicula simplex, Borgea planktonica, Pediastrum simplex, Scenedesmus quaducauda, Skeletonema costatum* and *Rhizosolenia* sp. Among zooplankton, copepoda were the most abundant and comprised calanoid and cyclopoid forms with various copepodid and naupliar stages. The calanoid group was represented by *Heliodiaptomus* sp., *Neodiaptomus* sp. and larval stages while the cyclopoid group was represented by *Mesocyclops strennus* and

Mesocyclops leuckarti. *Mesocyclops strennus* was encountered in all the months during the year, being the maximum in February (54 u/l). The occuance of calanoids was irregular.

The benthic fauna and flora mainly consisted of polychaetes (41,538/m^2), gastropods (1,978/m^2), nematods (5,934/m^2) copepoda (1,290/m^2), crab larvae (136/m^2) and diatoms (1,248/m^2).

The gross organic production fluctuated between 6·25 & 36·25, and the net production between nil and 7·8 mg C/m^3/hr.

Problem : 14·11 Statistical evaluation of sampling and estimation techniques of plankton and primary production

Personnel : K. K. Ghosh, B. N. Saigal, H. Singh, Amitabha Ghosh and S. K. Saha

Duration : One year and 8 months

Effect of sample size on surface plankton collected by the plankton net collection method showed high degree of variation in repeated samples, both qualitatively and quantitavely for 12, 15 and 20 l samples. Large size samples showed higher representation of less abundant forms and higher concentration of zooplankton *viz.*, *Moina* sp., *Brachionus* sp., *Cyclops* sp. and nauplii of copepods and the smaller samples were dominant in phytoplankton *viz.*, *Euglena* sp., *Phacus* sp., *Oscillatoria* sp.. *Microcystis* sp., *Anabaena* sp. and *Navicula* sp.

Repeated estimations of primary productivity using 250 ml light and dark bottle technique, have shown high degree of variation ranging from 226 to 544 mg C/m^3/hr. The investigations will be continued during the next year.

Problem : 14·12 Robustness of estimates of population sizes and mortality rates by monte-carlo methods

Personnel : K. K. Ghosh

Duration : Two years and 8 months

The estimation techniques available in literature for finite and assumed infinite populations have been examined. The geometric logistic and modifed logistic models of population growth with poisson or geometric models of mortality are being theoretically examined for the estimation procedures.

Project 15 : Fish pathology

Problem : 15·1 Etiology and control of diseases of cultured warm-water fishes
Personnel : A. K. Ghosh and S. R. Ghosh
Duration : Continuing

Biology of *Argulus siamensis* was studied in the laboratory.

Fish heavily infested with *Argulus* could be cured by the application of benzene hexachloride (10% a.i.) applied @ 0·5 ppm to the pond. The copepodicide neither affected the fish nor the fish food organisms and the bottom fauna under culture. Fish were dipped in a medium of 1 to 2 ppm BHC in water and transported from the infected pond to a noninfected one, at the time of stocking. Besides treatments by providing substrate in the pond for *Argulus* to lay eggs and periodically destorying the eggs by removal, the intensity of infection could be reduced.

Digenetic trematodes collected from the gallbladder of *Wallago attu*, were identified and recorded as *Isoparochis hypselobaqri*, Billet.

Formalin was used at different concentrations of 1 : 3,000, 1 : 4,000 and 1 : 5,000 to find out the effective dose for treatment of fry infected with monogenetic trematode infection in laboratory trials.

Project 16 : Weed control

Problem : 16·1 (Research work completed in 1973)
Problem : 16·2 (Work is being done under problem 16·7)

Problem : 16·3 Evolution and evaluation of weedicide formulations
Personnel : V. Ramachandran, S. Patnaik and T. Ramaprabhu
Duration : Continuing

During a field trial in a rearing pond (0·16 ha) of Killa Experimental Fish Farm, a noxious bloom of *Peridinium* sp. (density : 19,020 u/l) was cleared by aqueous ammonia (2 ppm) liberated by reacting 50 kg of ammonium sulphate and an equal amount of quick lime (calcium oxide). The bloom was cleared up bringing down the density at 20 u/l in two days while there was an increase in zooplankters like, *Brachionus* sp. (450-1,370 u/l) after about 15 days.

In field trials in a nursery pond (0·03 ha) and a large tank (0·24 ha), brick pellets soaked with 2, 4-D gave effective control of rooted submerged and emergent weeds like, lilies (*Nymphaea* spp. and *Nymphoides* spp.) and submerged weeds (*Hydrilla* sp., *Najas* sp. and *Ottelia* sp.) at about 10-20 kg a. i./ha.

In laboratory and field trials the bloom of blue-green alga, *Microcystis* sp. could be controlled by diuron herbicide at about 0·3 ppm. In four trials in ponds (area : 0·02-0·36 ha), the blooms, varying from 0·2 to 0·637 million colonies/litre, were killed in 10-15 days after treatment. Due to oxygen depletion by the death of dense blooms consequent to algicide treatment, some distress and mortality of fish were observed in shallow ponds during the hot season. Zooplankters like, *Brachionus* sp, *Cyclops* sp, and *Moina* sp. developed in large numbers after the death and decay of the blooms of *Microcystis* sp.

A field infestation of *Pistia* and water hyacinth (density : 13 and 16 kg/m^2 respectively) and other emergent and marginal weeds like, *I. carnea*, *I. aquatica*, *Jussiaea* sp. and *Colocassia* sp. in a section of killa moat (approx. area : 0·5 ha) was cleared by a formulation of 2,4-D-40% amine salt+20% parquat @ 5 kg+0·2kg a.i./ha.

Field trials with carbamate and propanil herbicides at different doses (2-6 kg a. i./ha) gave inconclusive results.

Problem : 16·4 (Research work completed in 1973)

Problem : 16·5 Eradication of weeds by chemical treatments
Personnel : Eva Mitra (Miss), S. C. Thakurta and A. C. Banerjee
Duration : Two years

Several laboratory experiments were carried out to find avenues to eradicate weed infestation by chemical treatments using 2,4-D sodium salt (Fernoxone) and urea in varied doses.

In a 10 l glass jar containing healthy populations of *Hydrilla* and *Vallisneria*, Fernoxone was applied @ 25 kg/ha in a single dose followed by $CuSO_4$ @ 5 kg/ha/dose in four intermittent doses in four consecutive days. Though *Hydrilla* was completely eradicated within 15-20 days of the treatment, *Vallisneria* was reduced to nil within 75 days even when 95% of the population was observed to exterminate within 45 days. However, no regrowth of the plants was observed within a year.

The above treatment was also repeated in laboratory in four replicates having submerged and floating infestations of *Hydrilla*, *Vallisneria* and *Eichhornia* and the results obtained showed exactly similar trend of destruction in case of *Hydrilla* and *Vallisneria* whereas 80% of *Eichhornia* was observed to have extirpated within 45-50 days.

With a view to destorying floating vegetations by chemical treatments, experiments were conducted in the laboratory in glass jars using *Azolla* and *Salvinia* as test weeds. Doses of Fernoxone applied were 10 and 5 kg/ha. Though *Azolla* plants were found to have perished completely within 20-30 days at both the doses, lower dose was found adequate for a quicker kill. *Salvinia* exhibited vegetative reproduction in some of the glass jars and the size of the reproduced was noticed to be smaller.

Problem : 16.6 Autecology of aquatic weeds
Personnel : E. Mitra (Miss), S. C. Thakurta and A. C. Banerjee
Duration : Four years

Collection of water, soil and plant samples have been made from 18 ponds situated in 3 different places around Calcutta. The analyses are in progress.

Problem : 16·7 Studies on the algal population of freshwater ponds with special reference to their utility for fish culture and control when in excess
Personnel : S. Patnaik
Duration : Three years

In the fish farms in North Orissa, the water pH and total alkalinity ranged fron 6·2 to 9·2 and 26 to 218 ppm respectively. The numerical quantity of phytoplankton ranged from 16 to 227 u/l and among the benthic algae *Spirogyra* sp. was dominant in most places.

In yard trials when fingerlings of catla, rohu and silver carp were fed with *Microcystis* bloom, catla got emaciated and died but rohu and silver carp survived.

In laboratory trials, bloom of *Peridinium* sp. was killed with 0·5 and 1·0 ppm copper sulphate in 3 days and with 0·25 and 1·0 ppm active simazine jn 6 days.

Problem . 16·8 Biodegradation, persistence and the effects of 2, 4-D and simazine herbicides on the productivity and fish life in cultivable waters

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

Duration : Three years

In a yard experiment in plastic pools of 0·6 sq m surface area and containing 450 litres of water, 2, 4-D and simazine herbicides applied @ 5·10 & 0·2 and 0·5 ppm respectively did not show any trend indicating harmful effects on bottom organisms comprising chironomid larvae, *Limnodrilus* sp. and *Pentaneura* sp. over a period of 5 months. The organisms were present in the treated and control pools at different times. The survival of *Cyprinus carpio* fry (22 mm/1·125 g stocked @ about 1,67,000/ha confirmed earlier findings of no harmful effect of 2,4-D at the doses tried.

In a field experiment in a nursery pond (area 0.028 ha) treated with 2,4-D granules @ 10 kg a. i./ha with rohu spawn stocked @ 4,000,000/ha a survival of about 40% of fry has been noted. This showed that there was no adverse effect on the survival of fry. In another field trial, 2,4-D applied @ 10 kg a. i./ha showed a reduction of nearly 50% of the weeds comprising *Ottelia alismoides* and *Nymphoides cristatum* in two months after treatment.

In a pond (0·24ha), treated with pellets soaked with 2,4-D @ 10 kg a. i./ha and stocked with major carp and common carp fingerlings @ 3,000/ha, no apparent harmful effect on the fish could be observed.

Laboratory experiments were conducted to determine the persistence of 2-4 D toxicity in pond soils. Soil samples , collected after 17 & 24 days of treatment with 2,4-D brick pellets, supported the germination of bean seedlings. The results, however, did not lead to any definite conclusion.

Problem : 16·9 Increasing fish production by conversion of aquatic vegetation into manure *in situ*.

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

Duration : Two years

In a yard experiment in plastic pools (area 2·5 sq m) where aquatic vegetation was killed and converted into manure *in situ*, *Cyprinus carpio* fry (19-25 mm, av. 21·1 mm/1·125 g) stocked @ 80,000/ha yielded after 5 months rearing, an average production of 460 kg/ha of fingerlings compared to 260 kg/ha in untreated pools.

In treated pools, *Pistia* (5-10 kg total up to 35 kg) was added at regular intervals and killed by paraquat spray and converted into manure. In the untreated pools, same amount of *Pistia* weeds were kept and removed without treatment after noting the loss or gain in their bulk. The average phosphate content in treated pools was higher (0·53 ppm) than in untreated pools (0·4 ppm). The plankton population was generally better in treated pools after the rotting of the disintegrating weeds, developing more zooplankters than phyto, while in untreated pools diatoms and desmids were more commonly noted.

In a field experiment in three nursery ponds (area 0·015 ha) stocked with catla, rohu, mrigal and common carp (1 : 3 : 4 : 5) @ 8,500/ha, the average yield of fish in two ponds, in which a total of 450 kg of water hyacinth was cumulatively killed by 2,4-D spray and allowed to rot and disintegrate to act as manure in the ponds, was 1,098·25 kg/ha/9 months which was higher than in control pond (685 kg/ha/9 months) in which the same quantity of weeds produced an additional quantity of 830 kg of weed mass. The average phosphate content in treated ponds (0·14 ppm) was higher than in control pond (0·0433 ppm) indicating increase in fertility of the water in treated ponds due to the killing of weeds while additional production of weeds in control pond reduced the same.

In another field trial, two ponds (0·08 ha and 0·04 ha) were prepared by poisoning and liming and stocked with fish catla., rohu, mrigal and silver carp (40 : 25 : 20 : 15) @ 2,000/ha. The physico-chemical conditions of one of the ponds (0·98 ha) in which weeds (mostly water hyacinth and *Pistia*) have been killed by spraying herbicide and in the other (having mostly duck weeds and *Pistia*) were constantly removed, showed that in the former the average phosphate content was 0·48 ppm and in the latter it was 0·55 ppm. In a 0·25 ha tank in which so far 6·250 kg of *Pistia* and 300 kg of water hyacinth were killed by chemical treatment, a marked increase in phosphate level 0·0745 to 0·207 ppm was noted in 4 months. Catla fry (average size : 42·6 mm/ 7·7 g) grew to 187 mm/80 g in about 3 months while rohu (24 mm/135 mg) increased to 99·25 mm/10·8 g. Mrigal showed a growth of 58·5 mm/5·8 g to 142·2 mm/40 g and silver carp attained a size of 241 mm/160 g.

Project 17 : Frog farming

Problem : 17·1, 17·2, 17·3 & 17·4 (Research completed in 1973)
Problem : 17·5 (Research suspended)

Problem : 17·6 Culture of frog food organisms
Personnel : C. R. Das, P. L. N. Rao and S. N. Mohanty
Duration : Two years

Experiments were conducted to evaluate the efficiency of different media to support the growth and multiplication of *Tubifex tubifex*. When pond soil and sludge were treated with a mixture of ground-nut oilcake, paper pulp and vegetable wastes in the ratio of 1 : 1 : 1 at a regular interval of three days in split doses for a period of one month, keeping the water level constant, the rate of multiplication was found to be 75 times in pond soil and 85 times in sludge base.

While in a similar set of experiment, when rain water was added, 85 to 95 times multiplication of the worms were observed. Other set of experiments conducted during the period with ground-nut oilcake, paper pulp and vegetable wastes in the proportion of 1 : 2 : 2 at a regular interval of 3 days, keeping water level constant, have shown 95 to 100 times of multiplications.

Problem : 17·7 Development of hatchery complex for Indian commercial frog species
Personnel : A. K. Mondal, M. L. Bhownik, V. K. Sharma, B. K. Mishra and P . Kumaraiah
Duration : Three years

Four experiments on methods of de-gumming of eggs of *Rana cyanophlyctis* were conducted in the laboratory by adoption of Woynarovich method, and success was obtained in achieving complete de-gumming of their eggs. However, the process being a laborious one, pectinase was also used. In two preliminary experiments conducted so far with pectinase, it was observed that de-gumming could be easily achieved in highly sticky eggs of *R. tigrina* if pectinase was used after proper treatment in urea-sodium chloride solution. Eggs used in all these experiments were obtained through induced breeding.

Probiem : 17·8 (a) Nursery management for Indian commercial frog species
Personnel : A. K. Mondal, M. L. Bhowmick, P. Kumaraiah, B. K. Mishra and V. K. Sharma
Duration : Five years

Iodine at 0·8 and 0·2 ppm doses has been found to have some effect on the pro-metamorphic stages of *R. hexadactyla* tadpoles, thereby reducing the period of metamorphosis by a few days. The observations are in progress.

Problem : 17·8 (b) Rearing of tadpoles of *Rana tigrina* up to the juvenile stage with artificial feed.

Personnel : S. N. Mohanty, P. L. N. Rao, V. Panigrahi and C. R. Das

Durarion : Two years

7,000 pure seed of *R. tigrina* obtained through induced breeding were used for rearing experiments conducted in the laboratory and yard. With the advent of functional mouth, tadpoles of *R. tigrina* were fed with zooplankton. In the beginning they are good swimmers and gradually become sluggish in nature and develope licking and tearing habits. Several types of supplementary feeds *viz*, fish meal, chopped earthworm and minced frog meat etc. were used as feed. Provisions of adequate food could reduce cannibalism to a great extent but could not absolutely check. In both laboratory and yard experiments, 70% of the tadpoles could be raised up to 2 legged stage and 50% up to the 4 legged stage. It has been noticed that the unused supplementary feed putrefies quickly and depletes dissolved O_2, level which is detrimental for tadpoles. It has also been established that with the advancement of metamorphosis stage, reduction of water level is absolutely necessary.

Problem : 17·9 (a) Mono-culture of *Rana hexadactyla*

Personnel : A. K. Mondal. M. L. Bhowmik, V. K. Sharma, P. Kumaraiah and B. K. Mishra

Duration : Five years ten months

During 1975, no production experiment with *R. hexadactyla* could be undertaken due to lack of pond facilities. Gut content analysis of 20 adults of *R. hexadactyla* collected from their various natural habitats revealed that the same is constituted mainly of various aquatic weeds and very negligible quantity of animal matter. The weeds encountered were *Spirogyra, Azolla, Spirodela, Marsilea, Hydrilla, Potamogeton* etc., which were in different stages of digestion. Laboratory culture of a blue bottle fly, *Chrysomia megacephala* in cages has been taken up for feeding of carnivorous stages of frogs. Successful breeding of the species could be obtained in medium containing fish meal, ground-nut oilcake, wheat bran and banana. Fecundity studies of seven gravid female flies revealed that the total egg counts varied between 145 and 272. Studies on the passage of insect food inside the gut of early frogs of *R. hexadactyla* revealed a time lapse of about 20 hours for the food to pass from the stomach to intestine.

Problem : 17·9 (b) Food & feeding habits of *Rana hexadactyla*
Personnel : P. L. N. Rao, C. R. Das, S. N. Mohanty and V. Panigrahi
Duration : Two years

Tadpoles of *Rana hexadactyla* were found to subsist entirely on plant matter preferably *Hydrilla* and *Lemna*. Metamorphosed juveniles are completely carnivorous, feeding on earthworms, termites, ants, maggots, moths and butterflies. Adults were seen to feed on varied items like earthworms, coleopterans, dipterans, hemipterans, odonates and orthopterans among insects, centipeds and millipeds; crustaceans like shrimps and crabs; molluscs like, snails and slugs. Parts of carp-minnows were also encountered along with undigested vegetable matter.

Problem : 17·9 (c) Frog farming
Personnel : C. R. Das, S. N. Mohanty, P. L. N. Rao and V. Panigrahi
Duration : Two years

By providing simulated natural environment both in yard and field experiments, natural breeding of *R. hexadactyla* was possible. It was observed that they breed throughout the three monsoon months, during the rainy or cloudy days. The eggs are adhesive in nature which were found to adhere on the fibrous roots of *Pistia stratiotes, Lemna polyrhiza* or on the twigs of *Hydrilla verticellata*. Approximately 100% hatchlings were obtained from these eggs. Consequent to natural breeding 3,000 pure seed of *R. hexadactyla* could be obtained. Tadpoles were reared in the laboratory, yard and escpecially designed nursery-cum-rearing tanks with aquatic plants. It was observed that *Hydrilla verticellata* formed a preferred food for the tadpoles. In rearing experiments, tadpoles have shown 80-90% survival and metamorphosis.

Juveniles were reared with the provision of insects of various species. *viz.*, termites, Odonata, Hymanoptera etc. In a rearing experiment, juveniles have attained an average length/weight 57·4 mm (range 48-64 mm)/23·5 g respectively.

Project 18 : *Sewage-fed fisheries*

Problem : 18·1 Fish culture in sewage-fed ponds
Personnel : Apurba Ghosh, L. H. Rao and S. K. Saha
Duration : Three years

The experiments on the culture of fisohs in sewage-fed ponds exhibited encouraging results. An experiment of twelve months duration on the large scale culture of *Tilapia mossambica* in a sludge pond (0·076 ha) located at the out-yard of the Titagarh Sewage Treatment Plant, Rahara, Khardah was conducted from August, 1974. The pond was initially fertilised with 1,67,200 litres of domestic sewage as pre-stocking management which in course of time, was diluted with freshwater, maintaining the rate of dilution of sewage : water as 1 : 3.1. The pond was stocked with *T. mossombica* (average size : 94 mm/14·3 g) @ 17,000/ha in the combination of 4 males : 6 females. No supplementary feeding was resorted to. Only management measure applied was to irrigate the pond adequately with sewage effluent (18,000-40,000 litres/day) at periodic intervals. For the monsoon months, the discharge of the sewage was required to be increased with a view to maintain the homogeneity of the effluent content of the pond. The dissolved oxygen content and the B. O. D. values of the pond water were observed to vary between 2·4 & 6·4 ppm, and 13·5 & 28·8 ppm respectively. The breeding of the species was observed to take place throughout the year except for December and January. Harvesting was done at periodic intervals and an estimated yield of 9,350 kg/ha of *Tilapia* could be achieved in a year. Periodic harvesting, natural replenishment of the stock due to repeated breeding of the species and fertilistion of the pond with high doses of sewage effluent are the prime factors responsibile for high production of *T. mossambica.*

Mixed culture of carps in a sludge pond with domestic sewage effluent : Experiment on the polyculture of Indian major carps and exotic carps was initiated in a sludge pond (0·17 ha) of the Titagarh Municipality at Khardah, West Bengal. Initial manuring of the pond was done with 7,80,000 litres of domestic sewage effluent which was latter diluted with rain/freshwater, the rate of dilution of sewage : water being about 1 : 2. While the stocking of the pond with *Catla catla, Labeo rohita, Cirrhinus mrigala* and *Cyprinus carpio* (common carp) was done in the month of August, 1975, the fingerlings of silver carp, *Hypophthalmichthys molitrix*, were introduced at the end of October, 1975. The composition of the stocking material was : catla 31·2%, rohu 17·5%, mrigal 36·7%, common carp 7·9% and silver carp 6·7% at a stocking density of 24,000 fingerlings/ha. *C. carpio* showed an interesting increment in the weight (567·0 g) within four months of culture and was followed by *L. rohita* (225·5 g), *C. catla* (127·1 g) and *C. mrigala* (118·8 g). *H. molitrix* attained 33·0 to 220·0 g within two months rearing. The experiment is in progress.

Analysis of the pond water was continued. The dissolved oxygen

content and BOD values of the water were found to fluctuate between 1·1 & 4·0 ppm. and 9·4 & 24·5 ppm respectively.

Project 19 : Hilsa fisheries

Problem	: 19·1	(Research work completed in 1973)
Problem	: 19·2	(Research work completed in 1974)
Problem	: 19·3	(Research suspended)
Problem	: 19·4	(Research work completed in 1973)
Problem	: 19·5	(Research work completed in 1973)
Problem	: 19·6	(Research suspended)

Problem	: 19·7	Apprisal of the present status of hilsa fishery of the lower stretch of the Ganga River system
Personnel	:	B. L. Pandey, S. K. Wishard (from 23.6.75) S. N. Sar and R. C. Singh
Duration	:	Four years

Estimated fish landing from the lower stretch of the Ganga River System based on sampling done at Bhagalpur, Sahibganj, Rajmahal, Farakka and Dhulian Fish Assembly centres on the river Ganga and Lalgola on the river Padma was 144·67 t against 279·99 t of the preceding year, thus showing a decrease by 49·40%. Farakka (17·54 t), Dhulian (21·62 t) and Lalgola (99·52 t) located below Farakka Barrage were highly productive contributing 97·89% of the total production. Bhagalpur, Sahibganj and Rajmahal accounted for 0·06, 0·11 and 2·82 t only. The production at individual centres during July-October was responsible for the bulk of the catches from the entire strech, in which Farakka, Dhulian and Lalgola centres contributed 79·20%. *Hilsa ilisha* measuring less than 180 mm were not available in the catches at Sahibganj, Farakka, Dhulian and Lalgola, while the catches at Bhagalpur in the month of September (100·00%) and at Rajmahal in April (22·26%) comprised juveniles only.

Segmentation of catches into individual subpopulations revealed that the 'slender' variety dominated at Bhagalpur, Sahibganj, Rajmahal and Dhulian forming 84·58, 93·81, 63·19 and 41·00% respectively by weight, while 'broader' variety dominated at Farakka and Lalgola forming 49·25 and 40·77% respectively.

Problem : 19·8 Culture of *H. ilisha* (Ham.) in confined freshwaters

Personnel : J. C. Malhotra, K. L. Shah, K. P Srivastava and Krishna Chandra

Duration : Five years

Due to low magnitude of *H. ilisha* runs, the investigations could not be taken up during the year at any of the desired sites in the Ganga river system.

Problem : 19·9 Fluctuations in the hilsa fisheries of the Hooghly and Roopnarayan estuaries

Personnel : K. K. Ghosh, D. D. Halder, P. B. Das and G. P. Bhattacharya

Duration : Three years

Hilsa landing in the freshwater zone of the Hooghly estuary have been estimated at 7,740 kg during winter from November to February, 21,852 kg during premonsoon months from March to June and 27, 784 kg, the monsoon catch from July to October. The larval abundance at Kalna in the shooting net collections was observed as 500/net/hr during May and 218/net/hr during October in the two main breeding seasons of hilsa.

Project 20 : Water pollution investigations

Problem : 20·1 (Research work completed in 1973)

Problem : 20·2 Pollution effect on aquatic bio-mass in different river systems of India by various sources

Personnel : R. S. Panwar, H. C. Joshi, D. Kapoor, Peer Mohamed and R. A. Gupta

Duration : Three years

Short (24 hr) and long (96 hr) term bio-assays were carried out using biocides like, Endrin, DDT, r-BHC, Malathion, Ethyl parathion and Rogor. Fish and different fish food organisms were used as test animals for the experiments under static and continuous flow conditions. TLm values of these biocides with cladoceran *(Daphnia carinata)* and gastropod *(Viviparus bengalensis)* under static conditions as determined by probit technique were as follows.

Test animal	Period of exposure (hr)	Temperature (°C)	TLm Value (ppm) Endrin 20 EC	DDT 25 EC	r-BHC 20 EC	E. parathion 50 EC	Malathion 50 EC	Rogor 30 EC
D. carinata	24	20±1	0·176	0·119	0·432	0·432	-	-
		27±1	0·153	2·2 $\times 10^{-2}$	0·369	1·32 $\times 10^{-3}$	4·11 $\times 10^{-2}$	0·398
		30-31	8·3 $\times 10^{-2}$	1·39 $\times 10^{-2}$	0·213	1·11 $\times 10^{-3}$	2·58 $\times 10^{-2}$	0·2774
	24	23-25	1·683	2·265	2.595	2·129	13·81	15·93
V. bengalensis								
	96	23-25	0·610	1·390	1·486	0·787	6·14	-

It was observed that regression of the probit values and logarithm of concentrations were highly significant which exhibited the evidence of extremely close correlation between the concentration and response.

TLm value of DDT, r-BHC and Ethyl parathion with *V. bengalensis* were 3·14, 3·91 and 2·98 ppm (24 hr) and 2·18, 2·16 and 1·76 ppm respectively under continuous flow condition.

For each experiment hydrological observations were recorded.

Bioassays were also performed with fry of major carp, *L. rohita* (size 35-45 mm) and Bivalve *(Parreysia favidens)* using r-BHC biocide under static condition.

Puntius sophore and *Labeo rohita* showed 60 and 40% survival respectively in 16 days when they were exposed to water collected from Amreeha Fish Pond, treated with 20 kg of r-BHC for protection of trapa.

Probit technique was also followed for calculating TLm values of different biocides with *Trichogaster fasciatus* and *Chironomus* larvae as test animals under static conditions. The results are as follows.

Test animal	Period of exposure (hr)	Tempera-ture 0°C	Endrin 20 EC	DDT 25 EC	r-BHC 20 EC	E. para-thion 50 EC	Mala-thion 50 EC	Rogor 30 EC
Chironomus larvae	24	28-29	$1{\cdot}296 \times 10^{-2}$	$7{\cdot}465 \times 10^{-2}$	$3{\cdot}88 \times 10^{-2}$	$8{\cdot}7 \times 10^{-5}$	$3{\cdot}76 \times 10^{-2}$	$4{\cdot}02 \times 10^{-2}$
T. fasciatus	24	30-32	0·0437	0·2631	0·1583	0·7835	3·35	-
	96	30-32	0·0416	0·1231	0·1460	0·4296	2·09	-

Problem : 20·3 Studies on estuarine pollution with reference to pulp and paper and tannery wastes

Personnel : B. B. Ghosh, S. B. Saha and M. M Bagchi

Duration : Four years

Pollutional effect on the primary productivity was studied around the effluent discharge points of Titagarh Paper Mills No. 2, Kankinara (sulphate process) and Tribeni Tissue, Tribeni (soda process) using BOD technique. The *in-situ* study (initiated in January, 1975) was made during low water level under different tidal phases.

The gross primay production (nil-68·7 mg C/m³/hr) was found to be much affected around the discharge points of Titagarh Paper Mills No. 2 when compared with that (nil-198·1 mg C/m³/hr) of Tribeni Tissue. The tidal phase played an important role in influencing the pollutional effect. In both the cases, the pollutional effect was found more during the neap tidal phase when compared with that of spring or bore tidal phase which was also corroborated by the chemical condition like oxygen consumed. In June, the primary production was found in the range of 2·0-8·9 mg C/m³/hr during neap tidal phase whereas during bore tidal phase it was in the range of 11·5-58·3 mg C/m³/hr around the outfall of Titagarh Paper Mills No. 2. The production started to decline since May and no production was noted in August particularly during neap tidal phase while a value of nil-14·6 mg C/m³/hr was noted during bore tidal phase around the outfall of Tribeni Tissue. The recovery of primary production from the adverse effects below the outfall took place at a longer stretch (beyond 0·5-1·0 km) below the outfall during spring or bore tidal phase.

The low primary production during July-October and high during post monsoon months (November-February) were noted around both the outfalls.

The adverse effect on the chemical conditions recovered within 0·5-1·0 km

from the discharge points whereas the effects on the primary production and plankton extended beyond 0·5-1·0 km below the outfall.

Problem : 20·4 Investigations on Hooghly estuarine eco-system to determine biological indicators of its water quality
Personnel : S. B. Saha
Duration : Two and half years

Surface plankton analysis indicated dominance of phytoplankton over zooplankton at both the centres - Tribeni and Kankinara, ratio being phyto-plankton : zooplankton as 10 : 1. Phytoplankton mainly comprised diatoms *viz., Melosira graulata* and *Coscinodiscus* spp. Zooplankton was mainly composed of rotifers *(Brachionus* spp., *Keratella* spp. & *Filinia* sp.*)* and various crustacean naupliar forms.

Tow peaks *viz.*, premonsoon (minor-50/l) and winter (major-95/l) were observed in plankton fluctuations. The minimum number (6/l) of plankters were observed at the outfall area and the maximum numbers (105/l) at the centres above the outfall area, with a few exceptions.

Distribution of benthic organisms was poor and irregular at both the centres. Near the outfall area the benthic population was almost nil.

Due to fluviatile conditions and tidal vigines both phyto and zooplankters get mixed up and distributed along the sampling area. As such, no definite species indicative of pollution was observed. Pollutional effects appeared to be more quantitative than qualitative.

Problem : 20·5 Biological indicators of water quality in the Ganga and the Yamuna river ecosystem at Allahabad
Personnel : S. N. Mehrotra and B. C. Jha
Duration : Four years

Observations on the Ganga and the Yamuna river ecosystems were continued. The data indicatad that the wastes have high OC value at the outfall areas (21·6-31·2 ppm in the Yanuna and 10-22·4 ppm in the Ganga) whereas the centres above and below the outfall areas denoted comparatively low values. pH at the outfall areas ranged between 7·6 & 8·0 in the Yamuna river and 7·4 & 8·0 in the Ganga river. The zones above and below the outfall areas in both the rivers indicated slightly higher pH (7·6-8·3). Alkalinity at the out fall areas varied from 90 to 260 ppm in the Yamuna river and 110-140 ppm in the Ganga river. DO at the outfall areas ranged between

4·0 & 7·6 ppm in the Yamuna river and 2·0-7·2 ppm in the Ganga river. DO at other points were high in both the rivers. CO_2 at the outfall area ranged between 9·4 & 16·0 ppm in the Yamuna river and 6·0 & 11·2 ppm in the Ganga river. Other points showed either low concentrations or absence of free CO_2 in both the rivers. Chloride at the outfall areas ranged between 26 & 36 ppm in the Yamuna river and 6·4 & 9·6 ppm in the Ganga river. Of the nutrients, both nitrate (0·18-0·34 ppm in the Yamuna and 0·13-0·4 ppm in the Ganga) and phosphate (0·2-0·28 ppm in the Yamuna and 0·11-0·36 ppm in the Ganga) showed high concentrations at the outfall areas as compared to the areas above and below the outfall areas. Primary productivity around the points of discharge ranged between 0 & 135 mg $C/m^3/hr$ in the Yamuna river and 0 & 150 mg $C/m^3/hr$ in the Ganga river.

Monthly plankton and bottom biota samples were collected from the rivers Ganga and Yamuna at three points ("Above"; "at" and "below" the outfalls).

River Ganga-Above the outfall : Phytoplankton dominated the zooplankton. Bacillariophyceae and and Chlorophyceae fromed the dominant phytoplankton group except in the summer months when the Chlorophyceae was replaced by Myxophyceae. Zooplankton was represented by rotifers, nauplii and cladocerans. Bottom biota were represented by a few molluscan species and chironomid larvae.

At the outfall : The water at the "outfall area" was highly turbid due to sewage discharge. Phytoplankton dominated the zooplankton. Bacillariophyceae and blue-green algae were prominant. Chlorphyceae were less in abundance as compared to that in the "area above the outfall". Mats of blue-green algae were observed at the bottom during spring time. Zooplankton was less abundant as compared to that in the "area above the outfall" and only the protozoans formed the bulk of the same. Chironomid larvae and other insect larvae were in abundance whereas molluscs were rarely encountered.

Below the outfall area : Bacillariophyceae (*Nitzschia* sp., *Calonis* sp., & *Gomphonema* sp.) were observed throughout the year. Chlorophyceae (*Shigerelonium* sp., *Oedogonium* sp., *Harmedium* sp., *Pandorina* sp., and *Chloracocen* sp.) were conspicious. Blue-green algae *(Oscillatoria* sp. , *Spirulina* sp. & *Schytonema* sp.) were also observed in large quantitites. Watermolds were encountered in good but were in lesser concentration than at the "outfall area'. Zooplankton mainly comprised protozoans, nauplii of copeoods, cladocerans, and rotifers. Chironomid larvae and other insect larvae and were in greater

abundance than at the above two centres However, no mollusc was encountered.

River Yamuna-Above the outfall area : Bacillariohhyceae were dominant being followed by Chlorophyceae and Myxophyceae. Red or brown algae were also encountered at times. Watermolds were rare. Zooplankters were represented mainly by rotifers, copepods and protozoans. Molluscs were in good numbers at the bottom. Chironomid larvae and other insects were also encountered at times.

At the outfall area : The water was blackish in appearance with huge bubblings at the bottom and was highly turbid. Plankton was poorly represented. Species of Bacillariophyceae were the dominant microflora and protozoans were the dominant zooplankters. Molluscs were practically absent. Chironomid larvae were encountered but rarely.

Below the outfall area : Phytoplankters were dominant over zooplankters. Bacillariophyceae formed the dominant microflora. Myxophyceae were also encountered. Chlorophyceae were not in abundance. Watermolds were also frequently observed. Zooplankton was poor and only comprised protozoans and a few copepod species. Bottom biota comprised dead molluscan shells, chironomid larvae, other insect larvae and egg mows. These were frequently observed during the summer months.

Problem : 20·6 Effects of biocides on the physiological activities of aquatic animals

Personnel : M. Peer Mohamed, R. S. Panwar, D. Nath. G. N. Srivastava and R. A. Gupta

Duration : Three years

Experiments wese conducted to study the effect of sub-lethal DDT and Ethyl parathion on the standard metabolism of *C mrigala*, *L.* rohita and *T. fasciatus* at different temperatures. Modified Fry's Respirometer was used for the present study. The sub-lethal concentration selected for the study was 0·02 ppm. The results obtained are as follows.

Test animals	Standard Metabolism at 20°C (mg/kg/hr)			
	Control fish and control fish medium	Control fish and treated fish medium (0·02 ppm DDT)	24 hr ex-pesure and test in treated medium (0·02 ppm)	48 hr exposure and test in treated medium (0·02 ppm)
C. mrigaia (av. l/wt : 44 mm/1·9 g)	65·8	82·4	96·0	153·7
L. rohita (av. l/wt : 59mm/1·9g)	74·6	80·2	98·9	131·0
T. fasciatus (av. l/wt : 7·10 mm/3·1 g)	68·3	83·3	97·5	120·8

The results indicated that probably, excitement is effective *vice* the central nervous system causing increased muscle-tone and subsequently increased rate of oxygen consumption.

Another set of experiments was conducted to study the long term effect of sub-lethal doses of DDT. Observations on the effects of sub-lethal DDT (0·01 and 0·02 ppm) on survival and metabolism of giant gourami, *T. fasciatus* at room temperature (18·5 to 30·5°C) and constant temperature (30° ± 1°C) have been made. The onset of mortality was observed after 48 days at room temperature and the percentage of mortality remained the same in both the concentrations. However, at controlled temperature (30° ± 1°C) the first sign of mortality occured after 24 days and after 17 days in concentrations of 0·01 and 0·02 ppm respectively. Observations on the metabolism of the experimental animals showed that the sub-lethal DDT increased the metabolic rate resulting in an energy waste.

Problem : 20·7 Bioassy of selected industrial wastes disposed into the Hooghly estuary

Personnel : P. Ray, K. K. Ghosh, B. B Ghosh and M. M. Bagchi

Duration : Three years

A new design for conducting the bioassay work was made. The work is in progress since December.

Project 21 : Fisheries of river basins

Problem : 21·1 & 21·2 (Research suspended)

Project 22 : Fish culture in running water

Problem : 22·1 (a) Carp culture in running water in the Ganga
Personnel : G. N. Mukherji (from 10.4.75) A. G. Jhingran, S. N. Mehrotra, Shree Prakash and R. K. Saxena
Duration : Three years

Cage culture experiments using four nylon cages were conducted at Phaphamaughat in the river Ganga. Two types of feeds *viz.*, (1) rice bran and mustard oilcake in the ratio of 1 : 1 and (2) rice bran and linseed oilcake in the same proportion were given as artificial feeds. The feeds were inoculated with mineral TMS and common salt @5% of their weight.

Cage No. 1—Cirrhinus mrigala fingerlings (length and weight range : 126-180 mm/20-45 g) were stocked @ 22/m^3 area and fed with feed No. 1. After 30 days of rearing, an average increment of 32·0 mm/10·28 g was observed.

Cage No. 2—Labeo rohita fingerlings (length and weight range : 101-145 mm/10-30 g) were stocked @ 42/m^3 area of cage and fed with feed No. 2 After 30 days rearing the average increment in length and weight was 3·38 mm/1.66 g. An equal number of *C. mrigala* fingerlings (151-180 mm/35-45 g) were introduced in the cage and reared for another 30 days. During the period of mixed rearing, *L. rohita* gained 9·12 mm/2·96 g while *C. mrigala* exhibited an increment of 9·00 mm/9·77 g.

Cage No. 3—L. rohita (11-130 mm/2-20 g), *C. mrigala* (96-130 mm/10-20 g) and *C. carpio* (71-135 mm/10-25 g) were stocked in the third cage and fed with feed No. 2. After 60 days of rearing the average gains recorded were 31·22 mm/5·46 g, 31·15 mm/9·29 g, 55·77 mm/34·23 g respectively.

Cage No. 4—73 fingerlings of *L. rohita* (61-130 mm/5-25 g), *C. mrigala* (96-155 mm/10-30 g) and *C. catla* (101-170 mm/14-70 g) were stocked

and were provided with feed No. 1. After 30 days of rearing, they exhibited average increments in length and weight as 9·45 mm/11.07 g, 9·09 mm/3.34 g and 12·60 mm/5·56 g respectively.

Problem : 22·1 (b) Carp culture in running water in the river Brahmaputra
Personnel : R. Chandra and S. C. Pathak
Duration : Six months

Work during the year could not be initiated because of shortage of working materials and other accessories.

Problem : 22·2 Catfish culture in running waters
Personnel : S. P. Singh, J. C. Malhotra, K. P. Srivastava, R. N. Seth and Krishna Chandra
Duration : Three years

The fry of *M. seenghala* (size range : 12-30 mm) collected from the breeding pits were transported to the laboratory and were kept in 10 litre glass jars and plastic pools, after giving a bath of 1 ppm Acriflavin. Several feeds were tried which consisted of boiled goat liver and spleen, fish flesh and chironomid egg mass, besides plankton. The artificial feed tried was : Shrimp powder, rice bran & ground-nut oilcake, powdered and mixed in the ratio of 2 : 1 : 1. TMS feed supplement and vitamins were added to this feed. It was, however, observed that the chironomid egg mass and zooplonkton was preferred most by the fry in the early part of rearing. The boiled fish flesh and raw fish cut into small pieces were most accepted feed in the later part of the rearing. The maximum length attained by the fry of *M. seenghala* till November was 136 mm.

The fry and fingerlings, during the course of rearing were infected with *Saprolegnia* sp. and *Achyla* sp. besides protozoans causing mortality. Treatment with one ppm $KMnO^4$ and 1 ppm salt solution could control the infection.

Monoculture in cages : The experiment to culture pabda *(Ompok bimaculatus)* in floating cage (1 × 1 × 1 m) in the river Ganga at Phaphamaughat was initiated on 3.5.75. 25 specimens of *O. bimaculatus* (size range : 110-222mm/ 5-50 g) obtained from Dhanraul reservoir (Mirzapur district, U. P.) were stocked in the cage.

Supplementary feeding was done @ 5% of body weight twice a day. Live minnows were introduced during early part of the experiment in the cage. The feed comprised protein 36·2%, carbohydrate 21·6%, fat 10·5% besides minerals and vitamins and TMS feed supplement.

During 60 days of the culture, the average increment in weight was 15·2 g/fish. The calculated increment in weight for 100 fish comes to approximately 9 kg/m³/yr as against 7 kg/m³/yr during the experiment in 1974, the survival being cent percent.

The experiment had to be suspended on 4. 7. 1975 due to heavy floods in the river Ganga, when it was no more possible to keep the cages in the running water at the site.

Suitability of cage size and material were studied. The floating type nylon cage (1 × 1 × 1 m) was found more suitable for cage culture experiments.

Project 23 : Bundh breeding

Problem	: 23·1 (a)	Bundh breeding of major carps in Uttar Pradesh
Personnel	:	S. J. Karamchandani, A. G. Jhingran, G. N. Mukherjee, D. Nath and M. D. Pisolkar
Duration	:	Four years

Mau dry bundh : Observations on mateorological, physical, chemical and biological factors in connection with bundh breeding of major carps were undertaken in Mau dry bundh near Beohari in Shahdole district in Madhya Pradesh during July-August, 1975.

Over 95 breeders of *Labeo rohita* measuring 285-415 mm in length and weighing 250-700 g, were stocked in Mau dry bundh in two batches in the ratio of 2♂ : 1♀ and 1♂ : 1♀ on 26.7.75 and 2.8.75 respectively. Breeding of rohu took place on 27.7.75, 3.8.75 and 5.8.75 between late hours in night, and early hours of mornings. In all, 15 lakhs of fertilised eggs were collected. The breeding in the bundh followed after a few hours of heavy rain in the vicinity and consequent addition of fresh rain water in the bundh drained from the adjoining areas. The rains in the catchment area did not bring sufficient water in the bundh so as to cause appreciable water current. The water level in the bundh at the time of introduction of breeders and during breeding was 1 to 1·5 m in the deepest region. The water level in the bundh was 1·5 to 2 m below the level of waste weir, whereas it was just touching the channel leading to sluice gate

which was not opened at any time during the period of observations. The breeding took place 1 m away from the water edge in the shallow areas of the bundh (with the depth varying from 0·25 to 0·50 m), just below the waste weir near the sluice gate and at a site opposite to the sluice gate. At these sites, water got drained from the embankment of the bundh, comparatively in larger quantities. Thus at the spawning sites there was mixing of large quantities of freshwater (rain) with the pre-existing water of the bundh.

Observations on physico-chemical conditions of the water made before, during and after the breeding of rohu in Mau dry bundh revealed that the values of air temperature (25·5°C), water temperature (28·0°C), pH (6·2), dissolved oxygen (5·3-5·2 ppm), free carbon-di-oxide (10-16 ppm), alkalinity and hardness were low during the breeding period. The water was fairly turbid (4·0 cm), as indicated by secchi disc.

During premonsoon months, survey of eight existing dry/wet bundhs and one newly constructed dry bundh was undertaken for taking up detailed observations on meteorological, physical, chemical, and biological factors in some of them during monsoon season in order to elucidate the factors which influence the spawning of major carps in dry/wet bundhs.

Problem : 23·1 (b) Bundh breeding of major carps in South Bihar
Personnel : S. P. Singh, R. C. Singh and B. L. Panday
Duration : Four years

District Singbhum was surveyed in South Bihar to locate suitable sites for bundh breeding. No sites, however, was found suitable in the vicinity of already existing bundhs *viz.*, Tonto, Ghagheri, Hemsagar and Jamuna. It was observed that the above mentioned bundhs were at low depression of great magnitude and the water level was far below the waste weir. Natural breeding of major carps had been reported from none.

A paddy field 0·05 ha in area, in the village Tonto near Chaibasa was selected for bundh breeding experiments. The site was ploughed, levelled and bunded on four sides. Inlet and outlet were provided. This dry bundh was fed with cannal water and breeders of rohu and mrigal were introduced in the ratio of 1 : 2.

A mild current and steady water level of 75 cm was maintained in the bundh. Since breeding did not take place on the two consecutive days follow-

ing the release of the breeders, pituitary gland extract @ 2 and 4 mg/kg body weight of males and females respectively was administered in a single dose. Breeding took place in the early morning and 16,250 ml *i. e.*, 3,73,750 eggs (@ 23 eggs/ml) were collected from the bundh of which 93·6% were fertilised. These were handed over to the District Fisheries Officer, Chaibasa. Bundh breeding of major carps was thus accomplished for the first time in Bihar.

Breeders were examined and it was found that mrigal and rohu had bred but grass carp did not respond.

Project CFCSP ; Coordinated Research Project on Composite Fish Cultnre and Fish Seed Production

Problem : CFCSP 1 Composite fish culture and fish seed production

Personnel : V. R. P. Sinha, M. V. Gupta, K. K. Sukumaran, H. A. Khan, R. M. Rao, M. Y. Kamal, K. N. Krishnamurthy, K. Alagaraja, K. K. Ghosh, M. Sinha, D. V. Pahwa, B. N. Singh, K. G. Rao, J. B. Rao, D. P. Chakraborty, Balbir Singh, P. M. Mathew, Dhirendra Kumar, B. C. Tyagi, P. K. Saha, D. N. Misra, P. K. Aravindakshan and B. K. Singh

Duration : Four years

At Poona centre, the six species combination *i. e., C. catla* 1 : *L. rohita* 1 *C. mrigala* 1 : *H. molitrix* 4 : *C. idella* 1·5 : *C. carpio* 2·5 at a stocking density of 6,000 fingerlings/ha gave a net production of 5,160 kg/ha/6½ months. The four species combination of *C, catla* 4 : *L. rohita* 1 : *C. mrigala* 1·5 : *C. carpio* 3·5 at the same stocking density yielded 2,460 kg/ha/8 months. Similarly 6 species combination *i. e., C. catla* 1 : *L. rohita* 1 : *C. mrigala* 1·5 : *H. molitrix* 2·5 : *C. idella* 1·5 : *C. carpio* 2·5 at a stocking rate of 6,000/ha at Jaunpur centre gave net productions of 5,535-7,748 kg/ha/18 months, whereas the four species combination of *C. catla* 3·5 : *L. rohito* 1·5 : *C. mrigala* 2·0 : *C. carpio* 3·0, with the same stocking density yielded 5,350 kg/ha/18 months. At Kalyani centre, the net production obtained with a stocking density of 7,000 fingerlings/ha with ratio of *C. catla* 1 : *L. rohita* 0·5 : *C. mrigala* 1·5 : *H. molitrix* 2·5 : *C. idella* 2·0 : *C carpio* 2·5, was 5,737 kg/ha/yr whereas, at Bhavanisagar, the gross productions were 2,203-2,754 kg/ha/yr at a stocking density of 6,000 fingerlings/ha. Net productions up to 7,284 kg/ha/8 months

have been obtained at Karnal centre with a stocking density of 4,750 fingerlings/ha in the ratio of *C. catla* 1 : *L. rohita* 1 : *C. mrigala* 1 : *H. molitrix* 2·5 : *C. idella* 2·0 : *C. carpio* 2.5.

Successful breeding of Indian and exotic carps has been achieved at different centres of the project. Silver carp at Gauhati & Bhavanisagar, and grass carp at Poona were bred for the first time.

Problem : CFCSP 2 Bundh breeding of silver carp, *Hypophthalmichthys molitrix* and grass carp, *Ctenopharyngodon idella*

Personnel : V. R. P. Sinha, B. K. Sharma and M. V. Gupta

Duration : Two years

Breeders of silver carp *(Hypophthalmichthys molitrix)* were transported from Kalyani to Simlapal in June, 1975. These fishes along with the grass carp *(Ctenopharyngodon idella)* transported in the previous year were shifted from the pond to the dry bundh on the 20th of July, 1975. Since the monsoon during the year was very much delayed and the rains were scanty, the breeding could not be undertaken till the 1st week of August, 1975. Ova of silver carp and grass carp were examined using catheter on the 2nd of August and most of them were found in regressing stage. However, an attempt to breed the fishes was made on the 4th of August. Three females and five males of each silver carp and grass carp were injected with pituitary extracts. All the silver carps bred profusely and 72 l of eggs were collected. Grass carp did not breed. The eggs were kept for hatching. Hatching was normal but all the hatchlings died after a few hours of hatching.

Problem : CFCSP 3 Reproductive physiology of Indian and Chinese carps

Personnel : V R. P. Sinha, M. V. Gupta, M. R. Sinha, B. K. Sharma and B. N Singh

Duration : Two years

Electrical conductivity of water samples collected fortnightly and monthly from Kulia fish farm (4 ponds, bheel and shallow tube well), Anjana fish farm of Krishnanagar (6 pond), the river Hooghly at Barrackpore and the pond in the office campus were studied during the year. The electrical

conductivity was observed to be lowest in case of river water followed by that of Krishnanagar and then of Kulia. The electrical conductivity was generally low at all the places during monsoon season.

Problem : CFCSP 4 Efficacy of Brahmaputra silt as a fertiliser in composite fish culture
Personnel : V. R. P. Sinha, Ravish Chandra and K. G. Rao
Duration : Two years

Work during the year could not be initiated because of the shortage of ponds. However, this work will be taken up in 1976.

Problem : CFCSP 5 Feeding inter-relationship of fishes in composite fish culture
Personnel : M. V. Gupta, V. R. P. Sinha, Balbir Singh and K. K. Bhanot (Smt.)
Duration : Three years

Investigations could not be initiated due to non-availability of working material. Hence the problem is discontinued.

Problem : CFCSP 6 Biology and role of grass carp, *Ctenopharyngodon idella* in composite fish culture
Personnel : M. V. Gupta
Duration : Three years

One of the experimental pond (0·15 ha) was dewatered completely to harvest the fish of the previous experiment. After harvesting was completed water was pumped into this pond to a level of 15-20 cm. At this level plants (*Hydrilla* sp. and *Ceratophyllum* sp.) were planted in the pond. In a few days time when the plants were established, water was pumped to a depth of 76·2 cm into the pond. The fingerlings were stocked in the pond after the plants have fully grown. 93 fingerlings of grass carp (*Ctenopharyngodon idella*) of average weight 82·6 g were stocked in the pond. These fingerlings consumed all the weeds present in the pond within seven weeks and attained an average weight of 748 g within the period. No weed from outside was supplied.

Problem : CFCSP 7 Effects of oxygen, carbon dioxide and temperature on the metabolism and assimilation of feed in certain Indian and Chinese carps

Personnel : B. N. Singh, V. R. P. Sinha, M. V. Gupta and D. P. Chakraborty

Duration : Two years

The nutrition and growth of fingerlings of mrigal (*Cirrhinus mrigala*) were studied in the aquaria in laboratory conditions in relation to carbohydrate and fat diets. The results obtained on acceptability of feeds, absorption efficiency and on assimilation & conversion efficiencies were found to be very significant. These results suggest that carbohydrate diets are better than high energy containing fat diets, for this fish in aquarium experiments largely because of its better acceptability and high rate of assimilation. These experiments have also shown that all the above mentioned factors responsible for maintenance and growth are adversely affected if O_2 concentration in water falls below a certain critical level.

Problem : CFCSP 8 Composite fish culture without fertilisation and feeding

Personnel : H. A. Khan and D. N. Misra

Duration : Three years

Seven ponds were stocked with *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio* in ratio of 1 : 1 : 1·5 : 2·5 : 1·5 : 2·5 respectively at a stocking density of 6,000/ha. One pond was kept as control without feeding and fertilisation against two ponds with fertilisation but without supplementary feeding, two ponds with supplementary feeding but without fertilisation and two ponds with feeding and fertilisation, both. Investigations relating to the growth of fishes and water and soil qualities of ponds are being carried out.

Problem : CFCSP 9 Composite fish culture in running waters

Personnel : K. N. Krishnamurthy and P. K. Arvindakshan

Duration : Three years

A pond of 0·03 ha with running water facilities was stocked with *C. catla, H. molitrix, C. mrigala, C. carpio, C. idella* and *Channa* spp. in the ratio of 1 : 3 : 6 : 3 : 4 : 3 at a stocking density of 10,000/ha. The fishes were fed

with ground-nut oilcake and rice bran in 1 : 1 ratio at 2% of their body weight. The pond was not fertilised. Grass carp was fed with hybrid napier grass @ 1% of body weight. The average weights attained by different species in six months rearing were 360 g for *C. catla*, 143 g for *H. molitrix*, 330 g for *C. mirgala*, 440 g for *C carpio* and 221 g for *C. idella*. The standing crop at the end fo 6 months rearing period was estimated to be 2,233 kg/ha.

Problem : CFCSP 10 Operational research project on composite fish culture

Personnel : V. R. P. Sinha. B. K. Sharma, A. Mukherjee and J. C. Markandey

Duration : Four years

After the completion of the first set of experiments in August, 1974, the second set of experiments could not be initiated till December, 1974, as the fish farm got inundated due to heavy flooding. The bundhs were temporarily repaired and after preparing the ponds, the stocking for the second experiment was done in February/March, 1975. The ponds got flooded again in July, 1975 and the bundhs were heavily damaged. Consequently certain stocked fishes escaped into the adjoining ponds. As the earth for the repairs of bundhs was not available, it was decided previously with the State Fisheries to harvest the entire stock and then dewater the ponds for taking out earth for repairing of bundhs. Harvesting was started in December, 1975 and over 9,700 kg of fish could be harvest. The earth for the repairing of bundhs was arranged form the adjoining field and as such it was decided to continue the experiment by replenishing the escaped and harvested stock.

Problem : CFCSP 11 Biology of the silver carp, *Hypophthalmichthys moltrix* (C & V) and its performance in composite fish culture

Personnel : B. K. Sharma and V. R. P. Sinha

Duration : Two years

Ovaries from mature specimens were preserved for fecundity estimations. Different stages of embryo (from fertilised eggs up to hatchling) were preserved for developmental studies. The investigation on growth was continued. The feeding relationship with other component species is also being investigated.

Problem : CFCSP 12 The pituitary-gonad feed back relationship in *Mystus vittatus* (Bloch)

Personnel : A. Mukherjee and V. R. P. Sinha

Duration : Two years

Hypophysectomy has been carried out in male & female *Mystus vittatus*, and testes & ovaries of hypophysectomized fish have been fixed at regular inter als for further examinations.

Hemicastration has been done in male & female *M. vittatus*, and the compensatory activity of the remaining gonads are under study.

Pituitary and gonads of *M. vittatus* have been fixed at regular intervals and the seasonal changes in their histophysiology is under study.

Piablem : CFBSP 13 Composite fish culture for demonstration to the fish farmers

Personnel : P. Das, M. Sinha and D. Kumar

Duration : One year

Indian major carps, Catla *(C. catla)*, rohu *(L. rohita)* and mrigal *(C. mrigala)* were cultured in the Nilganj pond with a view to demonstrating the production potential of Indian major carps alone with the same technology as evolved for six species culture and the methodology of the composite fish culture. The pond was stocked @ 7,500 fingerlings/ha in the species ratio of C 3·5 : R 3·5 : M 3·0. Manuring was done with both organic and inorganic fertilisers *viz.*, lime @ 584 kg/ha/yr cow dung @ 6,500 kg/ha/yr, ammonium sulphate @ 403 kg/ha/yr, single superphosphate @ 297 kg/ha/yr and muriate of potash 43·0 Kg/ha/yr in several instalments. Supplementary feeding was done daily with a mixture of mustard oilcake and rice bran @ 1-2% of the body weight. Six demonstrations on application of lime stocking of pond with fingerlings, supplementary feeding, application of organic manure, application of inorganic fertilizers, growth of fishes in 10 months rearing and partial harvesting were arranged for the fish farmers during the course of work.

A total of 171.86 kg fish and 76 Kg of prawn *(P. lamarrei)* have been harvested from the pond and thus the goss and net productions work out to be 5,564·45 and 5,153·62 kg/ha/15½ months respectively. The expenditure incurred towards feed, fertilizers, fingerlings and netting etc. was

Rs. 4,077·50 for the year. On the basis of this, the cost of production of one kg of fish was calculated to be Rs. 2·28 only.

Problem	: CFCSP 14	Techno-economic and socio-economic aspects of massive fish seed production for composite fish culture
Personnel	:	V. R. P. Sinha and K. K. Ghosh
Duration	:	Two years

Data on economics and adoption of different techniques are being procured. It is gathered from available reports that there are about 6,000 private spawn collecters In Orissa and about 18,000 in West Bengal & Bihar. Further data are being collected.

Problem	: CFCSP 15	Statistical evaluation of some growth parameters and their confidence intervals
Personnel	:	K. Alagaraja
Duration	:	Two years

Evaluation of production functions was taken up. Production functions and their variance functions were found out. Some of the production functions and their variance functions are given. in appendix 1

The first production function is recommended for its simplicity in its form and variance function. The variance function for the second production function though considered earlier by many workers, is given now in its complete form whereas in the available literature the covariance factor was not given The variance function for the third production function was not available in the literature. This is developed here. Few more production functions along with their variance functions are also developed.

Problem	: CFCSP 16	Evaluation of fish production and loss due to poaching from cultivated resources
Personnel	:	K. Alagaraja and V. R. P. Sinha
Duration	:	Three years

During 1975, clipping experiments were conducted at Kalyani and the total number of fish in the pond was estimated. Estimation of total number could be done from three months data only. Later, due to quick regeneration of clipped fins, it was found difficult to differentiate clipped ones from the rest.

Problem : CFCSP 17 A test on the equal catchability of tagged and non-tagged animals in mark recapture studies
Personnel : K. Alagaraja
Duration : Two pears

Under the null hypothesis that marked and unmarked ones are caught with same probability a model is developed resulting in a multinomial distribution. It is shown that whether observed data agree with this model can be tested using an exact test based on Bionomial distribution.

Project ABF : All India Co-ordinated Research Project on Air-breathing Fish Culture

Problem : ABF 1 Propagations and stocking of air-breathing fishes for culture in swamps
Personnel : P. V. Dehadrai, R. N. Pal, N. K. Thakur, N. K. Das, S. C. Pathak. D. N. Singh, S. Parameswaran and V. K. Murugesan
Duration : Eight years

In Bihar, production to the tune of 1,200 kg/ha/7 months could be achieved through mixed culture of *Clarias batrachus* and *H. fossilis* providing them with moderate feeding and without any fertilisatin. Breeding of magur in mini-rice fields with high survival of spawn was possible.

In Karnataka, the murrel culture experiments yielded 3,150 kg/ha/8 months when the fishes were fed with marine dried trash fish. Techniques of breeding of murrels and rearing spawn to stockable size were perfected.

In Assam, the cage culture techniques yielded more than 30,000 to 50,000 kg/ha of murrels (*Channa* spp.) and singhi *(H. fossilis)* when the production/sq m area of cage was assessed. Production demonstration of magur *(C. batrachus)* and koi *(Anabas testudineus)* was undertaken in open swamps. Government of Assam was given 10,000 fry of *Anabas* sp. and Government of Meghalaya was given 50,000 spawn of *Anabas* sp. and 10,000 fry of *Channa punctatus.*

Problem : ABF 2 Nutrient balance of the soil and water in a weed infested swamp
Personnel : P. V. Dehadrai and R. K. Das
Duration : Two years

The problem was taken up in the month of June. It was found that after raking the soil, in the 'bubble' placed in the swamp, the physico-chemical equilibrium of water changed immediately. Rise in the nutrient level was noted in the level of phosphorus, nitrogen, specific conductivity, dissolved oxygen, dissolved organic carbon etc. Gross production was noted to increase from 312·5 to 1,500 mg C/m^3/hr.

Problem : ABF 3 Food conversion among air-breathing fishes
Personnel : R. N. Pal, P. V. Dehadrai
Duration : Three years

Before starting the experiment, it was necessary to standardise the feed from cheap indigenously available raw materials. In comperision to the Halver's standard diet, three other feeds were tested on *Clarias batrachus* in the aquarium in collaboration with the Biochemistry Department of Calcutta University, of which two different protein percentages from plant source will be finally tested. The studies have been planned accordingly.

Problem : ABF 4 Digestive physiology of air-breathing fishes with particular reference to enzymes
Personnel : S. D. Tripathi, P. V. Dehadrai and P. K. Mukhopadhyay
Duration : Two years

While studying activities of digestive enzymes in the gastrointestinal track of the air-breathing catfish (*Clarias batrachus*), amylase, cellulase lipase and protease were assayed spectrophotometrically using standard methods under different nutritional conditions.

Amylase and cellulase, the key enzymes for the digestion of carbohydrates have been found to be present in significant amount in the intestine of *Clarias batrachns* which may lead to suggest the culture operations using artifical diet from plant origin.

Experiments regarding digestibility coefficient and net protein utilisation under plant protein-diet treatment are under study.

Problem : ABF 5 Culture of air-breathing fishes in derelict water
Personnel : R. N. Pal, P. V. dehadrai and R. K. Das
Duration : Two years

As a pilot project, one nursery pond (27 m × 25 m) was taken up in the Dhokardah fish farm. The same was dewatered partially and then poisoned with mahua oilcake. Later the same was stocked with 4,500 *Anabas testudineus* (av. wt. 7.5 g) *i.e.*, @ 70,000 nos./ha and 2,700 *Clarias batrachus* (av. wt. 30.5 g) *i.e.*, @ 40,000 nos./ha. For swampyfication and supplementary feeding, slaughter house waste was broadcast @ 10 kg/day for the first three months and 15 kg/day for another one and half months. During the same period, 1 kg supplementary feed comprising rice bran and mustard oilcake in the ratio of 1 : 1 was also broadcast daily. Average weights of *A. testudineus* and *C. batrachus* were recorded as 25 and 46.25 g respectively in 4 months.

Problem : ABF 6 Culture of air-breathing fishes in cages installed in swampy waters
Personnel : R. N. Pal, P. V. Dehadrai and S. D. Tripathi
Duration : One year

10 cages were installed in Arang-Sarisha beel as a Pilot Project in West Bengal. 50% of the cages were stocked with *Clarias batrachus* (initial av. wt. 18.0 g) @ 120/cage and the rest were stocked with *Heteropneustes fossilis* (initial av. wt. 7.0 g) @ 190/cage. The fishes were given supplementary feed irregularly. Within a period of three months, the maximum weights gained in case of *Heteropneustes fossilis* and *Clarias batrachus* were 13.5 and 8.7 g respectively.

Project R : All India Co-ordinated Research Project on Reservoir Fisheries

Problem : R 1 Ecology & fisheries of freshwater reservoirs
Personnel : A. V. Natarajan, G. K. Bhatnagar, V. V. Sugunan, V. Pathak, Ch. Gopalakrishnayya, A. Mathew, B. P. Gupta, V. R. Desai, R. K. Singh, N. P. Srivastava, M. Ramakrishniah, J. N. Pal, S. N. Singh, Y. Rama Rao, M. P. Singh Kohli and G. K. Vinci (Smt.)
Duration : Eight years

Bhavanisagar (Tamil Nadu) :

Physico-chemical characteristics : During the year in Bhavanisagar, the surface values of HCO_3 varied from 30.0 to 42.0 ppm in lentic, 30.0 to 50.0 ppm in intermediate and 28.0 to 44.0 ppm in lotic; PO_4-P was in the range of 0.08-0.02

ppm in lentic, 0.006 - 0.14 ppm in intermediate and 0.007 - 0.016 ppm in lotic ; NO_3-N varied from trace to 0.042 ppm in lentic, trace to 0.046 ppm in intermediate and trace to 0.038 ppm in lotic ; silica was in the range of 2.0-6.0 ppm in lentic, 1.7-6.0 ppm in intermediate and 1.6-4.6 ppm in lotic ; and specific conductivity ranged as 167.03-286.0 micro mhos lentic, 152.0-357.6 micro mhcs in intermediate and 180.8-345.0 micro mhos in lotic zones of the reservoir. Chemical stratification was observed in summer (April) in respect of dissolved (surface : 10.4 ppm, bottom : 5.6 ppm), free CO_2 (surface : 1.0 ppm, bottom : 6.2 ppm), HCO_3 (surface : 37.0 ppm, bottom : 42.0 ppm), PO_4 (surface : 0.02 ppm, bottom : 0.03 ppm), NO_3-N (surface : 0.04 ppm, bottom : 0.056 ppm) and specific conductivity (surface : 262.9 micro mhos, bottom : 276.3 micro mhos).

The net primary production was 200.0 : 301.0 mgC/m^2/12 hr in lentic, 125.0-416 mg C /m^2/12 hr in intermediate and 167.58 mg C/m^2/12 hr in lotic, zone of the reservoir.

Plankton : The average standing plankton crop for the reservoir during the year was of the order of 0.9 ml/m^3. Both qualitatively and quantitatively phytoplankters dominated over zooplankters. Among phytoplankters *Microcystis* sp. dominated over all other species. The spurt of this phytoplankter was observed in April and July. Next in improtance was Chlorophyceae represented by *Pediastrum*, sp. and *Mougeotia*. sp. Zooplankters were represented by *Cyclops* spp., *Keratella* sp., *Filinia* sp., *Brachionus* sp., *Polyaorthra* sp., *Daphnia* sp., *Actinosphaerium* sp. and *Arcella* sp.

Bottom biota : The average standing crop of bottom biota for the entire reservoir was of the order of 0.712 g/m^2. The benthos was represented by oligochaetes, larvae of *Tendipes*, larvae of *Chaoborus* and mayfly nymphs.

Breeding and Recruitment : During June to September, observations on spawn were conducted at Moolathurai. The spawn occurred as eggs and hatchlings. The reared spawn was later identified as *L. calbasu*, *L. bata* and *C. mrigala*.

Fish yield : Fish yield for the year was estimated at 216.699 t as against 156.625 t in 1974. In the catch, *L. calbasu* formed 73.937 t (34.1%) ; *M. aor*, 54.045 t (25.0%) ; *C. mrigala*, 30.336 t (14.0%) ; *W. attu*, 24.8 t (11.0%) and the rest, 33.58 t (15.4%). During the year, 25 units of gill-net were operated (20 share units + 5 departmental units).

The fish yield has increased progressively from 94·4 t in 1971 to a record yield of 216·7 t in 1975. The above increase (120·3%) was

possible largely due to increase in fishing effort by about 63%. In addition, stocking of *C. mrigala* in 1972 seems to have left its impact on the fishery as reflected by the increased catch of this fish from 6 t in 1971-72 to 30·336 t in 1975. The induction of additional effort did not affect the fish stock densities in general except marginally in the case of *C. catla* and *P. dubius* which need stocking support. The present yield of 58·64 kg/ha in this reservoir is an important landmark in the yield history of Bhavanisagar reservoir.

Biology of fish : Studies on the biology of *L. calbasu, P. dubius, C. mrigala, C. catla, W. attu* and *M. aor* were pursued during the year. The feed of *L. calbasu, P. dubius* and *C. mrigala* was dominated by detritus. In case of *C. catla* detritus formed 50·73%, copepods 26·28% and *Microcystis* sp. 16·36%. Females dominated the catch in case of *C. mrigala* (2·9 ♀ : 1 ♂), *C. catla* (2·77 ♀ : 1 ♂), *W. attu* (4 ♀ : 1 ♂) and *M. aor* (4 ♀ : 1 ♂).

Stocking : During the year, 1,83,576 fingerlings belonging to *C. carpio, C. catla, L. fimbriatus, L. rohita* and *C. mrigala* were stocked in the reservoir.

Nagarjunasagar (Andhra Pradesh) :

Physico-chemical characteristics : The values of HCO_3 were in the range of 74·6-116·24 ppm; NO_3-N, 0·35-2·2 ppm; PO_4-P, trace-0·003 ppm and sepcific conductivity, 230·4-787·5 micro mhos. HCO_3 showed column variations in January-March (surface, 103·68 ppm; bottom, 130·56 ppm) and April-June (surface, 106·4 ppm; bottom, 111·15 ppm) in lotic zone; in January-March (surface, 98·8 ppm; bottom, 105·45 ppm) in intermediate zone; and in January-March (surface, 104·5ppm; bottom, 112·1 ppm) in lentic zone.

Plankton : The plankton density was in the range of 0·016-2·227 ml/m³ in lotic zone. The concentration was higher in this zone, during August-October (1·05-2·23 ml/m³). In the intermediate zone, the standing crop of plankton varied in the range of 0·072-0·933 ml/m³ and in the lentic zone, 0·08-0.786 ml/m³. Peddamongal Bay had the richest plankton crop (0·327-30·106 ml/m³) which reached the levels of 23·862-30·186 ml/m³ during March-April.

The planktonic organisms encountered in the reservoir were as follows :

Phytoplankton	Representative Genera
Myxophyceae	: *Anabaena, Microcystis, Oscillatoria, Phormidium, Spirulina Nostoc.*

Chlorophyceae	:	*Botryococcus, Oedogonium, Pediastrum, Spirogyra, Tetraspora, Ulothrix, Volvox.*
Bacillariophyceae	:	*Fragilaria, Gyrosigma, Navicula, Surirella, Synedra, Tabellaria.*

Zooplankton

Protozoa	:	*Actinosphaerium, Arcella, Ceratium. Difflugia*
Rotifera	:	*Brachionus, Filinia, Keratella, Lecane, Polyarthra.*
Cladocera	:	*Chydorus, Daphnia, Diaphanosoma.*
Copepoda	:	*Cyclops, Diaptomus* & nauplii.

Fish fauna : Forty two species of fish have so far been identified from the reservoir. Drag-netting was done in all the zones of the reservoir to study the trash fishes. Throughout the year *Oxygaster phulo* and *Rhinomugil corsula* dominated the catches. *R. corsula* (not encountered in the reservoir in previous years since 1971 when the sub-centre was established) is now available throughout the reservoir in enormous numbers. Other important species in the drag-net catches were *Barilius* spp., *Puntius* spp., *Osteobrama vigorsii*, *O. cotio*, *Chela atpar*, *Glossogobius giuris* and *Xenentodon cancila*.

Breeding and recruitment : Spawn collections were done in lotic zone in the months of July and August. The reared spawn were found to comprise *Labeo fimbriatus* (27·21%), *Puntius leilus* (16·58%), *Garra* spp. (17·36%) and *Oxygaster phulo* (8·55%). Catfishes formed less than 12%.

Fish yield : The fish yield for the year was estimated at 98·4 t of which *L. calbasu* fromed 8·92%; *C. mrigala*, 0·33%; *C. catla*, 2·23%; *L. rohita*, 1 05%; *L. fimbriatus*, 7·23%; *M. aor*, 15·93%; *M. seenghala*, 8·24%; *M. punctatus*, 3·56%; *P. pangusius*, 20·17%; *S. childrenii*, 20·88% and *W. attu* 3·58%. Peddamongal Bay accounted for over 55% of landings. Catfish landings dominated over those of carps.

Biology of fishes : Specimens of *L. calbasu*, *L. fimbriatus*, *M.* aor, *P. pangasius*, *S. childrenii*, *Tor khudree*, *Mystus seenghala* and *Osteobrama vigorsii* were examined in details. The gut content analysis of the species was as under :

L. calbasu : Diatoms (31·23%), organic detritus (25·69%), mud (23·98%), *Spirogyra* spp. (16·93%), and rotifera (0·70%).

L. fimbriatus	:	Diatoms (29·63%), organic detritus (27·05%), mud (26·25%); *Spirogyra* spp. (14·37%), crustacean larvae (0·41%) and *Keratella* spp. (0·21%).
M. aor	:	Fish remains (46·77%), *Oxygaster* spp. (22·06%), *Glossogobius giuris* (5·14%). *Ambassis* spp. (2·94%), organic detritus (14·71%), prawns (7·35%), and insects (0·74%).
P. pangasius	:	Bivalves (48·72%), gastropods (35·80%), digested vegetation (12·90%) and mud (2·58%).
S. childrenii	:	Fish (86·0%), organic detritus (29·31%), prawns (3·52%) and insects (1·38%).
T. khudree	:	Organic matter (50%), molluscs (30%), rotifers (5%), macrovegetation (5%) and mud (10%).

Stocking : Fingerlings of *Cirrhinus mrigala* numbering 93,000 were stocked and 7,000 were clipped before releasing into the reservoir.

Rihand (Uttar Prad sh) :

Physico-chemical characteristics : During the year, HCO_3 varied from 26·0 to 60·0 ppm; No_3-N, 0·15 to 0·5 ppm; PO_4-P, trace to 1·4 ppm and specific conductivity, 41·0 to 165 micro mhos. Thermocline was observed in summer between 7 and 19 m depth. Dissolved oxygen was more or less uniform from surface to 19 m depth except for a fall between 10 and 16 m depth. The variation in CO_2, HCO_3 and specific conductivity from surface to bottom was only marginal. The net primary production varied from nil to 340·91 mg $C/m^2/12$ hr.

Plankton : The standing plankton crop varied from 0·56 to 7·72 ml/m^3. The plankton was rich during October-Decemder (5·16-7·72 ml/m^3). The phytoplankton was dominant in lentic and Intermediate zones with the dominance of *Microcystis* sp. and occasional occurrence of *Melosira* sp., *Fragilaria* sp., *Synedra* sp. and *Ceratium* sp. The occurrence of bloom of *Ceratium* sp. was observed in the reservoir only in the month of February. The zooplankton was important mostly in lotic zone and was represented by *Diaptomus* sp., *Cyclops* sp.. *Diaphanosoma* sp., *Daphnia* sp., *Chydorus* sp., *Filinia* sp., *Keratella* sp. and *Difflugia* sp. The plankton concentration was the maximum in littoral zone which decreased from surface to sub-surface waters and showed a pulse each in summer and winter.

Benthos : The bottom biota occurred in the range of 0·004-1·145 g/m^2. The concentration of benthos was more in the lotic sector due to muddy and clay bed. The gravelly and rocky bed of lentic and intermediate zones was not favourable as reflected by low abundande of benthos. The bottom biota was mainly represented by insect larvae like, *Chironomus* sp. & *Chaoborus* sp. (Diptera), caddisworms (Tricoptera), mayfly nymphs (Ephemeroptera), dragonfly nymphs (Odonata) and oligochaetes.

The periphyton complex was studied by taking samples from tree trunks and boulders. The abundance of periphyton varied from nil to 1·9 ml/cm^2. The overall concentration of periphyton was found to be more in lotic sector and the forms mainly represented were *Oscillatoria* sp., *Fragilaria* sp., *Gyrosigma* sp., and *Navicula* sp.

Breeding and recruitment : Observations on spawning, made during the year, revealed the successful breeding of *C. catla* and *C. mrigala*. The spawn collected on July 16, on rearing was found to comprise *C. catla* (43·6%), *C. mrigala* (38·5%), *L. calbasu* (5·1%), *L. rohita* (5·1%) and *C. reba* (7·7%). Fish fry collected using Jaunpur scoop-net and drag-nets of small meshes revealed the composition as *P. sarana* (8·8%), *C. catla* (6·9%), *C. mrigala* (6·5%), *W. attu* (5·6%), *L. bata* (5·3%), *L. calbasu* (4·6%) *R. corsula* (1·3%), *N. notopterus* (1·2%) and *L. rohita* formed only a small percentage (0·9%) in the above collections.

Fish yield : During the year, the fish yield from the reservoir was estimated at 242 t being made up entirely by single species *viz.*, *C. catla*. The gill-nets of commercial fishermen were in the range of 148-185 mm mesh bar.

Biology : Three sub-species of *C. catla* were identified and these are distinguishable by length of pectoral being "long", "medium" and "short". The sub-species with long pectoral, subsisted mainly on zooplankton while the other two showed preference for *Microcystis* sp.

Tagging/clipping and stocking : 1,220 fry of major carps were clipped and released in the reservoir. Only 8,000 fry of major carps were stocked during 1974-75.

Getalsud Reservoir (Bihar) :

Physico-chemical characteristics : During the year, bicarbonate varied from 22·0 to 54·0 ppm; NO_3-N, 0·10 to 0·35 ppm; PO_4-P, trace to 0·024 ppm and the specific conductivity of the water 62·55 to 227·84 micro mhos.

Lotic zone appeared to be the richest as far as physico-chemical

parameters are concerned. However, the DO values were as low as 2·4 ppm during summer in the lotic zone. This may be due to shallowness of the zone resulting in high temperature as well as enhanced organic decomposition.

It was observed that when flood water entered the reservoir, at the beginning, two distinct layers formed in deep zone, one very turbid and the other comparatively transparent. The mixing of the two took place very slowly in subsequent months. Net primary production in the reservoir was of the order of 285·32 to 1499·84 mg $C/m^2/12$ hr.

Plankton : The standing crop of plankton ranged as 1·78-17·213 ml/m^3 in the lotic, 0·89-1078 ml/m^3 in the intermediate and 1·61-7·15 ml/m^3 in the lentic zone. The plankton productivity was of larger magnitude during October-December in comparison to other months of the year. The phytoplankton was dominant in lentic & intermediate zones and zooplankton was dominant in March-May. Phytoplankton represented by *Microcystis* sp., was the dominant species in the plankton. Other phytoplankters encountered were *Ceratium* sp., *Botryococcus* sp., *Diatoma* sp., *Oedogonium* sp., *Oscillatoria* sp. Zooplonkters were represented by nauplii, *Diaptomus* sp., *Cyclops* sp., *Bosmina* sp., *Diaphanosoma* sp., *Keratella* sp., *Polyarthra* sp., *Trichocerca* sp. and *Arcella* sp.

Benthos : Benthos occurred in the magnitude of 12-98 mg/m^2 in the lentic, 5-64 mg/m^2 in the intermediate and 277-11,666 mg/m^2 in the lotic zones. Oligochaetes were dominant in all the zones, and were maximum in the lotic zone. Larvae of insects (*Chaoborus* sp., *Tendipes* sp. and *Philopotamus* sp.) were also represented.

Fish yield : Getalsud is a new reservoir and commercial fishing is yet to commence. Sampling by departmental drag-net yielded mainly trash fish like, *Osteobrama cotio, Chela laubuca,* and *Amblypharyngodon mola.*

Recovery of silver carp : On March 15, 1974, an experimental consignment of 2,860 fingerlings of silver carp (*Hypophthalmichthys molitrix* with av. l/wt. 76 mm/7 g was released in Getalsud reservoir. Two specimens were recovered in 1975. One of them reached a size of 1.7 kg in 503 days and the other 2.1 kg in 518 days.

Cage culture in Getalsud reservoir : A new experiment on 'floating nurseries' was launched at Getalsud reservoir (Bihar) in August, 1974. The cages, made of

bamboo strips with an inner lining of synthetic *hapa* were made in two sizes : 4.5×1.5×1.5 and 2.4×1.8×1.5 m. The fry ranging 10-31 mm in length were stocked @ 300-2,200/cage.

During the first two months, the rate of growth (mm) month was of the order of 17, 25 and 20 in *C. mrigala*, *C. catla* and *L.* rohita respectively.

The investigations were continued in 1975. The rate of growth of fingerlings per month in 1975 was 14, 17, 30, 19 and 22 mm in case of *C. mrigala*, *L. rohita*, *C. catla*, *L. bata* and *C. reba* respectively.

Mortality was observed during initial stages due to non-adjustment to cage conditions and nibbling tendencies in fry.

Govindsagar (Himachal Pradesh) :

Physical characteristics of water : Thermal stratification was observed in summer. Thermocline occurred between 2 and 6 m depth. The water temperature dropped from 27.0°C at 2 m to 22.0°C at 6 m depth. Lotic water was cooler (16·2°C) in summer because of freshets from snow melting. Intermediate zone was warmer (29.0°C) in comparison to lotic zone in summer.

Plankton : In the lentic zone, the standing crop of plankton varied in the range of 0.133-10.85 ml/m³, the maximum in the range occuring in June. In June, phytoplankton was dominant and was led by *Ceratium* followed by *Ulotrichales* sp., *Staurastrum* sp., *Botryococcus* sp., *Peridinium* sp. and diatnms. Copepoda (*Diaptomus* sp.) were abundant along with cladocerans (*Daphnia* sp.), and *Leptodora* sp.), rotifers (*Keratella* sp,) and protozoans (*Actinosphaerium* sp.) in the zooplankton.

In the intermediate zone, the crop of plankton varied in the range of 0.353-6.8 ml/m³. The maximum plankton concentration in this zone occurred in April. The plankton composition, in April in this zone, was made up by *Ceratium* sp. among phytoplankton and *Actinosphaerium* sp., *Diaptomus* sp., *Keratella* sp. and *Diaphanosoma* among zooplankton.

Fish yield : The fish yield, during the year, was estimated at 475 t (i.e. 43.1 kg/ha/yr). The yield, during the year, registered a 101% increase from 1972 and 1973 levels. This is largely due to enhancement of mesh bars of gill-nets. Gangetic major carps which were insignificant in earlier years, formed a significant fraction of the yield in 1975. The species and percentage composition

of the yield in 1975 were as follows : *C. catla* (44·2%), *L. rohita* (24·9%), *C. carpio* (17.4%), *C. mrigala* (3.1%), *L. dera* (3.9%), *Tor putitora* (3.5%), *L. bata* (1·9%) and *M. seerghala* (1.2%). In Bilaspur, the commercial fishermen use gill-nets of mesh bars 87-175 mm.

The fish yield was the maximum in July (165.68 t). Lathiani centre contributed about 71% to the catch followed by Bhakra market (22.5%). *C. catla* was the most dominant fish accounting 61.96% in the catch followed by *L. rohita* (25.06%) and *C. carpio* (7.93%).

In the month of July, two silver carp *(Hypophthalmichthys molitrix)* weighing 4.5 kg (766 mm) and 5.12 kg (803 mm) were encountered in the catch. The above are recoveries arising from escape of silver carp fingerlings from state fish farms a few years ago.

(c) *Research contemplated*

Over and above the problems on which investigations are being continued as per the project programme in force, a number of problems under different projects which could not be initiated during the year under report for paucity of staff faciities and other resources, are also envisaged to be taken up during 1976. The details of such problems are presented below :

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

Problem : 1·1 Composite culture of Indian and exotic species
(Old programme will continue)

Problem : 1·21 Carp fry rearing for optimum survival and growth under high stocking density
(Old programme will continue)

Problem : 1·22 Biology of fish food organisms
(Old programme will continue)

Problem : 1·23 Evolving efficient method for sampling of bottom dwelling fishes in ponds
(Old programme will continue)

Problem : 1·24 Studies on the effect of chemical fertilisers in relation to pond productivity
(Old programme will continue)

Problem : 1·25 Mass culture of phyto- and zooplankton in field to feed fish
(Old programme will continue)

Problem : 1·26 Nutritional requirements of fry and fingerlings of carps
(Old programme will continue)

Problem : 1·27 Comprative study of the structures of the gill apparatus of the Indian major carps, catla, rohu and mrigal and its development with age and correlation with feeding
(Old programme will continue)

Problem : 1·28 Commercial production of carps through composite culture in large sized ponds
(Old programme will continue)

Problem : 1·29 Comparative study of the efficacy and economics of available fish poisons and their residual effects on the fish pond ecosystem
(Old programme will continue)

Problem : 1·30 "Operational research" in fish culture
(Old programme will coutinue)

Problem : 1·31 Use of anaesthetics in transport of fry and fingerlings under oxygen packing
(Old programme will continue)

Problem : 1·32 Bionomics and culture of tendipedid larvae, a favoured fish food organism
(Old programme will continue)

Problem : 1·33 Studies on detection of digestive enzyme complex of freshwater culturable food fishes
(Old programme will continue)

Problem : 1·34 Observations on culture possibilities of fish in jute-retted pond waters
(Fish mortality is commonly reported from jute-

retted ponds. The present study is aimed at assessing the cultural possibilities of *Tilapia mossambica* and air-breathing fishes in such contaminated water bodies)

Problem : 1·35 Culture of fish along with deep water paddy (Trials are to be taken up to assess the cultural possibilities of fish in deep water paddy fields)

Problem : 1·36 Snail control in ponds under fish culture (For their habit to competed with fish for both natural and artificial food, the aquatic snails are considered as pests in fish culture waters. The study is directed at evolving a suitable technique for the effective control of snail population in ponds)

Problem : 1·37 Devising effective sampling techinque for estimating production (Attempts will be made to formulate an effective method for estimation of standing fish crop in ponds under culture)

Problem : 1·38 Biology of some bloom forming blue-green algae of fish ponds (Biological aspects of some blue-green algae responsible for formation of blooms are to be investigated)

Problem : 1·39 Effect of lime in pond soils (The efficiency of different forms of liming materials and their role in releasing nutrients in pond water for higher fish production is to be assessed)

Problem : 1·40 Comparative efficiency of organic manures on the fertility of pond soils (Comparative efficiency of various types of organic manures will be studied. Attempts are to be made for the standardisation of the doses of manures and their pollutional impact in the freshwater bodies are to be evaluated)

Project 2 : Induced fish breeding

Problem : 2·2 Use of various hormones for inducing spawning in carps
(Old programme will continue)

Problem : 2·4 Hatching of eggs of major carps in newly designed hatching jars under controlled conditions
(Old programme will continue)

Problem : 2·6 Experiments on the production of multiple broods from the same individual of major carp in the course of one year
(Old programme will continue)

Problem : 2·7 Isolation of fish gonadotropin for hypophysation of carps in large scale
(Old programme will continue)

Problem : 2·8 Induced breeding of important cultivated fishes (Other than carps)
(Old programme will continue)

Problem : 2·9 Studies on the process of maturation, ovulation and resorption of gonads in Indian major carps
(Old programme will continue)

Project 3 : Reservoir Fisheries

Problem : 3·6 Fisheries of peninsular tanks : Assessment of biological production potentialities
(Old programme will continue)

Problem : 3·8 Fisheries of peninsular tanks — Introduction and propagation of less known cultivable species
(Old programme will continue)

Problem : 3·9 Development of fisheries of Loni reservoir
(Old programme will continue)

Problem : 3·12 Assessment of primary productivity potentials in tanks
(Primary productivity of fish tanks will be

assessed fortnightly using light and dark bottle technique).

Problem : 3·13 Composite fish culture of Indian and exotic carps in tanks simulating long seasonal irrigational tanks
(Technique of composite fish culture will be tried in larger water bodies like, freshwater irrigational tanks).

Project 4 : Riverine carp spawn prospecting and collection techniques

Problem : 4·5 Yearly variation of quality and quantity of spawn in the river Ganga
(Old programme will continue)

Project 5 : Brackishwater fish farmiag

Problem : 5·12 Methods of silt control and experimental trials on sluice
(Old programme will continue)

Problem : 5·17 Brackishwater prawn culture in Madras region
(Old programme will continue)

Problem : 5·18 Culture of edible oysters in Pulicat lake
(Old programme will continue)

Problem : 5·20 Use of compost as fertilizer in coastal fish ponds
(Old programme will continue)

Problem : 5·21 Fish and prawn seed resources of Pulicat lake
(Old programme will continue)

Problem : 5·22 Rearing of fry of brackishwater fishes
(Old programme will continue)

Problem : 5·23 Experimental culture of brackishwater fish food organisms in the laboratory and field
(Old programme will continue)

Problem : 5·24 Effect of hormones on the growth and photo-synthetic behaviour of plankters
(The problem has been merged with problem 5·23)

Problem : 5·25 Nutritional requirements of cultivable brackishwater fish and prawns
(Old programme will continue)

Problem : 5·26 Transformation of nitrogen and phosphorus in water logged saline soils related to different grades of water salinity
(Old programme will continue)

Problem : 5·27 Detailed contour survey of Kakdwip island for designing the brackishwater fish farm
(Old programme will continue)

Problem : 5·28 Behaviour of lake-mouth bar and its bearing on the fishery of lake Pulicat
(Old programme will cotinue)

Problem : 5·29 Role of silt load in the Hooghly estuary on the nutrient balance of the environment and its effect on primary production process
(Old programme will continue)

Problem : 5·30 Shapes and structures of ponds, feeder canals and dykes relative to stability, water management and fish culture under brackishwater environment
(Old programme will continue)

Problem : 5·31 Studies on the macrophytic flora in the lake Pulicat with special reference to their utilization as organic manure and artificial feed for fish
(Old programme will continue)

Problem : 5·32 Culture of edible portunid crabs
(Studies will be made to explore the possibility of culturing brackishwater portunid crabs from juvenile to marketable size)

Problem : 5·33 Nursery management in the culture of *Eleutheronema tetradactylum*
(Optimum ecological conditions for the rearing of fry of *E. tetradactylum* will be ascertained to develop nursery management techniques for culture of the species).

Problem : 5·34 Stock manipulation in polyculture of Indian and exotic carps, mullets, *Chanos* sp. and prawns in low saline ponds in the Sunderbans
(Polyculture of Indian and exotic major carps, mullets, milkfish and prawns will be taken up in low saline ponds in Sunderbans region)

Problem : 5·35 Culture of *Chanos chanos*
(Mono- and mixed-culture of *Chanos chanos* will be undertaken in the brackishwater ponds at Bakkhali and Kakdwip).

Problem : 5·36 Collection and rearing of *Penaeus monodon* seed for stocking and supply
(Collection and rearing of *P. monodon* to stockable size will be done to meet the internal demand. Supply of *P. monodon* seeds shall be taken up with a view to working out the feasibility of long distance transport of prawn seeds).

Problem : 5·37 Crop rotation under prawn-cum-fish culture
(Period of maxima of different natural fish food organisms in culturable brackishwater bodies will be studied, and fish & prawn seeds will be introduced accordingly in rotation to maximise the yield/unit area with the minimum inputs).

Problem : 5·38 Stok manipulation in seleciive culture of *Lates calcarifer* and *Eleutheronema tetradactylum*
(Experiments will be conducted to obtain the maximum sustained production of these two carnivorus species by manipulation of stocking material and rearing periods without adversely affecting the other cultivate species like, mullets and prawns)

Problem : 5·39 Intensive culture of *Penaeus indicus* in association with other penaeid prawns
(Intensive culture of *Penaeus indicus* and other penaeid prawns will be taken up by manipulating the stocking density to increase prawn production per unit area).

Problem : 5·40 Stock manipulation in intensive farming for mullets in monoculture and in association with penaeid prawns

(Culture experiments, by suitable manipulation of stock and rearing periods will be conducted for maximising production of mullets and prawns per unit area).

Problem : 5·41 Development of devices for large scale collection, segregation and rearing of brackishwater fish and prawn seed for stocking in intensive culture

(For multiple stocking in intensive culture a supply of stocking material is an essential constant prerequisite. Attempts will be made to develop techniques for large scale collection and rearing of the fry of fish and prawns to sustain their supply throughout the period of culture and to support the commercial needs).

Problem : 5·42 Specified protein levels in supplementary feeds for enhancing growth of brackishwater fishes and prawns

(Experiments will be conducted to determine the specified proteins from easily available feeds such as, fish meal, prawn powder etc., for using these as supplementary feeds to enhance the growth of brackishwater fishes and prawns

Problem : 5·43 Physico-chemical characteristics of the soil around the outfall area of various industries with special reference to the growth of benthic populations

(Different chemicals discharged into the Ganga river system along with the industrial wastes are observed to be toxic. A detailed scientific assessment of the effects of such toxic substances upon the benthic life around the outfall area of these industrial discharge points will be made).

Problem : 5·44 Role of trace elements in the mineralisation of organic nitrogen

(Effects of trace elements, Co, Zn, B, Mo etc.

on the mineralisation of organic matter used as fertilisers in brackishwater ponds, will be studied)

Problem : 5·45 Nutrient status of brackishwater ponds in Madras region
(Investigations will be taken up to evaluate the nutrient levels of the brackishwater ponds in Madras region).

Problem : 5·46 Flocculating colloidal soil suspensions in impounded waters of low salinity
(Experiments will be conducted to determine the factors responsible for the turbid conditions in the ponds having low salinity levels).

Project 6 : Freshwater prawn culture

Problem : 6·1 Freshwater prawn culture techniques
(Old programme will continue)

Problem : 6·2 Propagation and culture of *Macrobrachium malcolmsonii*
(Old programme will continue)

Problem : 6·3 Freshwater prawn fishery of the middle stretch of the Ganga
(Old programme will continue)

Problem : 6·4 To study the biology and production of prawn in the lower stretch of the Ganga.
(The availability of different prawns species and their fluctuations in commercial prawn landings in the lower stretch of the Ganga river system (Bhagalpur to Lalgola) are to be studied. Breeding and rearing of commercial freshwater prawn species will be attempted).

Project 8 : Estuarine and brackishwater lake fisheries

Problem : 8·1 Brackishwater fish seed prospecting of the Hooghly-Matlah estuarine system
(Old programme will continue)

Problem : 8·4 Brackishwater prawn seed prospecting of the Hooghly-Matlah and Rupnarayan estuarine system
(Old programme will continue)

Problem : 8·5 Breeding and rearing of the palaemonid prawn *Macrobrachium rosenbergii*
(Old programme will continue)

Problem : 8·6 Standardisation of brackishwater seed prospecting collection and transporting techniques
(Old programme will continue)

Problem : 8·7 Reproduction and biology of cultivable brackish-water fishes
(Old programme will continue)

Project 9 : Selective breeding and hybridisation

Problem : 9·4 Selective breeding and hybridisation of carps and other cultivated fishes with special reference to cytogenetical features of the hybrids
(Old programme will continue)

Project 10 : Fish farm designing

Problem : 10·1 Designing fish farms under soil condition of Orissa
(Old programme will continue)

Problem : 10·2 Studying seepage losses in ponds
(Old programme will continue)

Project 11 : Economics in fishery investigations

Problem : 11·4 Assessment of marketable fish size for fish culture enterprises in West Bengal
(Old programme will continue)

Problem : 11·5 Pilot survey on the economic impact of the operational research projects, co-ordinated research projects and extension activities in West Bengal
(The extent to which the research results of

high yielding technology of fish production are adopted by the fish farmers will be examined. The economic impact of the new technology on the general living standard of the fish farmers will also be evaluated).

Problem : 11·6 Economics of semi-intensive fish farming in fresh-water ponds of West Bengal and Orissa
(Average input cost structure and economics of semi-intensive fish farming to obtain a minimum target of production will be determined. It will focus the attention of the fish farmers to adopt the scientific cultural techniques).

Project 12 ; Exotic Fish Culture

Problem : 12·4 Suitable supplementary feeds for grass carp fry and fingerlings
(Old programme will continue)

Problem : 12.5 Techniques for large scale production of grass carp and silver carp seed
(Old programme will continue)

Problem : 12·6 Compatability and competition between silver carp and Indian major carps
(Old programme will continue)

Project 13 : Cold water Fish Culture

Problem : 13·2 Artificial feeds and trout nutrition
(Old programme will continue)

Problem : 13·8 Standardisation of trout hatchery practices
(Old programme will continue)

Problem : 13·13 Studies on the biological indicators in an eutrophic lake (Dal lake)
(Old programme will continue)

Problem : 13·14 Crude culture of fish food organisms under temperate climate
(Old programme will continue)

Problem : 13·15 Study on carrying capacity of a trout stream
(The study is aimed at evolving a standard methodology to be implemented in the country for stocking policy of trout streams).

Problem : 13·16 Seed production of *Schizothorax* spp. through hypophysation and artificial fertilization and exploitation of natural resources
(Production of stocking material of *Schizothorax* spp., a high altitude fish, either through hypophysation and artificial fertilisation or from natural sources is to be attempted).

Problem : 13·17 Role of *Cyprinus carpio specularis* in the decline of endemic carp fishery in Dal lake
(The study is directed at ascertaining the role of *C. carpio specularis* in declining the endemic fishery of Dal lake which will help in formulating conservation methods for the improvement of the endemic fishery).

Problem : 13·18 Water quality and benthic life in Asiganga, trout stream at Uttarkashi
(Water quality and benthic fauna and flora of the trout stream at Uttarkashi are to be studied so as to formulate a suitable stocking policy).

Problem : 13·19 Breeding of brown trout of Uttarkashi
(Modern techniques for rearing spawners and hatchery practices are to be employed to produce brown trout seed)

Project 14 : *Riverine and Lacustrine fish catch statistics*

Problem : 14·1 Fish catch statistics of the middle stretch of the Ganga river system
(Old programme will continue)

Problem : 14·2 Fish catch statistics of the lower stretch of the Ganga river system
(Old programme will continue)

Problem : 14·6 Effect of major environmental changes on the fisheries of commercially important stocks of the Hooghly-Matlah estuary
(Old programme will continue)

Problem : 14·7 Survey of the fish and fisheries of the river Brahmaputra
(Old programme will continue)

Problem : 14·10 Ecological changes in the Hooghly estuary in the context of freshwater release from Farakka Barrage into the system
(Old programme will continue)

Problem : 14·11 Statistical evaluation of sampling and estimation technique of plankton
(Old programme will continue)

Problem : 14·12 Robustness of estimates of population sizes and mortality rates by Monte Carlo-methods
(Old programme will continue)

Project 15 : Fish pathology

Problem : 15·1 Etiology and control of parasitic diseases of some culturable fishes
(Old programme will continue)

Project 16 : Weed control

Problem : 16·3 Evolution and evaluation of weedicide formulation
(Old programme will continue)

Problem : 16·5 Eradication of weeds by chemical treatments
(Old programme will continue)

Problem : 16·6 Autecology of aquatic weeds
(Old programme will continue)

Problem : 16·7 Studies on the algal population of freshwater ponds with special reference to their utility for fish culture and control when in excess
(Old programme will continue)

Problem : 16·8 Biodegradation, persistence and the effects of 2,4-D and Simazine weedicides on the productivity and fish life in culturable waters
(Old programme will continue)

Problem : 16·9 Increasing fish production by conversion of aquatic vegetation into manure *in situ*
(Old programme will continue)

Project 17 : Frog farming

Problem : 17·7 Development of hatchery complex of Indian commercial frog species
(Old programme will continue)

Problem : 17·8(a) Nursery managment for Indian commercial frog species
(Old programme will continue)

Problem : 17·8(b) Rearing of tadpoles of *Rana tigrina* up to the juvenile stage with artificial feed
(Old programme will continue)

Problem : 17·9(a) Mono-culture of *Rana hexadactyla*
(Old programme will continue)

Problem : 17·9(b) Food and feeding habits of *Rana hexadactyla*
(Old programme will continue)

Problem : 17·9(c) Rearing of tadpoles of *Rana hexadactyla* up to the adult stage
(Old programme will continue)

Problem : 17·10 Culture of earthworms for feeding frogs
(The investigation is intended to evolve a suitable technique for the mass culture of earthworms which will be of immense help in frog culture operations being utilized as readily available living food material).

Project 18 : Sewage-fed fisheries

Problem : 18·1 Fish culture in sewage-fed ponds
(Old programme will continue)

Project 19 : Hilsa fisheries

Problem : 19·7 Appraisal of the present status of hilsa fishery of the lower stretch of the Ganga river system
(Old programme will continue)

Problem : 19·8 Culture of *Hilsa ilisha* (Ham.) in confined freshwater
(Old programme will continue)

Problem : 19·9 Fluctuation in the hilsa fisheries of the Hooghly estuary
(Old programme will continue)

Project 20 : Water pollution investigations

Problem : 20·3 Studies on estuarine pollution with reference to pulp & paper and tannery wastes
(Old programme will continue)

Problem : 20·4 Investigations on the Hooghly estuarine ecosystem to determine biological indicators of its water quality
(Old programme will continue)

Problem : 20·5 Biological indicators of water quality in the Ganga and the Yamuna river ecosystems at Allahabad
(Old programme will continue)

Problem : 20·6 The effects of biocides on the physiological activities of aquatic animals
(Old programme will continue)

Problem : 20·7 Bioassay of selected industrial wastes disposed into the Hooghly estuary
(Old programme will continue)

Problem : 20·8 Pollution studies in different inland waters caused by pesticides
(Attention is to be paid to assess the pollutional effects caused by short term and long term applications of commonly used pesticides on fish and fish food organisms with a view to formu-

lating national policies on the use of the pesticides both, quantitatively and the qualitatively in Agriculture, Public health, etc.).

Project 21 : Fisheries of river basins

Problem : 21·1 Ecological studies of *Mans* and *Chaurs* in Gandak basin

(Nutritional resources of the *Mans* and *Chaurs* with rererence to fish production in river Gandak are to be estimated with a view to suggesting remedeal measures for rapid development of *Mans* and *Chaurs*).

Problem : 21.2 Ecological studies af *Dhars* and fishery development in tanks and ponds in Kosi basin
(An appraisal of nutritional resource of Dhars, tanks and ponds will be made with a view to developing the fishery of these areas).

Project 22 : Fish culture in running water

Problem : 22·1(a) Cage culture in running water in the Ganga
(Old progromme will continue)

Problem : 22·1(b) Carp culture in running water in the river Brahmaputra
(Old programme will continue)

Problem : 22·1(c) Carp culture in running and still water 'Kol' of the Ganga in cages
(Cage culture of carp in running and still waters of Ganga with provision of supplementary feeding will be taken up to determine optimum production of carp from unit surface area of such environment)

Problem : 22·2 Catfish culture in running water
(Old programme will continue)

Project 23 : Bundh breeding

Problem : 23·1(a) Bundh breeding of major carps in Uttar Pradesh
(Old programme will continue)

Problem : 23·1(b) Bundh breeding of major carps in South Bihar
(Old programme will continue)

Project CFCSP : All India coordinated research project on composite fish culture and fish seed production

Problem CFCSP 1 : Composite fish culture and fish seed production
(Old programme will continue)

Problem CFCSP 2 : Bundh breeding of silver carp, *Hypophthalmichthys molitrix* and grass carp, *Ctenopharyngodon idella*
(Old programme will continue)

Problem CFCSP 3 : Reproductive physiology of Indian and Chinese carps
(Old programme will continue)

Problem CFCSP 4 : Efficacy of Brahmaputra silt as a fertiliser in composite fish culture
(Old programme will continue)

Problem CFCSP 5 : Feeding inter-relationship of fishes in composite fish culture
(Old programme will continue)

Problem CFCSP 6 : Biology and role of grass carp, *Ctenopharyngodon idella* in composite culture
(Old programme will continue)

Problem CFCSP 7 : Effects of oxygen, carbon dioxide and temperature on the metabolism and assimilation of feed in certain Indian and Chinese carps
(Old programme will continue)

Problem CFCSP 8 : Composite fish culture without fertilisation and feeding
(Old programme will continue)

Problem CFCSP 9 : Composite fish culture in running water
(Old programme will continue)

Problem CFCSP 10 : Operational research project on composite fish culture
(Old programme will continue)

Problem CFCSP 11 : Biology of the silver carp, *Hypophthalmichthys molitrix* (C & V) and its performance in composite fish culture
(Old programme will continue)

Problem CFCSP 12 : The pituitary-gonad feed back relationship in *Mystus vittatus* (Bloch)
(Old programme will continue)

Problem CFCSP 13 : Composite fish culture for demonstration to the fish farmers
(Old programme will continue)

Problem CFCSP 14 : Techno-economic and socio-economic aspects of massive fish seed production for composite fish culture
(Old programme will continue)

Problem CFCSP 15 : Statistical evaluation of some growth parameters and their confindence intervals
(Old programme will continue)

Problem CFCSP 16 : Evaluation of fish production and loss due to poaching from cultivated resources
(Old programme will continue)

Problem CFCSP 17 : A test on the equal catchability of tagged and non-tagged animals in mark recapture studies
(Old programme will continue)

Project ABF : All India coordinated research project on air-breathing fishes

Problem ABF 1 : Propagation and stocking of air-breathing fishes for culture in swamps
(Old programme will continue)

Problem ABF 2 : Nutrient balance of the soil and water in a weed infested swamp
(Old programme will continue)

Problem ABF 3 : Food conversion among air-breathing fishes
(Old programme will continue)

Problem ABF 4 : Digestive physiology of air-breathing fishes with particular reference to enzymes
(Old programme will continue)

Problem ABF 5 : Mixed culture of air-breathing fishes in a swamp
(Old programme will continue)

Problem ABF 6 : Culture of air-breathing fishes in cages installed in swampy waters
(Old programme will continue)

Problem ABF 7 : Nutritional and bio-chemical studies of the air-breathing catfish, *Clarias batrachus* (Linn.)
(Studies on nutrient requirements, food conversion, digestive physiology and enzyme activities of the air-breathing catfish, *Clarias batrachus* will be made with a view to formulating a cheap nutritionally sound artificial feed which will economise its cultural operations).

Project R : All India coordinated research project on ecology and fisheries of freshwater reservoirs

Problem R 1 : Ecology and fisheries of freshwater reservoirs
(Old programme will continue)

3. PAPERS PUBLISHED

The following papers were published by the staff of the Institute during the year 1975 :

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Natural production of *Tilapia* in a small stocking pond at Killa Fish Farm, Cuttack. *J. Indian Fish. Ass.*, I (2) : 15-24

Bagchi, M. M. and K. H. Ibrahim 1974
A note on the haematological study of rohu *Labeo rohita* (Ham.) *J. Inland Fish. Soc. India,* **6** : 93-94

Chakraborty, R. D., D. S. Murty, P. R. Sen, A. C. Nandy and D. P. Chakraborty 1974
Periodic harvesting to enhance production in composite culture of Indian and exotic carps. *Ibid,* **6** : 167-171

Chakraborty, R. D., P. R. Sen and N. G. S. Rao 1975
Harvesting of ponds under composite culture by netting-species representation in the hauls. *Sci. & Cult ,* **41** (9) : 454-459

Chaudhuri, H. 1975
Fish seed production— a pre-requisite to intensive freshwater fish culture. *Indian Fmg.,* Special No., **25** (6) : 12-16

Datta, Anup Kumar and Amitabha Ghosh 1975
Bifurcated barbel in a catfish *Heteropneustes fossilis* (Bloch). *Curr. Sci.,* **44** (11) :389

_____1875
Notes on an abnormal intestinal caecum in murrel *Channa gachua* (Ham.) *Ibid,* **41** (4) : 186

David, A , K. V. Rajagopal and K. Gopinathan 1973
Experimental observations on subsurface and bottom fishing in the Tungabhadra reservoir. *Proc. nat. Acad. Sci. India* (B), **43** (4) : 237-248

David, A., N. G. S. Rao and S. L. Raghavan 1975
Preliminary observations on the periphyton production in a lentic water mass. *Indian J. exp. biol.,* **13** (2) : 205-208

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Observations on cage culture of air-breathing fishes in swamps in Assam. *J. Inland Fish. Soc. India,* **6** :89-92

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Experimental observations on the food requirement of fry of *Mugil parsia* Hamilton. *In* Coastal Aquaculture in the Indo-Pacific Region. London, Fishing News (Books) Ltd. 429-437

Ghosh, A. N., N. K. Das and H. S. Mazumder 1972
Pilot observations on the culture of prawns in brackishwater ponds at Kakdwip, West Bengal. *Proceedings of the Seminar on Mariculture and Mechanised Fishing*, Madras, November 28 and 29, 1972 : 86-88

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Observations on the larvae and juveniles of the 'Bhekti' *Lates calcarifer* (Bloch) from the Hooghly-Matlah Estuarine System. *Indian J. Fish.*, **20** (2) : 372-379

Ghosh, Apurba , L Hanumantha Rao and S. C. Banerjee 1974
Studies on the hydrobiological conditions of a sewage fed pond with a note on their role in fish culture. *J. Inland Fish. Soc. India,* **6** : 51-61

Ghosh. K. K , M. Sinha and N. K, Srivastava 1972
Mass marking of carp hatchlings by biological stains. *Proc. nat. Acad. Sci. India* (B), **42** (4) : 423-430

Ghosh, K. K., M. Sinha and N. K. Srivastava 1973
On the escapement of carp hatchlings from shooting nets. *Indian J. Fish.*, **20** (2) : 395-410

Ghosh. K. K. 1974
On the choice of a growth curve for Indian major carps— von Bertalanffy or Gompertz ? *Journal of the Indian Society of Agricultural Statistics.* **26** (2) : 57-70

Ghosh. S. R. 1975
A study on the relative efficiency of organic manures and the effect of salinity on its mineralisation in brackishwater fish farm soil. *Aquaculture,* **5** (4) : 359-366

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Taxonomy and biology of tropical fin-fish for coastal aquaculture in the Indo-Pacific Region. *In* Coastal Aquaculture in the Indo-Pacific Region. London, Fishing News (Books) Ltd. : 120-149

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The potential for intensive cultivation of estuarine prawns in India. *Proceedings of the Seminar on Mariculture and Mechanised Fishing,* Madras, November 28 and 29, 1972 : 27-30

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An assessment of the prawn fishery of the sea-ward reaches of Hooghly estuary. *J. mar. biol. Ass. India,* **15** (1) : 406-410

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A note on the transport of Chinese carp breeders using MS 222 *J. Inland Fish. Soc. India,* **6**: 99-100

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Observations on the role of water temperature in induced breeding of Indian carps. *Proc. nat. Acad. Sci. India* (B), **41** (2): 163-166

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Role of Chilka lake fisheries in the development of coastal aquaculture in Eastern India. *In* Coastal Aquaculture in the Indo-Pacific Region. London, Fishing News (Books) Ltd. : 109-115

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Observations in a Pilot fish farm in lower Sunderbans. *In* Coastal Aquaculture in the Indo-Pacific Region. London, Fishing News (Books) Ltd. : 472-485

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Estuarine fisheries resources of India in relation to adjacent seas. *J. mar. biol. Ass. India,* **15** (1): 323-334

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Scope and role of Inland aquaculture in India's economy. *Ibid,* Special No. **25** (6) : 10-11

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Pollution by pesticides. *Sci. rept.* **12** (10) : 492-493

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Length-weight relation of *Cirrhina mrigala* (Hamilton) from commercial catches at Allahabad. *Proc. nat. Acad. Sci. India* (B), **41** (4) : 419-422

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Observations on the growth rate of *Catla catla* (Hamilton) based on the recovery of one tagged specimen from Kulgarhi reservoir, Madhya Pradesh. *J. Inland Fish. Soc. India,* **6**. : 88

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Synopsis of biological data on rohu *Labeo rohita* (Hamilton 1822). *FAO Fish Synops.,* (111) :100 p.

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Administrative and financial problems of pisciculture. *Ibid,* **6** : 172-174

4. EXTENSION

The Extension Unit of the Institute continued to provide its services to the public, specially to the fish farmers and to the State Government Agencies.

Results of immediate practical application :

Publicity brochure on Central Inland Fisheries Research Institute and the extension pamphlets *viz.*, Intensive Fish Farming, Technique of Nursery pond Managment, Breeding of Common carp, and Induced Breeding of Major carps were continued to be distributed to the interested fish farmers, State Fisheries Departments and other organisations. Arrangements for printing one broad based illustrated pamphlet on "Glass Jar Hatchery", designed and developed at the Freshwater Fish Culture Division of the Institute, have been made.

Induced breeding of major carps *(L. rohita* and *C. mrigala)* was demonstrated at a private fish farm at Chapra, District Nadia, West Bengal and 16·62 lakh spawn of these species obtained from 4 sets of brooders was handed over to Dr. P. K. Mondal, the owner of the fish farm.

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

(Nothing to report)

Publicity activities :

Demonstrations on composite fish culture were arranged at the National Demonstration Pond, Nilgunj during January 27 to February 5, 1975 for the benefit of the Bank Officials who were trained in different aspects of composite fish culture, fish seed production and their operational economics.

Negatives and photographs depicting the achievements of the Institute in different aspects of culture fisheries and other activities of the Institute were sent to the Indian Council of Agricultural Research for the ICAR Exhibition held at New Delhi during 7.4.75 to 12.4.75 on the occasion of the Budget Session of the Parliament.

A news item about the modern methods of composite fish culture developed by the Central Inland Fisheries Research Institute for increasing fish porduction by 15-times appeared in the leading newspaper "Jugantar" on the 14th of January, 1975.

The Sunday edition of the "Amrita Bazar Patrika" dated September 28, 1975 carried a news item under the caption "Greater fish output likely". The views expressed were that of Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute who opined that the new technology developed by the Central Inland Fisheries Research Institute in the recent years has made it possible to raise 9,000 kg fish per hectare per year as against a mere 600 kg estimated as annual yield per hectare in India.

The "Hindu" dated the 29th September, 1975 carried a news item "Fish revolution round corner says expert". The news carried in brief the views expressed by Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Barrackpore who has pointed out that development of fish and frog culture covered by the collective term "aquaculture" holds a great promise in playing a valuable role in supplementing and balancing the country's economy. He expressed that development and expansion of aquaculture will mean more fish providing protein food to the growing population and more of direct & indirect employment opportunities.

The "Hindu" in its issue of October 16, 1975 carried the news under the caption "Project to breed fish resistant to pollution" which highlighted the views expressed by Dr. P. V. Dehadrai, Project Coordinator, Air-Breathing

Fish Culture, who while participating in the inaugural ceremony of the Demonstration Centre for the culture of murrels at the Bullundar Tank, Bangalore, observed that about 60 lakh hectare of derelict water areas in the form of ponds and tanks in the country are lying unused. He emphasised that with the techniques developed by the Central Inland Fisheries Research Institute, such polluted water areas could be utilized for culturing air-breathing fish which by nature are suitable for such waters. The murrels thrived well in polluted waters of Karnataka and an annual per hectare yield of 10-12 t could be expected from these waters. He further expressed that under the All India Coordinated Research Project on Air-breathing Fish Culture of the Central Inland Fisheries Research Institute, at Karnataka, a production of of 3,000 kg/ha/yr of murrels has been achieved so far.

The news item announcing the first workshop organised by the "All India Coordinated Research Project on Brackishwater Fish Farming" held at Barrackpore during December 4 & 5, 1975 was broadcast in the local news bulletin at 7·50 p. m. on December 4, 1975 by the All India Radio, Calcutta.

An interview of the Director-in-Charge of the Institute in English and another interview in Bengali given by the Senior Extension Officer on the activities and achievements of the Institute were broadcast by the All India Radio, Calcutta in the Radio News Real programme on December 12 and 7, 1975 respectively.

The All India Radio, Calcutta also broadcast interviews in Bengali and English given by the Officer-in-Charge, Brackishwater Experimental Fish Farm Unit of the Institute at Kakdwip, West Bengal on December 24 and 26, 1975.

The Extension Unit of the Institute participated in the Farmer's Training Programme, jointly organised by the Block Development Officer, Canning-1 and the Bidhan Chandra Krishi Vishwa-Vidyalaya, Kalyani, during July, 1975.

The Institute participated in different exhibitions organised in the State of West Bengal on different occasions during the year to exhibit posters depicting important research achivements of the Institute, working model of the "Glass Jar Hatchery", clay models of various types of fishes, aquaria with living fishes and transparency boxes etc. The exhibitions in which the Institute took part are listed below :

i) Exhibition at Kaligram, Midnapur, West Bengal held during January 18 & 19, 1975.

ii) Exhibition at Narendrapur, West Bengal held during January 19 to 22, 1975.

iii) "Krishi Mela" exhibition at Bidhan Chandra Krishi Vishwa-Vidyalaya Mohanpur, Haringhata, West Bengal held during February 23 to 27, 1975.

iv) "National Fair 1975" at Calcutta Maidan, West Bengal held during March 3 to April 20, 1975.

v) "Basanti Mela" exhibition at Akshoynagar, Kakdwip, West Bengal held during April 18 to 25, 1975.

vi) "Bidhan Mela" and exhibition at V. I. P. Road, Calcutta, West Bengal held during July 1 to 16, 1975.

vii) "Agrichem 1975" exhibition at Jadavpur University Campus, Calcutta, West Bengal held during December 24, 1975 to January 3, 1976.

Besides, participating in the above exhibitions the Institute also sent various exhibits for the "Science Fair" held at Nagpur during November 9 to 14, 1975 and for the exhibitions held at Baruipore and Gosaba, West Bengal on May 10, 1275 and December 6, 1975 respectively.

Posters depicting the work and achievements of the Institute were displayed and explained to the visiting Indian and foreign dignitaries on 20 different occasions during the year. Poster exhibitions were also arranged for the under trainees at the Institute *viz.*, bank officials, air-force officials of Barrackpore & Kanchrapara Units, scientists from Nepal, trainees from the Gramsevak Training Centre (Malda), trainees of the Regional Training Centre of CIFE (Agra), trainees from the Central Institute of Fisheries Education (Bombay), participants of Summer Institute held at CIFRI, and the students of Fisheries College (Mangalore), Dharam Samaj College (Aligarh), R. G. Kar Medical College (Calcutta) & North Eastern Hill University (Shillong).

Visits by students :

Students of Fisheries College, Mangalore, visited the Institute during November

15 to 18, 1975. Lectures on different aspects of Inland Fisheries coupled with field demonstrations were arranged for them. During December, 1975, 18 students of M. Sc. Final (Zoology) from Dharam Samaj College, Aligarh (U. P.), 10 students of R. G. Kar Medical College, Calcutta, and 26 students of North Eastern Hill University, Shillong visited the Institute. The visiting students were acquainted with the working and the achivements of the Institute. Field trips to Composite Fish Culture Sub-centre at Kulia and the Sewage-fed Fishries Farm, Khardah, West Bengal were also arranged for them.

Miscellaneous activities :

The Extension Unit of the Institute has taken up composite fish culture work at Sarpadihi (West Bengal), under the Integrated Rural Development Scheme under Operational Research programme of the Indian Council of Agricultural Research.

Technical advice on different aspects of composite fish culture, methods of common carp breeding, induced breeding technique of major carps, control measures for fish deseases and weeds in fishery ponds etc. were rendered to 71 fish farmers owning 283 fish ponds who called at this Institute with their problems. Another 25 fish farmers were rendered technical advice through correspondence. Twentytwo Government Departments and other organisations were advised on technical matters relating to fish culture and were also provided with the extension pamphlets so far broughtout by the Institute.

The Senior Extension Officer and other staff of the Extension Unit of the Institute visited the fish ponds belonging to 9 fish farmers who had been trained earlier at this Institute in composite fish culture with a view to rendering them further advice and assess their progress. One farmer, Shri Swapan Kumar Nandy of Bansberia, West Bengal has been able to achieve fish yield @ 6,000 kg/ha/yr through composite fish culture under the supervision of the Extension Unit of the Institute.

The Extension Staff of the Institute attended the Fish Farmers' Days organised by the Basantimela Committee, Akshoynagar, Kakdwip on April 22, 1975, by the Jute Agricultural Research Institute at Mohanpur in May, 1975, by the Bidhan Chandra Agricultural University of Kalyani at Haringhata on June 13, 1975 and at the Farmers' Training Programme at Canning, West Bengal in July, 1975. Problems relating to pisciculture were discussed with the fish farmers and the new technology of composite fish culture were explained to them.

5. CONFERENCES AND SYMPOSIA

A short-term training course in composite fish culture and spawn prospecting and its operational cost was organised by the Institute at Barrackpore for the bank officials during January 27 to February 5, 1975.

The Institute organised an 8-days training programme on composite fish culture and spawn prospecting for the air-force officials. Field demonstrations at the Kulia centre under the auspices of the All India Co-ordinated Research Project on comppsite fish culture and fish seed production was also arranged for them.

A Summer Institute on "Intensive Freshwater Fish Culture", sponsored by the Indian Council of Agricultural Research, was held at Barrackpore from 15.6.75. to 30.6.75. and subsequently at Freshwater Fish Culture Division of the Institute at Cuttack from the 1st to 14th of July, 1975 and was attended by 24 participants from various universities, institutions and State Fisheries Departments.

The First Workshop of the All India Co-ordinated Research Project on Brackishwater Fish Farming was held at the Central Inland Fisheries Research Institute, Barrackpore, during December 4-5, 1975.

The 3rd All India Symposium on Estuarine Biology was held at the University of Cochin, Kerala, during February 4 to 6, 1975 and the under-mentioned papers were presented by the scientists of this Institute.

Pakrasi, B. B., N. C. Bssu & R. K. Banerjee
Role of grey mullets in polyculture in coastal tanks of West Bengal.

Vergnese, P. U., A. N. Ghosh and P. B. Das
On growth, survival and production of Jumbo tiger prawn, *Penaeus monodon* Fabricious in brackishwater ponds.

Ghosh, Apurba, S. C. Thakurta and P. R. das
Physicochemical and hydrobiological conditions of brackishwater impoundments (bheris) around Port Canning, West Bengal.

Rajyalakshmi, T.
Environmental ecology of *Macrobrachium rosenbergii*, *M. malcolmsonii* and *Metapenaeus monoceros* in certain drain channels opening into Kakinada Bay.

Raman, K.

Studies on the hydrobiology and benthic ecology of lake Pulicat.

International Conference on Prawn Farming was held at Vung Taul in Vietnam during Marh 31 to April 4, 1975 and the paper entitled "A brief review of the studies on the biology, fishery, and culture of *Macrobrachium* in India" by K. Raman was presented.

The first All India Symposium on Comparative Animal Physiology was held at Marathwada University during November 10-15, 1975 and the undermentioned two papers were presented by the scientists of the Institute.

Peer Mohamed, M.

Effect of sub lethal D. D. T on survival and metabolism of the fish *Colisa fasciata* (Bloch & Schnieder).

Singh, B. N.

Metabolic energy requirements and energy budgets of certain Indian air-breathing fishes.

The first All India Symposium on Pest Resistance to Pesticides was held at Ludhiana during November, 1975 under the joint auspices of ICAR and the Punjab Agricultural University. A paper entitled "Observations on the biology and control methods for *Argulus siamensis*, a crustacean parasite of cultivable carps in freshwater ponds" by Ajoy Kumar Ghosh was presented at the above symposium,

The Symposium and General Session of the VIII Annual Convention of the Indian Society of Agricultural Chemistry was held at Durgapur during November 27 & 28, 1975 and undermentioned three papers were presented by the scientists of the Institute.

Chattopadhyay, G. N. and H. C. Karmakar

Role of organic manure in brackishwater fish farming.

Krishna Chandra

A note on the absorption of oxalate by Indian soils.

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

Utilisation of human and cattle urine in increasing fish production.

A symposium on 'Multi-use of the Coastal Zone' was organised by the Indian Fisheries Association of CIFE, Bombay, held during November, 20 to 22, 1975. Undermentioned five papers by the scientists of the Institute were presented at the above symposium.

Bhanot, Kailash K
Brackishwater fish seed prospecting for coastal aquaculture in West Begal.

Gopalakrishnan, V. and Apurba Ghosh
Mullet resources of Hooghly-Matlah estuarine system in West Bengal, India.

Banerjee, R. K., B. B. Pakrasi and E. Mitra
Utilization of mangrove plants as compost in coastal pond fertilisation.

Basu, N. C., B. B. Pakrasi and R. K. Banerjee
Observations on the cultural prospects of exotic carps in low saline coastal tanks of West Bengal.

Ray, P., B. B. Ghosh and D. D. Halder
The problems of waste disposal and their effect upon the environment in Hooghly estuary near Calcutta

South East Asian Workshop on Noxious Aquatic Vegetation was held in Biotrop, Bogor, Indonesia during June, 1975 and the paper entitled 'Control of a noxious bloom of *Peridinium* sp., in a fish pond by ammonia" by V. Ramachandran was presented.

6. SUMMARY

Project I :

I·I Fry of Indian major carps stocked @ 50,000/ha exhibited encouraging growth during $1\frac{1}{2}$ months of rearing. Rearing experiments, conducted with fry of Indian and exotic carps at a high stocking density of 2·5 lakhs/ha for a period of 3-6 months gave a survival of 71·5%. Productions to the tune of 8,867 and 7,503 kg/ha/yr were obtained when Indian and exotic carps were stocked @ 10,000 fingerlings/ha in two ponds. The aggregate survival was 91% in one pond and 84% in the other. All the species of carps grew to around 1 kg in weight. Indian major carps alone, when stocked @ 6,000 fingerlings/ha recorded productions of 3,930 and 3,017 kg/ha/yr in two ponds with a high rate of survival. A production of 3,065 kg/ha/10 months was achieved with 80% survival when Indian and exotic carps fingerlings were stocked @

6,000/ha. Fertilisation and manuring of the ponds were done but no supplementary feed was provided for the fishes.

1·2 (Research suspended)

1·3 & 1·4 (Research work completed in 1972)

1·5 (Research work completed in 1970)

1·6 (Research work completed in 1972)

1·7 (Research work completed in 1973)

1·8 (Research work completed in 1971)

1·9 to 1·11 (Research work completed in 1972)

1·12 (Research work completed in 1973)

1·13 (Research work completed in 1972)

1·14 & 1·15 (Research suspended)

1·16 (Research work completed in 1971)

1·17 (Research suspended)

1·18 (Research work completed in 1975)

1·19 (Research work completed in 1973)

1·20 (Research work completed in 1974)

1·21 Experiments could not be initiated due to paucity of stocking material.

1·22 No satisfactory result could be achieved in the laboratory culture of cladocerans using cow dung, poultry manure and mahua oilcake as the culture media. However, it was observed that poultry manure at 700 ppm level supports the growth of cladocerans to some extent.

1·23 10 to 15% increase in catch was obtained with a newly designed net which has been constructed with a view to collecting surface and bottom dwelling forms simultaneously. Average catch of bottom dwelling forms was found to be 30% of the total catch.

1·24 80% survival of *L. rohita* spawn was achieved in the laboratory when ureaform was applied in slightly acid soil @ 25 kg N/ha. Encouraging results were obtained when in composite culture of Indian and exotic carps, chemical fertiliser was applied alone and in combination with organic manure.

The net productions at a stocking density of 7,500/ha were 4,220·82 kg/ha/yr with chemical fertiliser and 3,275·78 kg/ha/yr with both chemical fertiliser and organic manure.

1·25 Mass culture of *Nitzschia closterium* and *Navicula cryptocephala* was achieved by using urea, single superphosphate and sodium silicate in 100 : 10 : 5 ratio.

Mass culture of *Moina* sp. was done giving cultured *Chlorella* sp. as feed.

1·26 *Cyprinus carpio* spawn and fry were exposed to five different test diets comprising protein and carbohydrate at 0-60% level. The growth of the fry was found to be the best at 45% protein and 25% carbohydrate level. Fry of *Labeo rohita* were found to grow best with the test diet having 45% protein.

1·27 Densely arranged filamentous gill-rakers of *Catla catla* were found to be more efficient in seiving than those of *L. rohita* and *C. mrigala*. This is further confirmed by the gill-rakers and gill-filament ratios in the three species. Food analysis of the three species revealed that catla is predominantly a zooplankton feeder whereas the other two species principally thrive on phytoplankton.

1·28 Fish of 5,628·6 kg/2·25 ha, 3,718·8 kg/ha and 2,057·1 kg/0·67/ha were harvested in 27, 19 and 16 net-days respectively, the gross average weights of fish in the ponds being 1·19, 1·76 and 0·96 kg in the above mentioned order.

1·29 Seed husk of tamarind was found to be a promising fish poison as it effectively killed the test fishes (*C. carpio* and *T. mossambica*) at 8-10 ppm level. When applied at a high dose, the time of killing was greately reduced.

1·30 To demonstrate the high yielding composite fish culture techninque to the fish farmers, composite culture was taken up in 10 ponds (0·02-0·035 ha) belonging to private parties. Productions @ 1,000-2,000 kg/ha/6-7 months were obtained from these ponds. The villagers could earn Rs. 200 to Rs. 1,100 from these experimental culture. In five of the ponds, demonstrations were arranged for the villagers to show the fry rearing technique.

1·31 Fingerlings of *L. rohita*, transported to a distance of about 100 km under oxygen and chloralhydrate (300 ppm) packing, recorded better survival than those under oxygen packing only.

1·32 Observations on the life-cycle of tendipedids revealed that the adults lay eggs within 2-3 days after their emergence. The larval stages were found to exist for 20-35 days. The production of tendipedid larvae was poor in experimental culture using milk powder, urea and triple superphosphate as medium of culture in one case, and cow dung & chicken droppings in another.

1·33 Amylase and invertase were found to be present all along the digestive tract of *C. mrigala* and *L. rohita*. Lipase was also detected in the gastro-intestinal tract of *L. rohita*, *C. mrigala* and *H. fossilis*.

1·34 to 1·40 (Research contemplated)

Project 2 :

2·1 (Research work completed in 1970)

2·2 Satisfactory response (80%) in the induced breeding of Indian major carps (catla, rohu and mrigal) could be achieved by administering salmon gonadotropin @ 4-5 mg/kg of the recepient fishes which indicated practically no significant difference in potency between salmon gonadotropin and carp pituitary extract.

2·3 (Research work completed in 1972)

2·4 4·327 million spawn of Indian major carps could be produced through the glass jar hatchery complex wherein spawning of catla was observed to be better than in the *hapas* fixed in stagnant water of ponds.

In another set of experiments, by employing glass jar hatchery complex for hatching of spawn, silver carp and grass carp yielded 0·48 million spawn inspite of low percentage of fertilisation.

2·5 (Research suspended)

2·6 Due to scanty and delayed monsoon, only two sets, one each of rohu and mrigal, attained maturity for the second time and were successfully bred to yield an additional 3·8 lakhs of spawn.

2·7 The experiment was vitiated due to non-availability of U.V. Cord recorder and lypholizer required for isolation of gonadotropin.

2·8 Though the females in two sets of *Notopterus chitala* injected with homoplastic pituitary extract released eggs through stripping, fertilisation of the eggs could not be achieved since the males were not in proper stage of maturity. Sex differenciating characters of *N. chitala* have been found out.

2·9 Gonads of Indian major carps were collected and preserved for histological studies.

Project 3 :

3·1 to 3·5 (Research work completed in 1972)

3·6 Experiments simultaneously carried in two large tanks (2 ha each) with Indian major carps and exotic carps with same stocking density (5,000/ha) exhibited encouraging weight increment in respect of all the species employed. While in one tank, catla, rohu and mrigal recorded increments in weight by 223·00, 39·01 and 54·40 g respectively in 104 days, common carp and silver carp showed respective weight increments of 79·20 and 43·20 g in 54 days only.

3·7 (Research work completed in 1970)

3·8 Milting males of *Puntius pulchellus* were observed in Vanivilassagar fish farm from August to December but no ripe female could be encountered.

3·9 Besides hydrobiological observations and studies on fishing operations, observations on the natural breeding of major carps in the Loni reservoir and the escapement of resultant eggs and spawn down the waste-weir were continued. With the overflow of the waste-weir in the middle of July, the breeding of fish took place in the shallower regions above the waste-weir. Poor samples of spawn collected by operating Midnapore type of shooting-nets both up and down the waste-weir indicated heavy escapement of spawn. The bottom biota was abundant (1,683 organisms/m^2) in October while the same was minimum in July (76 oganisms/m^2)

In experimental fishings, gill-nets contributed the maximum (147·10 kg). Commercial fishing which was conducted for a day in February and 40 days in the months of September and November, accounted for 738·50 kg of fish.

3·10 & 3·11 (Research suspended)

3·12 & 3·13 (Research contemplated)

Project 4 :

4·1 & 4·2 (Work being done under a co-ordinated research project.)

4·3 (Research work completed in 1971)

4·4 (Research work completed in 1973)

4·5 (Research suspended)

Project 5 :

5·1 In Bakkhali fish farm, the K-pond (0·25 ha) with low saline status was stocked @ 6,140 nos./ha with Indian major carps, exotic carps, brackishwater fishes and prawns, the percental combination in terms of freshwater fishes, brackishwater fishes and prawns being 69·6, 23·1 and 6·6 respectively. Fertilization with N:P. (@ 600 kg/ha) & cow dung (10,000 kg/ha), and supplementary feeding were the management measures applied. All the species introduced showed encouraging growth increments during one year of rearing. A net production of 1,650 kg/ha/yr is expected from the K-pond. The R-pond (0·25 ha) recorded a net production of 745·5 kg/ha/5 months through the culture of above species at a stocking density of 5,120 nos./ha.

5·2 (Research work completed in 1973)

5·3 (Research suspended)

5·4 to **5·7** (Research work completed in 1972)

5·8 (Research work completed in 1975)

5·9 & 5·10 (Research work completed in 1973)

5 11 (Research work completed in 1974)

5·12 Design, drawing and estimates of an open type wooden sluice box (0·71 m × 1·81 m × 60 m) with the provision of adjustable shutter have been prepared for construction and fitting the same in Kakdwip fish farm for regulating the inflow of water.

5·13 Observation on the nursery management revealed that the stocking density is directly proportional to volume of water instead of the surface area.

Mugil tade (59·89 mm) stocked @ 9,000 nos./ha attained a size of 151·85 mm/39·85 g with 59·44% survival which in all respects surpassed the attainments obtained in the stocking densities of 25,000 and 19,000/ha.

P. monodon fry stocked @ 1,900/ha grew to an average size of 167·60 mm/40·0 g in 105 days when cultured in combination with *M. parsia* and *M. tade* stocked @ 3,100 and 1,200/ha respectively in the same pond and attained an average size of 115·76 mm/18·82 g and 196·27 mm/36·67 g in 165 days respectively.

Healthy survival (90%) of mullet fry could be achieved under a stocking density of 60,000/ha. The attainment may be helpful in evincing the constraints in experiments with regard to the scarcity of stocking material when the natural seed is not available and thus help in the year round farming of mullets.

5·14 Experiments conducted have brought out the finding that rearing of *P. monodon* for six months is economic both in terms of survival and production. A stocking density of 10,000 to 20,000 nos./ha with 35-80 mm sized seed gives better results than a higher stocking density of 30,000 to 50,000/ha.

Mixed culture of *P. monodon* and *M. Parsia* gives an added production.

The experiments on evolving an artificial feed for *P. monodon* revealed that the pelleted feed containing 40-75% fish meal gives 4-5 g increase in weight/prawn /month with 80-90% survival. Feed with less than 40% fish meal is inadequate.

5·15 *P. indicus* (16·0 mm) when stocked at two different densities of 200 and 133 nos./m^3 of water, the prawns at higher density grew to an average size of 108·0 mm/9·6 g in 160 days rearing with provision of periodic thinning of the stock as against an average size of 88·0 mm/5·0 g attained in 167 days rearing at the lower stocking rate without provision of stock manipulation.

Juveniles of *P. indicus* (av. size 73 mm) exhibited a growth pattern of 4·9 mm/0·684 g in 100 days rearing under a stocking density of 4 nos./m^3 of water which appears to be the optimal stocking density of the species.

5·16 Seed collection techniques of *L. calcarifer* have been standardised. Fry as small as 8 mm in length can now be collected in large quantities. In combined culture of *L. calcarifer* and *M. tade* in the ratio of 1 : 4, the former attained 256·42 mm/231·78 g and the latter 196·50 mm/72·24 g in a period of 360 days. Experiments for induced gonadial maturity of *L. calcarifer*, while in captivity, have not been met with success so far.

5·17 *Penaeus monodon* fry registered increments in the weight by 330·7 and 273·1% when subjected to artificial feeding for 45 days with (1) rice bran + prawn powder + tapioca and (2) rice bran + gram tapioca respectively. Percental survival recorded in course of feeding with the above feeds were of the order of 100 and 87·5 respectively. Though the growth of the fry was encouraging, the length attained by the species were more significant and promising.

5·18 Oysters ranging from 18-85 mm shell heights have been transplanted from Ennore to Pulicat in September for experimental observations. Fresh cultch material *viz.*, asbestos sheets and dead oyster shells have been set up for spat collection. However, no spat fall has so far been observed.

5·19 (Research work transferred to project 5·26)

5·20 Compost charged @ 5,000 kg/ha resulted in good growth of fish fingerlings and net gains in the weights recorded in respect of catla, mrigal, common carp and parsia were 175, 147, 295 and 15 g respectively in 90 days. The phytoplankton production was observed to be high and the bottom biota was dominated by chironomid and tubifex worms. Studies on the nutrient release revealed that liberation of ammonical nitrogen and nitrate nitrogen was of a higer order in sewage sludge than the compost whereas available nitrogen showed no marked variation.

5·21 Observations on seasonal abundance and ingress of fish and prawn larvae into the Pulicat lake were interrupted due to prolonged closure of the lake-mouth. However, assessment made on the basis of three months' observations (*i. e.*, February, November and December) indicated that among prawns, *P. monodon* larvae were the most abundant (418·0/net/hr) followed by *Sillago sihama* (175·5/net/hr) among fishes.

5·22 Of the growth promoters tried on mullet fry, yeast gave the maximum growth increment (268%) while the minimum increment (128%) was obtained with cobalt chloride. Feeding experiments with various artificial feeds on different estuarine fishes were carried out in the laboratory with a view to studying their effects on growth. Fingerlings of *Chanos chanos* showed encouraging increment in the growth when fed with commercial feed in combination with lablab. In another experiment, *T. jarbua* fingerlings registered a gain in the weight @ 16·7 mg/month with 60% survival when fed with artifical feed comprising fish meal + wheat flour + yeast.

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5·23 *Oscillatoria lemosa* could be isolated. It is being cultured in the laboratory in Bristol's solution and in brackishwater medium fertilised with N-P-K at 15 : 5 : 3 ratio.

5·24 Effects of Indol Acetic Acid (IAA) and Gibberellic Acid (GA) on the growth and photosynthetic behaviour of plankton indicate that IAA at 15 ppm concentration could stimulate a moderate increase (5%) in the population of *Chlorella* sp. and *Scenedesmus* sp. after 15 days whereas GA accelerated the growth of *Nitzschia closterium* at 20 ppm concentration in 20 days.

5·25 No progress

5·26 Availability of phosphorus was found to depend on water salinity. The productivity of brackishwater pond could be considerably increased with the application of urea, superphosphate and cow dung in a single dose. Plankton and soil flora were observed to range between 40 & 1,268/l, and 28 & 980 nos./m^2 respectively in the treated pond whereas the same were 26 - 424/l, and nil-109 nos./m^2 in the control pond.

5·27 (No progress)

5·28 The total fish yield from the Pulicat lake during the year was estimated to be 759·626 t, thus registering a decline by 22·55% over that of the previous year. This decline may be attributed to prolonged closure of the lake-mouth which restricted the fishing operations. Fish motalities were also observed during May-July probably due to high salinity and temperatures.

5·29 The nutrient status in silt at all the centres of observations *i. e.*, Barrackpore, Kakdwip and Taldi was found to be comparatively low during pre-monsoon and monsoon months, whereas in water phase, nitrogen and phosphorus content was observed to be significantly high.

5·30 Detailed designs, drawings and estimates of earthen embankments of different cross sections, feeder canals with different discharge capacities and ponds have been prepared.

5·31 The growth of macrophytic organisms in the lake Pulicat was adversely affected due to severe drought. Filamentous algae were found to emerge in appreciable quantities with pre-monsoon showers. Studies on periphyton attached to different substrata at different water zones of the lake were made. Microscopic examinations showed the maximum abundance

of periphytic organisms in May (1,955 u/sq cm) and the minimum in November (121 u/sq cm). Fry of mullet indicated satisfactory improvement in the growth when fed with artificial feed comprising filamentous algae, slaughter house waste and ground-nut oilcake at 2 : 2 : 1 : 1.

5·32 to **5·46** (Research contemplated)

Project 6 :

6·1 Juveniles of *Macrobrachium malcolmsonii* (av. weight : 3 g), stocked @ 20,000 and 5,300/ha in two 0·04 ha ponds and @ 4,750/ha in a 0·4 ha fish pond, grew to about 20 g in three months time.

Berried prawns, maintained in brackishwater in laboratory conditions, released larvae which were reared in glass jars or earthen vats with brackishwater (salinity 17‰). It was found that the survival was better in earthen vats where the larvae survived for 20 days as against 8 days in glass jars.

Young ones of *M. rosenbergii* (av. weight : 43·5 g) which were stocked in two ponds of 0·5 and 0·4 ha @ 35 nos./pond grew to 295·15 and 230·09 g respectively after one year's rearing.

6·2 Monoculture of *M. malcolmsonii* was attempted in 4 ponds which were stocked @ 75,000/ha. The average size at stocking being 22·2 mm/10·12 g, per hectare, production after a period of $7\frac{1}{2}$ months of rearing, was 75·5, 209·0, 83·3 and 96·8 kg with the respective survival of prawns being 4·5, 10·9, 8·2 and 4·7%. Hydrological features of the four ponds were also studied.

6·3 The larvae of *M. birmanicum choprai* collected from the commercial catches at Buxar, were reared in the laboratory condition at Allahabad for 11 days.

6·4 (Research contemplated)

Project 7 :

7·1 & 7·2 Investigations being conducted under a coordinated project.

Project 8 :

8·1 Brackishwater fish seed prospecting was conducted at Kakdwip, Uluberia, Monirampore & Kalna on the Hooghly river, Port Canning on the Matlah river, Geokhali & Kolaghat on the Rupnarayan river, Raidighi on the Thakuran river and Gosaba on the Bidya river. Of the commercial species, seed of *M. parsia* was encountered at Kakdwip, Geokhali, Kolaghat, Raidighi and Gosaba. *H. ilisha* was found at Uluberia, Monirampore, Port Canning, Kolaghat and Raidighi. Other species encountered in the collections at different centres were : *E. tetradactylum, M. tade, M. cephalus, I. elongata, P. pama, S. argus, S. taty, S. phasa,* etc.

8·2 & 8·3 (Research work completed in 1973)

8·4 Prawn seed prospecting was conducted at ten centres on the Hooghly-Matlah-Rupnarayan estuarine system. Seeds of *P. monodon* was abundant at Geokhali, and *P. indicus, M. brevicornis* & *P. styliferus* at Kakdwip while *M. monoceros* was the most adundant form at Tamluk.

8·5 Rearing of the larvae of *M. rosenbergii* was successfully achieved. One of the postlarvae is being reared in freshwater under laboratory condition. Of the different feeds tried, nauplii of *Artemia* sp. were found to be the best as larval diet. Tapioca was found to be the most preferred food for adults of *M. rosenbergii.*

8·6 *C. carpio* fry (8-10 mm) when exposed to 0·5% Lignocaine, were narcotised within 10 minutes. The fish, however, could recover themselves when transferred to freshwater.

8·7 Sex-ratio and fecundity analysis of *S. panijus* and *P. indicus* are being worked out.

Project 9 :

9·1 (Research work completed in 1972)

9·2 (Research work completed in 1973)

9·3 (Research suspended)

9·4 The somatic chromosome number of *C. catla* × *L. rohita* hybrid was found to be 50.

The head length of the hybrid was found to be shorter than of the parent *Catla catla* while the girth at the first dorsal fin was greater than of *L. rohita*. Observations on the food and feeding habits of the hybrid revealed that it mainly thrives on copepods, rotifers and diatoms.

Project 10 :

10·1 Fish farms located at Badjor, Kathpal and Bethnoti in Orissa were surveyed in connection with the designing and construction of new ponds.

10·2 Studies on seepages losses in ponds were continued in eight newly constructed mini ponds (2m×2m) at Killa fish farm. Ponds treated separately with a mixture of cement and soil, cow dung and sodium carbonate exhibited higher retention capacity than the pond treated with sodium chloride and the ponds kept as control.

Project 11 :

11·1 & 11·2 (Research work completed in 1974)

11·3 (Research work completed in 1973)

11·4 Six fish markets were covered to assess the size groups and the prices of the fish sold. No marked variation in the prices between the markets was noticed. Retail price of the fish was observed to fluctuate between Rs. 5 and Rs. 14/ kg depending upon the size of fish. The markets were mainly fed with the catches from private fish ponds. A survey of wholesale fish markets indicated that the fish catches mainly comprised large size groups and their prices fluctuated between Rs. 8 and Rs. 11/kg. The wholesale price of smaller size groups (750-1,000 g) ranged between Rs. 6 and Rs. 8/kg.

11·5 & 11·6 (Research contemplated)

Project 12 :

12·1 & 12·2 (Research work completed in 1973)

12·3 (Research work completed in 1972)

12·4 Satisfactory growth of grass carp fingerlings was registered with ground-nut oilcake + rice bran among the different feeds tried. In another

set of experiment, when the fingerlings were provided with *Hydrilla* sp., *Spirodela* sp., *Lemna* sp., *Enhydra* sp. and plankton, the weights of the fingerlings decreased. These might have been due to limitation of space for the fingerlings. All the feeds tried were accepted by the fish.

12·5 Due to lack of regular monsoons during July, breeding of grass carp and silver carp was very poor. However, in the middle of August, with the onset of monsoon, silver carp was bred successfully by administering pituitary extract.

A record production of 10·6 lakhs of silver carp and 65,000 grass carp spawn was obtained. The seed of these two species was supplied to different State Fisheries Departments and IDRC/CIFRI projects.

12·6 No conclusion could be drawn on the compatibility and competition between silver carp and the Indian major carps based on two sets of experiment conducted. The growth of rohu was higher in combination with silver carp as compared to catla in one set while in the other the result was reverse.

Project 13 :

13·1 (Research work completed in 1970)

13·2 Eleven field trials for feeding pelleted feed to brown trout and rainbow trout were conducted. Pellets containing crude protein at the levels of 26·4, 28·0, 35·0 and 39·0% gave respective conversion ratios as 2·9, 1·9, 2·0 and 1·4 when fed to brown trout whereas the conversion ratios were 3·1, 1·4, 1·5, 2·1 and 1·7 with the pellets having crude protein levels of 26·4, 28·0, 35·0, 37·6 and 39·0% respectively in the case of rainbow trout.

13·3 (Research work completed in 1971)

13·4 & 13·5 (Research work completed in 1970)

13·6 (Research work completed in 1972)

13·7 (Research work completed in 1970)

13·8 748 females and 400 males of brown trout were segregated and fed @ 1% of the body weght on deviscerated and partially boiled *C. carpio*. The segregated females of brown trout (328 mm/578 g) released 1,049 green

eggs as against 740 green eggs from the control fish when both the sexes were kept in the same pond.

13·9 (Research suspended)

13·10 Brown trouts sampled from 5 streams (Lidder, Erin, Sind, Bringhi and Verinag) were found to feed mainly on developmental stages of Trichoptera, Ephemeroptera and Diptera. With the increase in size, the fish preferred to feed on aerial insects and fish.

Coefficients of accessibility or foarge ratios determined for the genera *Epeorus, Baetis, Heptogenia, Mystacides, Actherix* and *Tendipes* were 1·41, 1·11, 1·15, 1·53, 1·00 and 1·37 respectively.

The available bottom organisms in the five streams were nymphs of Ephemeroptera, larvae of Trichoptera & Diptera, larvae & adults of Coleoptera and miscellaneous forms.

13·11 (Research suspended)

13·12 (Research suspended)

13·13 Hydrobiological studies were undertaken in the Dal lake which indicated pollutional impact at various points.

13·14 Trials were made to culture *Daphnia* sp., *Ceriodaphnia* sp. and *Cyclops* sp. in different organic media. The growth and multiplication of the organisms under temperate climate were studied.

NPK mixture was found to be a suitable medium for the culture of chlorophycean forms. Of the different concentrations tried, it took 25 days for a culture in 200 ppm NPK to reach a cell density of ·2,00,000/ml from an initial inoculum of 4,000 cells/ml.

13·15 to **13·19** (Research contemplated)

Project 14 :

14·1 Estimated fish landings at Sadiapur, Daraganj and Buxar were 83·78, 33·26 and 7·22 t respectively. Contribution of major fish groups was estimated in the total catch examined. Scales of *L. rohita, C. catla* and *C. mrigala* have been collected for examining the fluctuations in the relative abundance of

different age groups in their population. Hydrological studies at selected centres of the Ganga and the Yamuna rivers were continued.

14·2 Total fish landings from the river Ganga at Bhagalpur, Sahibgunj, Rajmahal, Farakka, Dhulian and Lalgola were 67·41, 25·66, 32·80, 42·65, 5·32 and 105·42 t respectively. Studies on the physico-chemical and biological conditions obtaining at different centres were continued during the year.

14·3 (Research work completed in 1969)

14·4 (Research work completed in 1971)

14·5 (Research work completed in 1973)

14·6 A total of 13,525·8 t of fish was landed from the Hooghly-Matlah estuary, showing an increase by 1,659·8 t over that of the corresponding period of the previous year. *Harpodon nehereus* followed by *Hilsa ilisha* dominated the catches. Amongst the gears operated, bag-nets contributed the highest (61·6%), being followed by large seines. Zone III (lower Sunderbans) accounted for 80·1% of the total catch. Estimated catch during the winter months from the migratory fishery was 5,941·8 t only. The major species encountered were : *H. nehereus*, *P. pama*, *S. phasa*, *S. taty* and *T. savala*.

14·7 A total of 241·4 t of fish was landed at four centres, Dhubri centre being the prime contributor (65·9 t). Hydrological observations at all the four centres were continued.

14·8 & 14·9 (Research suspended)

14·10 Hydrological studies at selected centres were made. Salinity was found to be the highest at Gosaba and the lowest at Kalna. Plankton studies indicated higher abundance of freshwater forms in the estuary up to Geokhali. Marine forms were encountered from the lower estuary only. Phytoplankton dominated the zooplankton. Other hydrobiological factors and primary productivity at the selected centres of the estuary were also studied.

14·11 High degree of variation, quantitative and qualitative, was observed in repeated sampling of plankton by adopting the plankton net collection method. Large size samples showed better representation of less abundant forms. Primary productivity also showed a high degree of variation with repeated samples using 250 ml light and dark bottles.

14·12 Various existing methods of estimation of population sizes and mortality have been examined.

Project 15 :

15·1 Heavy infestation of *Argulus* sp. could be controlled by benzene hexachloride @ 0·5 ppm without affecting the fish and fish food organisms. Under laboratory conditions, the infection of monogentic trematode could be controlled by the application of formalin at different concentrations.

Project 16 :

16·1 (Research work completed in 1973)

16·2 (Research being done under problem 16·7)

16·3 *Peridinium* sp. could be effectively cleaned within 2 days with an application of aqueous ammonia at 2 ppm level. A marked increase in zooplankton was recorded after 15 days from the date of application of ammonia at above stated dose.

Brick pellets soaked with 2,4-D were found effective in controlling lilies and submerged weeds like, *Hydrilla* sp., *Najas* sp. and *Ottelia* sp. Bloom of *Microcystis* sp. could be controlled by the application of diuron herbicide at about 0·3 ppm. 2,4-D 40% amine salt + 20% paraquat @ 5 kg/ha cleared *Pistia* sp. and water hyacinth and some marginal weeds like, *Ipomea* spp.

16·4 (Research work completed in 1973)

16·5 Fernoxone applied @ 25 kg/ha in 4 intermittent doses could effectively control *Hydrilla* sp. and *Vallisneria* sp. in laboratory conditions. The same formulation when applied @ 5 and 10 kg/ha effectively killed *Azolla plunata*. The lower dose was found to be more effective.

The regrowth of weeds observed in the laboratory when urea was applied @ 150 to 500 kg/ha in experimental jars containing weeds

Superphosphate @ 1,500 kg/ha was found to control all types of aquatic weeds.

16·6 Analyses of plant, water and soil samples collected from different ponds during the year are being done.

16·7 Studies on the hydrobiology of the fish farms in the Northern Orissa were continued.

In yard trials, catla died but the silver carp and rohu survived when their fingerlings were fed with the bloom of *Microcystis* sp.

Bloom of *Peridinium* sp. could be controlled by the application of simazine @ 1·0 ppm (a. i.)

16·8 2,4-D and simazine were found to be apparently harmless to the bottom organisms when they were applied @ 5, 10 and 0·2, 0·5 ppm respectively. 2,4-D at above mentioned doses did not affect the survival of *C. carpio* fry. In a nursery pond, 40% survival of *L. rohita* fry was obtained when the same was stocked @ 4,000,000/ha and treated with 2,4-D granules @ 10 kg (a. i.)/ha. Brick pellets soaked with 2,4-D were observed to be harmless to cmmon carp and Indian major carp fingerlings when applied @ 10 kg (a. i.)/ha.

16·9 By killing and converting aquatic vegetation into manure *in situ* in plastic pools, an increased production of *C. carpio* fingerlings could be obtained. In field trials, a better production of fish was obtained when water hyacinth was killed by 2,4-D spray and allowed to disintegrate in the pond and to act as manure. Nutrient levels of treated plastic pools and ponds were higher than those of control.

Project 17 :

17·1 to **17·4** (Research work completed in 1973)

17·5 (Research suspended)

17·6 Culture of *Tubifex* sp. was achieved successfully in laboratory condition using pond soil and sludge treated with a mixture of ground-nut oilcake, paper pulp and vegetable wastes in 1 : 1 : 1 ratio. The growth was 75-times in pond soil and 85-times in sludge base and their multiplication increased by 95-times with application of rain water.

17·7 Success was achieved in complete de-gumming of the eggs of *R. hexadactyla* by adopting Woynarovich method. Sticky eggs of *R. tigrina* could be easily de-gummed with the application of pectinase prior to the treatment by urea-sodium chloride solution.

17·8 (a) Iodine applied @ 0·8 and 0·2 ppm levels, was found to accelerate metamorphosis in *R. hexadactyla*.

17·8 (b) 7,000 early hatchlings of *R. hexadactyla* were produced through hypophysation. The resultant larvae were rearedd up to the tadpole stage by providing them with artificial feed. 70% of the tadpoles could be reared up to 2 legged stage and 50% up to 4 legged frog stage. It was observed that reduction of water level is essential for the metamorphosis of the developing tadpoles.

17·9 (a) Gut content analysis of adult frogs revealed that *R. hexadactyla* principally feeds on aquatic weeds. Cellulase has been detected in the digestive tract of *R. hexadactyla*. Laboratory culture of the insect *Chrysomia megacephala* has been taken up for feeding the carnivorous stages of the frog.

17·9 (b) Examination of food and feeding habit of *R. hexadactyla* revealed that the adults were entirely harvivorous whereas the metamorphosed juveniles were carnivorous in nature.

17·9 (c) Natural breeding of *R. hexadactyla* was achieved in yard and field trials and 3,000 larvae of the species thus obtained were reared in the laboratory and yard experiments for further studies.

Hydrilla was found to be a preferred food for the tadpoles while juveniles were fed with different species of insects.

17·10 (Research contemplated)

Project 18 :

18·1 An estimated production of 9,350 kg/ha of *Tilapia mossambica* was obtained through mass culture of the fish in a sewage-fed pond (0·076 ha) at Kharda, West Bengal. Only management measure adopted was to irrigate the pond with sewage effluent at periodic intervals. No supplementary feeding was resorted to.

Composite culture of Indian and exotic carps has been initiated in a 0·17 ha sewage-fed pond. The stocking was done @ 24,000/ha. *C. carpio* exhibited an excellent weight increment of 567·0 g being followed by *L. rohita* (225·5 g), *C. catla* (127·1 g) and *C. mrigala* (118·8 g). *H. molitrix* attained an average weight of 220·0 g within two months rearing.

Project 19 :

19·1 to **19·5** (Research work completed in 1973)

19·6 (Research suspended)

19·7 Estimation of hilsa landings at different centres showed decrease by 49·40% than that of the previous year. Centres located below the barrage at Farakka were found to be highly productive contributing 97·89% of the total catch. "Slender" variety of *Hilsa ilisha* dominated at Bhagalpur, Sahibganj, Rajmahal and Dhulian while "broader" variety was predominant at Farakka and Lalgola centres.

19·8 No progress during the year

19·9 Landings of *Hilsa ilisha* from the freshwater zone of the Hooghly-Matlah estuary were estimated as 7,740, 21,892 and 27,784 kg during winter, premonsoon and monsoon months respectively. Larval abundance of hilsa was observed at Kalna during May and October, the two principal breeding seasons of *Hilsa ilisha*

Project 20 :

20·1 (Research work completed in 1973)

20·2 Bio-assay experiments were carried out with different biocides using fish, fish food organisms and molluscs as test animals. TLm values for different species were determined. The regression of probit values and logarithms of concentrations were highly significant which exhibited an extremely close relation between the concentration and response.

20·3 Pollutional effects of different industrial effluents on the primary productivity in the Hooghly river were observed. The gross primary productivity was found to be much effected around the discharge points of Titagarh Paper Mills. The tidal phases were found to influence the pollutional effects caused by the industrial effluents.

20·4 Surface plankton analysis revealed that the pollutional effects were rather quantitative than being qualitative. Benthic population was found to be very poor at the points of discharge of the industrial wastes.

20·5 Observations on the physico-chemical and biological conditions in the Ganga and the Yamuna rivers at selected centres near Allahabad were

made. Results indicated that the DO values were higher at the outfall areas while centres above and below the outfall areas had lower values.

20·6 Standard metabolism of different fishes exposed to sublethal doses of DDT and ethyl parathion was studied. The results indicated that the excitement affects the CNS, causing increased muscle tone and subsequently increased oxygen consumption. Observations were also made on the effect of longterm exposure of fish to sublethal doses of DDT. It was observed that sublethal DDT increased metabolic rate of the experimental fish.

20·7 Work has been initiated

20·8 (Research contemplated)

Project 21 :

21·1 & 21·2 (Research comtemplated)

Project 22 :

22·1 (a) *C. mrigala, L. rohita, C. catla* and *C. carpio* were cultured in nylon cages in the running water. The fish were provided with two types of artificial feeds comprising (1) mustard oilcake + rice bran and (2) linseed oilcake + rice bran. During the period of culture, the fishes exhibited good growth.

22·1 (b) (Research suspended)

22·1 (c) (Research contemplated)

22·2 Preliminary experiments conducted on the food and feeding of *M. seenghala* fry revealed that egg mass of chironomids and zooplankton were preferred by the early fry as food while boiled and raw fish flesh were most acceptable to the advanced fry.

Monoculture of *O. bimaculatus* in cages has been initiated providing the fish with supplementary feed. During 60 days of culture, the average increment in weight was recorded as 15·2 g/fish.

Project 23 :

23·1 (a) Bundh breeding of *L. rohita* could be successfully achieved in 'Man' dry bundh and 15 lakhs of fertilised eggs could be collected. Observations on the physico-chemical conditions of water of bundhs were made.

23·1 (b) *L. rohita* and *C. mrigala* were bred successfully in paddy fields which were used as bundh for the purpose of breeding experiments. Both male and female breeders were administered with pituitary extract in a single dose prior to releasing them in the bundhs. 16,250 ml of eggs were collected from the bundh.

Project : All India coordinated research project on composite fish culture and fish seed production

CFCSP I to 17 A production of 5,160 kg/ha/6½ months was achieved at Poona sub-centre, when fingerlings of *C. catla, L. rohita, C. mrigala, H. molitrix, C. idella* and *C. carpio* were stocked at the rate of 6,000/ha. At the same stocking density, productions to the tune of 5,535-7,748 kg/ha/18 months were obtained at Jaunpur sub-centre. A net production of 7,284 kg/ha/8 months was achieved at Karnal sub-centre through six species culture at a stocking density of 4,750 fingerlings/ha. Similar high production was also obtained at Kalyani centre. However, at Bhavanisagar sub-centre, the productions were comparatively low.

H. molitrix at Bhavanisagar and Gauhati sub-centres and *C. idella* at Poona sub-centre were bred for the first time.

Bundh breeding of *H. molitrix* was achieved by administering pituitary extract and 72 litres of eggs could be collected.

Electrical conductivity of different pond waters and the water samples of the river Hooghly was determined.

Fingerlings (93 nos.) of *C. idella* were found to consume completely the *Hydrilla* sp. and *Ceratophyllum* sp. planted in a 0·15 ha pond within seven weeks and attaining an average weight of 748 g during the period.

Carbohydrate-diets were found better than fat-diets for *C. mrigala* because of acceptibility and high rate of assimilation.

Experiments on composite fish culture without fertilisation and feeding were initiated in seven ponds with Indian major carps and exotic carps at Jaunpur sub-centre.

An estimated production of 2,233 kg/ha/6 months was obtained in the composite culture of catla, silver carp, mrigal, common carp, grass carp and *Channa* spp., stocked @ 10,000 nos./ha in the ratio of 1 : 3 : 6 : 3 : 4 : 3, in a 0·03 ha pond with the running water facilities. The above species of

Indian and exotic carps attained average weights of 360, 143, 330, 440 and 227 g respectively.

The experiments on composite culture in large sized ponds could not be completed on account of adverse flood condition resulting in severe damage to the bundhs. Harvesting of the adjoining ponds was initiated in December, 1975 and the same accounted for 9,700 kg of fish. The repairing of the bundhs is being continued and fresh experiments will be conducted by replenishing the harvested stock.

Overies from mature silver carps were collected for fecundity estimations. Studies on different stages of embryonic development of the fish were made.

Gonads of hypophysationised *Mystus vittatus* were preserved. Compensatory activity of the remaining gonads after hemicastration are being studied. Histophysiology of pituitary and gonads of *M. vittatus* are under study.

A net production of over 5,153·62 kg/ha/5½ months was obtained when fingerlings of Indian major carps were stocked @ 7,500/ha in the national demonstration pond at Nilgunj. The pond was fertilised with organic manure and inorganic fertilisers and the fishes were provided with supplementary feed.

From the data collected, it was found that there exist 6,000 private spawn collectors in Orissa, and 18,000 in West Bengal & Bihar.

Due to quick regeneration of clipped fins, it was not possible to identify the clipped fishes for estimation of total number of fish in a pond at Kalyani.

Some production functions and their variance functions were found out while some other production functions along with their variance functions are being worked out presently.

Project : All India coordinated research project on propagation and stocking of seed of air-breathing fishes for culture in swamps

A3F 1 to 6 A production of 1,200 kg/ha/7 months was achieved at Bihar sub-centre through mixed culture of *H. fossilis* and *C. batrachus*. In Karnataka sub-centre, experiments on murrel culture yielded 3,159 kg/ha/8 months while in Assam sub-centre productions to the tune of 30,000 to 50,000 kg/ha were achieved through cage culture of *Channa* spp. and *H. fossilis* when the production/m^2 area of cage was assessed.

Success was achieved in inducing *C. batrachus* to breed in mini rice fields with a high survival of spawn.

Raking of the bottom soils was found to change the chemical equilibrium of the pond water with immediate rise in the nutrient levels.

Two different types of protein feeds were screened for experimental feeding of *Clarias batrachus*.

Amylase and cellulase were found to be present in significant amount in the intestine of *C. batrachus*.

A. testudineus and *C. batrachus* grew to an average weight of 25 and 46·25 g respectively when they were stocked in a nursery pond (27 m × 25 m) @ 70,000 and 40,000 nos./ha. For swampification of the pond and supplementary feeding, slaughter house waste was broadcast @ 10 kg/day for 3 months and then @ 15 kg/day for another one and a half months.

C. batrachus (18·0 g) and *H. fossilis* (7·0 g) were stocked in cages installed in Arang-Sarisha beel, @ 120 and 190/cage respectively. Of the 10 cages installed 5 were stocked with *C. batrachus* while other five were stocked with *H. fossilis*. The fishes were provided with supplementary feed and the maximum weight gained per fish was 13·5 g for *H. fossilis* and 8·7 g for *C. batrachus*.

ABF 7 (Research contemplated)

Project : All India coordinated research project on ecology and fisheries of freshwater reservoirs

R I Investigations were conducted on fish yield, dynamics of fish stocks, physico-chemical characteristics of soil & water, organic production, and fish food resources in Bhavanisagar, Nagarjunasagar, Rihand, Getalsud and Govindsagar reservoirs. The estimated fish yield during the year was of the order of 208 t in Bhavanisagar, 111 t in Nagarjunasagar, 242 t in Rihand and 475 t in Govindsagar reservoirs. An increase of 68% fishing effort from that of 1971-72 level has resulted in the improvement in the catch by 121·4% at Bhavanisagar whereas in Govindsagar, 101·0% increase (from 1972-73) in the catch could be possible due to increase in the mesh size of the gears operated. At Getalsud reservoir, the stocked exotic silver carp, *Hypophthalmichthys molitrix* registered a growth of 1·7 to 2·1 kg in 17 months. Natural breeding and recruitment was noted in respect of *Catla catla* and *Cirrhinus mrigala* in Rihand, *Labeo calbasu* and *Cirrhinus mrigala* in Bhavani-

sagar and *L. fimbriatus* and some catfishes in Nagarjunasagar. Three sub-species of *C. catla* were identified in Rihand.

Ecological studies conducted so far in the above mentioned reservoirs revealed that the inflow from the catchment area largely determines the water quality of the impoundment rather than the reservoir soil. Organic production was of a higher order in Govindsagar, Bhavanisagar and Nagarjunasagar. The standing crop of net plankton was high in Govindsagar and Getalsud. *Microcystis* sp. formed the dominant segment of phytoplankton in all the reservoirs except in Govindsagar where *Ceratium* sp. ranked the first. Biomodel plankton production was significant in all these reservoirs. Bottom biota was rich in Nagarjunasagar, chiefly contributed by molluscs while in other reservoirs insect larvae and oligochaetes were predominant.

7. PERSONNEL

Retirement : Dr. A. David, Fishery Scientist retired during the year under report.

Promotion : The following promotions took place during the year under report :-

Shri P. K. Sthanapati	:	From Assistant to Superintendent
Shri S. C. Saha Shri M. R. Roy	:	From Senior Clerk to Head Clerk
Shri H. K. Madulia	:	From Laboratory & Field Assistant to Junior Survey Assistant
Shri M Subrahmanium Shri L. P. Misra Shri Awadh Sah	:	From Junior Clerk to Senior Clerk

Transfers : The following transfers were made during the year under raport :-

Fishery Scientist

Smt. T. Rajyalakshmi	:	Rajahmundry to Barrackpore

Junior Fishery Scientist

Shri R. M. Rao	:	Barrackpore to Badampudi
Shri D. V. Pahwa	:	Allahabad to Calcutta and then to Karnal
Shri B. V. Govind	:	Ranchi to Bangalore
Dr. G. N. Mukherjee	:	Bhagalpur to Allahabad
Shri S. K. Wishard	:	Allahabad to Bhagalpur
Shri M. Y. Kamal	:	Patna to Ranchi

Assistant Fishery Scientist

Shri K. K. Vass	:	Barrackpore to Srinagar
Shri N. K. Das	:	Darbhanga to Hazaribagh and then to Kakdwip

Senior Research Assistant

Shri A. Chawdhury	:	Diamond Harbour to Calcutta
Shri P. N. Jaitly	:	Patna to Ranchi
Shri D. K. Kaushal	:	Hazaribagh to Bilaspur
Shri K. M. Das	:	Kakdwip to Barrackpore
Shri V. K. Murugesan	:	Bhadra to Bangalore
Shri C. B. Joshi	:	Srinagar to Uttarkashi
Shri R. K. Das	:	Nagarjunasagar to Barrackpore
Shri D. Nath	:	Allahabad to Cuttack

Research Assistant

Shri A. R Chowdhury	:	Namkhana to Kakdwip
Shri N K. Srivastava	:	Allahabad to Cuttack
Shri P. R. Das	:	Port Canning to Barrackpore

Overseer

Shri P. N. Bhattacharya	:	Kakdwip to Barrackpore

Junior Survey Assistant

Shri D. N. Srivastava	:	Kalyani to Allahabad
Shri K. S. Banerjee	:	Bhagalpur to Barrackpore
Shri S. P. Ghosh	:	Hasnabad to Calcutta and then to Barrackpore

Senior Clerk

Shri S. P. Sastry	:	Rajahmundry to Cuttack
Shri I. N. Kodandaraman	:	Bhadra to Bangalore

Junior Clerk

Shri Kallu Singh	:	Allahabad to Bangalore
Shri S. Bhattacharjee	:	Kakdwip to Barrackpore

Laboratory and Field Assistant

Shri N. N. Majumdar	:	Cuttack to Calcutta
Shri Sukumar Saha	:	Calcutta to Barrackpore
Shri Comil Lakra	:	Ranchi to Getalsud

Laboratory Boy

Shri S. Sasmal	:	Allahabad to Cuttack

Messenger

Shri R. L. Debroy	:	Barrackpore to Kakdwip

Watchman

Shri M. Mahadeva	:	Bhadra to Bangalore
Shri B. N. Krishnappa	:	Bhadra to Bangalore

Fisherman

Shri Dukhram	:	Karnal to Poona
Shri S. T. Gavate	:	Poona to Kalyani
Shri S. S. Vanjari	:	Poona to Kalyani and to Poona again
Shri L. K. Halder	:	Jaunpur to Maldah
Shri K. Ningegowda	:	Bhadra to Bangalore
Shri Subrami	:	Bhadra to Bangalore
Shri Maligegowda	:	Bhadra to Bangalore
Shri A. Kemparasa	:	Bhadra to Bangalore

Staff : The following staff rendered their services to the Institute :

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 (officiated as Director-in-Charge from 24.5.75 to 24.9.75)
Fishery Scientist	:	Sarvashri V. Ramachandran, R. D. Chakraborty and Dr. S. B. Singh
Junior Fishery Scientist	:	Sarvashri M. A. V. Lakshmanan (also working for IDRC Project since 21.2.75), R. M. Bhowmick, N. G. S. Rao, G. N. Saha, G. V. Kowtal, P. R. Sen, D. S. Murty, S. Patnaik, N. K. Tripathi and Dr. C. R. Das
Junior Engineer	:	Shri C. Saha
Assistant Fishery Scientist	:	Sarvashri A. K. Ghosh, R. K. Jana, D. K. Chatterjee, C. Selvaraj, S. K. Mukhopadhyay (on study leave), T. Ramaprabhu, K. H. Ibrahim (on other duty under Government of Tanzania), S. Jena and S. N. Datta
Assistant Statistician	:	Shri M. D. Rout
Senior Research Assistant	:	Sarvashri S. N. Mohanty, S. D. Gupta, P. L. N. Rao, S. R. Ghosh, Binayak Dash, D. Nath (from 8.7.75), D. R. Kanaujia, R. K. Dey and Dr. K. J. Ram
Research Assistant	:	Sarvashri P. V. G. K. Reddy, S. L. Kar and N. K. Srivastava (from 21.6.75)
Draftsman	:	Shri Chakradhar Sahoo
Estimator	:	Shri Muralidhar Mantri
Assistant	:	Sarvashri P. C. Kanungo and A. K. Das and others

1·2 Sewage-fed Fisheries Unit, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri Apurba Ghosh
Senior Research Assistant	:	Sarvashri L. H. Rao and Susanta Saha
Overseer	:	Shri P. N. Bhattacharyya
		and others

2. Reverine and Lacustrine Fisheries Division (Allahabad)

2.1 Central Inland Fisheries Research Substation, Allahabad (Uttar Pradesh)

Fishery Scientist	:	Shri J. C. Malhotra and Dr. A. G. Jhingran
Junior Fishery Scientist	:	Sarvashri D. V. Pahwa (up to March, 1975), S. K. Wishard (up to 22.6.75), S. J. Karamchandani, Dr. R. S. Panwar, Dr. M. Peer Mohamed and Dr. G. N. Mukherjee (from 10.4.75)
Assistant Fishery Scientist	:	Sarvashri S. P. Singh, K. L. Shah and K. P. Srivastava (from March, 1975)
Senior Research Assistant	:	Sarvashri S. N. Mehrotra, R. K. Tyagi, D. Kapoor, Shree Prakash, R. N. Seth, H. C. Joshi, D. Nath (up to 7.7.75), K. P. Srivastava (up to March, 1975), B. C. Jha, Ramwater Gupta, G. N Srivastava and K. Chandra
Research Assistant	:	Sarvashri R. K. Saxena, N. K. Srivastava (up to 20.6.75) R. K. Dwivedi (on study leave) and M. D. Pisolkar
Assistant	:	Shri K. B. Rajani
		and others

2.2 Central Inland Fisheries Research Unit, Bhagalpur (Bihar)

Junior Fishery Scientist	:	Dr. G. N. Mukherjee (up to 9.4.75) and S. K. Wishard (from 23.6.75)
Senior Research Assistant	:	Sarvashri S N. Sar and B. L. Pandey
Research Assistant	:	Shri R. C. Singh
		and others

2.3 Krishna Godavari Unit, Rajahmundry (Andhra Pradesh)

Fishery Scientist	:	Shrimati T. Rajyalakshmi (*ad hoc* up to 5.6.75)
Senior Research Assistant	:	Shri K. V. Rao
Research Assistant	:	Shri T. S. Ramaraju

and others

2·4 Reservoir Fisheries Research Unit, Hazaribagh (Bihar)

Senior Research Assistant	:	Sarvashri M. Ramakrishnaiah, D. K. Kausal (up to 19.6.75) and P. K. Malhotra
Research Assistant	:	Sarvashri S. K. Sarkar, B. Roy (on study leave) and B. K. Banerjee

and others

2·5 Tank Fisheries Research Unit, Bangalore (Karnataka)

Fishery scientist	:	Dr. A. David (Retired on 28.2.75)
Junior Fishery Scientist	:	Shri B. V. Govind (from 8.2.75)
Senior Research Assistant	:	Shri P. K. Sukumaran
Research Assistant	:	Shri Lakshmiraghavan

and others

2·6 Cold Water Fisheries Research Unit, Srinagar (Kashmir)

Junior Fishery Scientist	:	Dr. K. L. Sehgal
Assistant Fishery Scientist	:	Shri K. K. Vass (from April, 1975)
Senior Research Assistant	:	Sarvashri M. J. Bhagat, Kuldip Kumar, C. B. Joshi and Shyam Sundar

and others

2·7 Brahmaputra Survey Unit, Gauhati (Assam)

Junior Fishery Scientist	:	Shri Ravish Chandra
Senior Research Assistant	:	Sarvashri H. P. Singh, M. Chowdhuri and V. Kolakar (from April, 1975)

and others

3. Estuarine Fisheries Research Division (Barrackpore)

Senior Fishery Scientist : Dr. V. Gopalakrishnan (on FAO assignment)

3·1 Estuarine Fisheries Research Substation, Calcutta (West Bengal)

Fishery Scientist : Shri B. B. Pakrasi

Senior Research Assistant : Sarvashri N. C. Basu and A. Chaudhuri (from April, 1975)

Assistant : Shri M. L. Biswas

and others

3·2 Estuarine Fisheries Research Section, Barrackpore (West Bengal)

Fishery Scientist : Smt. T. Rajyalakshmi (joined on 6.6.75 and proceeded on study leave since 7.6.75)

Junior Statistician : Shri K. K. Ghosh

Fishery Economist : Shri M. Randhir

Assistant Fishery Scientist : Sarvashri B. B. Ghosh, K. K. Bhanot, D. D. Halder, A. C. Nandy, S. B. Saha and K. K. Vass (up to April, 1975)

Senior Research Assistant : Sarvashri G. C. Laha, M. M. Bagchi, P. M. Mitra, S. K. Mazumder, P. K. Mukhopadhyay, A. Chaudhuri (up to April, 1975) and Dr. H. Singh

Research Assistant : Sarvashri P. R. Das, B. K. Saha, R. N. Dey, A. R. Chaudhury (up to April, 1975), R. K. Chakraborty, D. K. De (on study leave), H. S. Mazumdar and P. B. Das

and others

3·3 Estuarine Fisheries Research Unit, Kakdwip (West Bengal)

Fishery Scientist : Shri A. N. Ghosh

Junior Fishery Scientist : Dr. P. U. Verghese

Assistant Fishery Scientist : Shri N. K. Das (from July, 1975)

Senior Research Assistant : Sarvashri G. N. Chattopadhyay, K. M. Das (up to 20.7.75), H. C. Karmakar, P. K. Ghosh, A. K. Roy, Hardayal Singh and N. M. Chakraborty (from April, 1975)

Research Assistant	:	Sarvashri A. R. Chaudhury (from April, 1975) P. K. Pandit and M. K. Mukhopadhyay
Overseer	:	Shri B. Basak

and others

3·4 Pulicat Lake Unit, Madras (Tamil Nadu)

Fishery Scientist	:	Shri K. Raman
Junior Fishery Scientist	:	Shri K. V. Ramakrishna
Assistant Fishery Scientist	:	Sarvashri R. D. Prasadam and G. R. M. Rao
Senior Research Assistant	:	Sarvashri S. Radhakrishnan, R. Ganapathy, C. P. Rangaswamy, K. Gopinathan, M. Kaliyamurthy and K. O. Joseph
Research Assistant	:	Shri S. Srinivasagam

and others

3·5 Sunderban Survey Unit, Kakdwip (West Bengal)

Junior Fishery Scientist	:	Shri A. V. P. Rao
Fisheries Farm Engineer	:	Shri A. Sengupta
Assistant Engineer	:	Shri A. B. Mukherjee
Overseer	:	Shri P. N. Bhattacherjee (up to 3.11.75)

and others

3·6 Prawn Breeding Unit, Kakinada (Andhra Pradesh)

Junior Fishery Scientist	:	Dr. M. Subrahmanyam
Senior Research Assistant	:	Shri K. G. Rao
Research Assistant	:	Sarvashri D. R. Rao and K. S. Rao

and others

4. Units under direct control of the Director

4·1 Soil Chemistry and Weed Control Unit, Calcutta (West Bengal)

Fishery Scientist	:	Dr. (Miss) E. Mitra (up to 1.12.75 on *ad-hock* basis)

Research Assistant	:	Sarvashri A. R. Chaudhury (from April, 1975) P. K. Pandit and M. K. Mukhopadhyay
Overseer	:	Shri B. Basak

and others

3·4 Pulicat Lake Unit, Madras (Tamil Nadu)

Fishery Scientist	:	Shri K. Raman
Junior Fishery Scientist	:	Shri K. V. Ramakrishna
Assistant Fishery Scientist	:	Sarvashri R. D. Prasadam and G. R. M. Rao
Senior Research Assistant	:	Sarvashri S. Radhakrishnan, R. Ganapathy, C. P. Rangaswamy, K. Gopinathan, M. Kaliyamurthy and K. O. Joseph
Research Assistant	:	Shri S. Srinivasagam

and others

3·5 Sunderban Survey Unit, Kakdwip (West Bengal)

Junior Fishery Scientist	:	Shri A. V. P. Rao
Fisheries Farm Engineer	:	Shri A. Sengupta
Assistant Engineer	:	Shri A. B. Mukherjee
Overseer	:	Shri P. N. Bhattacherjee (up to 3.11.75)

and others

3·6 Prawn Breeding Unit, Kakinada (Andhra Pradesh)

Junior Fishery Scientist	:	Dr. M. Subrahmanyam
Senior Research Assistant	:	Shri K. G. Rao
Research Assistant	:	Sarvashri D. R. Rao and K. S. Rao

and others

4. Units under direct control of the Director

4·1 Soil Chemistry and Weed Control Unit, Calcutta (West Bengal)

Fishery Scientist	:	Dr. (Miss) E. Mitra (up to 1.12.75 on *ad-hock* basis)

Junior Fishery Scientist	:	Dr. (Miss) E. Mitra (from 2.12.75) and Shri P. Ray
Assistant Fishery Scientist	:	Shri S. C. Banerjee *(ad-hoc)*
Senior Research Assistant	:	Sarvashri A. C. Banerjee, R. K. Banerjee and S. C. Thakurta

and others

4·2 Frog Culture Unit, Kalyani (West Bengal)

Fishery Scientist	:	Dr. A. K. Mandal
Junior Fishery Scientist	:	Dr. M. L. Bhowmick and Shri M. K. Bandyopadhyay (up to 5.2.75)
Senior Research Assistant	:	Sarvashri V. K. Sharma, B. K. Misra and P. Kumaraih

and others

4·3 Library and Documentation Unit, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri B. N. Saigal
Senior Research Assistant	:	Sarvashri A. K. Dutta, Amitabha Ghosh and Smt. K. K. Bhanot
Research Assistant	:	Shri P. K. Chakrabarti (on study leave)
Senior Library Assistant (Gr. I)	:	Smt. Anjali De
Senior Library Assistant (Gr. II)	:	Smt. Sukla Das
Senior Artist	:	Shri J. Ghosh
Artist Photographer	:	Shri A. R. Mazumdar

and others

4·4 Fisheries Extension Unit, Barrackpore (West Bengal)

Senior Extension Officer	:	Shri P. Das
Extension Officer	:	Shri B. K. Sharma
Senior Research Assistant	:	Sarvashri A. Mukherjee and Jagdish Chander
Photographic Assistant	:	Shri P. K. Ghosh
Artist	:	Shri S. K. Das

and others

4·5 Technical Officer to the Director at Barrackpore

Junior Fishery Scientist	:	Shri S. D. Tripathi (up to June, 1975)— working for IDRC Project also since 21.2.75

4·6 Adminitrative Section, Barrackpore (West Bengal)

Adminitrative Officer	:	Shri C. D Kulkarni
Assistant Administrative Officer	:	Shri S. N. Chakraborty (from 7.7.75)
Superintendent	:	Sarvashri S. N. Chakraborty (up to 6.7.75), P. K. Sthanapati and K. C. Roy (from 7.7.75 on *ad-hoc* basis)
Assistant	:	Sarvashri K. C. Roy (up to 6.7.75), A. K. Sengupta, N. G. Chatterjee, B. C. Dutta and M. R. Roy (from 1.3.75)
Stenographer	:	Shri G. Lahiri

and others

4·7 Accounts and Audit Section, Barrackpore (West Bengal)

Accounts Officer	:	Shri M. K. Sarkar
Assistant	:	Sarvashri S. C. Roy *(ad-hoc)* and S. C. Saha (from 1.3.75)

and others

4·8 Stores Section, Barrackpore (West Bengal)

Assistant Administrative Officer	:	Shri S. K Chatterjee (from 7.7.75)
Superintendent	:	Shri S. K. Chatterjee (up to 6.7.75)

and others

5. Institute based Coordinated Project

5·1 Coordinated Project on Reservoir Fisheries

5·1·1 Main Centre, Hazaribagh (Bihar)

Senior Fishery Scientist	:	Shri A. V. Natarajan
Junior Fishery Scientist	:	Shri V. T. Prabhakaran
Assistant Fishery Scientist	:	Shri N. K. Das (from March to July, 1975)

and others

5.1.2 Subcentre, Nagarjunasagar (Andhra Pradesh)

Junior Fishery Scientist : Shri G. K. Bhatnagar

Senior Research Assistant : Sarvashri V. V. Sugunan, V. Pathak and R. K. Das (up to 1.2.75)

Research Assistant : Smt. Gobi Kumari Vinci (from April, 1975) and others

5.1.3 Subcentre, Bhavanisagar (Tamil Nadu)

Junior Fishery Scientist : Shri Ch. Gopalakrishnayya

Senior Research Assistant : Sarvashri A. Mathew and B. P. Gupta and others

5.1.4 Subcentre, Rihand (Uttar Pradesh)

Junior Fishery Scientist : Shri V. R. Desai

Senior Research Assistant : Sarvashri R. K. Singh and N. P. Srivastava and others

5.1.5 Subcentre, Ranchi (Bihar)

Junior Fishery Scientist : Shri B. V. Govind (up to 7.2.75)

Senior Research Assistant : Sarvashri J. N. Pal and S. N. Singh and others

5.1.6 Subcentre, Bilaspur (Himachal Pradesh)

Junior Fishery Scientist : Dr. Y. Rama Rao

Senior Research Assistant : Sarvashri M. P. Kohali and D. K. Kausal (from 20.6.75) and others

5.2 Coordinated Project on Composite Fish Culture and Fish Seed Production

A. Composite Fish Culture Centres

5.2.1 Main Centre, Barrackpore (West Bengal)

Senior Fishery Scientist	:	Dr. V. R. P. Sinha
Junior Fishery Scientist	:	Sarvashri R. M. Rao (up to 18.1.75), D. V. Pahwa (from March to June, 1975 and was posted in Calcutta) and Dr. B. N. Singh
Senior Research Assistant	:	Sarvashri D. P. Chakraborty, P. K. Saha and P. C. Mahanta

and others

5.2.2 Subcentre, Kalyani (West Bengal)

Junior Fishery Scientist	:	Shri M. V. Gupta
Senior Research Assistant	:	Shri Dhirendra Kumar

and others

5.2.3 Subcentre, Badampudi (Andhra Pradesh)

Junior Fishery Scientist	:	Shri R. M. Rao (from 19.1.75)
Assistant Fishery Scientist	:	Shri J. B. Rao (from March, 1975)
Senior Research Assistant	:	Shri J. B. Rao (up to March 1975)

and others

5.2.4 Subcentre, Bhavanisagar (Tamil Nadu)

Junior Fishery Scientist	:	Shri K. N. Krishnamurthy
Senior Research Assistant	:	Shri P. K. Aravindakshan

and others

5.2.5 Subcentre, Jaunpur (Uttar Pradesh)

Junior Fishery Scientist	:	Shri H. A. Khan
Assistant Fishery Scientist	:	Shri S. C. Pathak (up to 24.2.75)
Senior Research Assistant	:	Shri D. N. Misra

and others

5.2.6 Subcentre, Karnal (Haryana)

Junior Fishery Scientist : Sarvashri K. K. Sukumaran (on FAO assignment since 23.9.75) and D. V. Pahwa (from June, 1975)

Senior Research Assistant : Shri B. C Tyagi

and others

5.2.7 Subcentre, Poona (Maharashtra)

Junior Fishery Scientist : Dr. K. P. P. Nambiar (up to 7.1.75)

Senior Research Assistant : Dr. P. M. Mathew and Shri B. K. Singh (from April, 1975)

and others

B. Seed Production Centres

5.2.8 Main Centre, Barrackpore (West Bengal)

Junior Statistician : Dr. K. Alagaraja

Junior Fishery Scientist : Shri M. R. Sinha

and others

5.2.9 Subcentre, Gauhati (Assam)

Junior Fishery Scientist : Dr. K. G. Rao

and others

5.2.10 Subcentre, Ranchi (Bihar)

Junior Fishery Scientist : Shri M. Y. Kamal (from 28.5.75)

Senior Research Assistant : Shri P. N. Jaitly (from 28.5.75)

and others

5.2.11 Subcentre, Patna (Bihar)

Junior Fishery Scientist : Shri M. Y. Kamal (up to 27.5.75)

Senior Research Assistant : Shri P. N. Jaitly (up to 27.5.75)

and others

5.3 Coordinated Project on Air-breathing Fish Culture

5.3.1 Main Centre, Barrackpore (West Bengal)

Senior Fishery Scientist	:	Dr. P. V. Dehadrai
Junior Fishery Scientist	:	Shri R. N. Pal
Senior Research Assistant	:	Shri R. K. Das (from 2.2.75)

and others

5.3.2 Subcentre, Darbhanga (Bihar)

Junior Fishery Scientist		Shri N. K. Thakur
Senior Research Assistant	:	Sarvashri N. K. Das (up to March, 1975) and S. A. K. Nasar

and others

5.3.3 Subcentre, Gauhati (Assam)

Junior Fishery Scientist	:	Shri S. C. Pathak (from 25.2.75)
Senior Research Assistant	:	Shri D. N. Singh

and others

5.3.4 Subcentre, Bangalore (Karnataka)

Junior Fishery Scientist	:	Shri S. Parameswaran (on FAO assignment from 5.7.75)
Senior Research Assistant	:	Shri V. K. Murugesan

and others

5.4 Coordinated Project on Brakish Water Fish Farming

(Pending recruitment of technical personnel, the work is being looked after by the staff of the Estuarine Fisheries Research Division under the supervision of the Director of the Institute)

6. IDRC Project

6.1 West Bengal Centres

6.1.1 Main Centre, Barrackpore (West Bengal)

Fishery Scientist	:	Shri S. D. Tripathi (from 30.5.75) — actually an officer of Cuttack Substation
Junior Fishery Scientist	:	Shri S. D. Tripathi (from 21.2.75 to 29.5.75) - actually technical officer to the Director
Senior Research Assistant	:	Shri K. M. Das (from 21.7.75)

and others

6.1.2 Subcentre, Harishchandrapur (Maldah), West Bengal

Senior Research Assistant (On deputation from the State Fisheries Department)	:	Sarvashri A. Mahalanobish (from 5.8 75) and K. K. Sengupta (from 16.6.75)

and others

6.1.3 Subcentre, Hanspukur (24-Parganas), West Bengal

Senior Research Assistant (On deputation from the State Fisheries Department)	:	Sarvashri J. Chatterjee (from 13.6.75) and S. R. Das (from 13.6.75)

and others

6.2 Orissa Centres

6.2.1 Main Centre, Cuttack (Orissa)

Junior Fishery Scientist	:	Shri M. A. V. Lakshmanan (from 21.2.75)— actually an officer of Cuttack Substation
Senior Research Assistant	:	Shri D. Nath (from 21.7.75)

and others

6.2.2 Subcentre, Puri (Puri), Orissa

Senior Research Assistant	:	Vacant
Research Assistant	:	Shri N. K. Srivastava (21.6.75)

and others

6.2.3 Subcentre, Aska (Ganjam), Orissa

Senior Research Assistant	:	Dr. S. P. Rai (from 6.6.75)

and others

(i) $\hat{P}_t = (\hat{N}_t + \hat{N}_{t+1})\ (\hat{\bar{W}}_{t+1} - \hat{\bar{W}}_t)/2$

$$V(\hat{P}_t) = \tfrac{1}{4}\left\{(N_t+N_{t+1})^2\left[V(\hat{\bar{W}}_{t+1})+(\hat{\bar{W}}_t)\right]+(\bar{W}_{t+1}-\bar{W}_t)^2\left[V(\hat{N}_t)+V(\hat{N}_{t+1})\right]\right\}$$

(ii) $\hat{P}_t = \hat{G}_t\hat{\bar{B}}_t$

$$V(\hat{P}_t) = \bar{B}^2_t\ V(\hat{G}_t) + G^2_t V(\hat{\bar{B}}_t) + G_t\bar{B}_t\ P(\hat{\bar{W}})\left[B_{t+1}\frac{V(\hat{\bar{W}}_{t+1})}{\bar{W}^2_{t+1}} - B_t\frac{V(\hat{\bar{W}}_t)}{\bar{W}^2_t}\right]$$

(iii) $\hat{P}_t = (\hat{\bar{W}}_{t+1} - \hat{\bar{W}}_t)(\hat{N}_t - \hat{N}_{t+1})/\hat{Z}_t$

$$V(\hat{P}_t) = \left\{(\bar{W}_{t+1}-\bar{W}_t)^2\left[V(\hat{N}_t)+V(\hat{N}_{t+1})\right]+(N_t-N_{t+1})^2\left[V(\hat{\bar{W}}_t)+V(\hat{\bar{W}}_{t+1})\right]\right\}/Z^2_t + \frac{1}{Z^4_t}(\bar{W}_{t+1}-\bar{W}_t)^2(N_t-N_{t+1})^2\left[\frac{V(\hat{N}_t)}{N^2_t}+\frac{V(\hat{N}_{t+1})}{N^2_{t+1}}\right] - \frac{2}{Z^3_t}(\bar{W}_{t+1}-\bar{W}_t)^2(N_t-N_{t+1})\,P(\hat{N}_t)\left[\frac{V(\hat{N}_t)}{N_t} + \frac{V(\hat{N}_{t+1})}{N_{t+1}}\right]$$

etc. in the usual notation.

APPENDIX- II

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(I. C. A. R.)
BARRACKPORE, WEST BENGAL

Ministry/Departmant/Office of Central Inland Fisheries Research Institute, Barrackpore, West Bengal,
Statement showing the total number of I.C.A.R. Servants and the number of Scheduled Castes/
Tribes amongst them as on 1st January, 1976

Class	Permanent Temporary	Total No. of employees	Scheduled Castes	Percentage to total employees	Scheduled Tribes	Percentage to total employees	Remarks
1	2	3	4	5	6	7	8
Class I	Permanent	44	1	2%	—	—	—
	Temporary	25	—	—	—	—	—
Class II	Permanent	31	1	3%	—	—	—
	Temporary	84	6	7%	—	—	—
Calss III	Permanent	132	27	20%	1	1%	—
	Temporary	88	13	15%	6	7%	—
Class IV	Permanent	139	35	25%	2	1%	—
(Excluding sweepers)	Temporary	90	20	22%	—	—	—
Class IV	Permanent	6	6	100%	—	—	—
(Sweeper)	Temporary	13	12	99%	1	8%	—

CENTRAL INLAND

ORGANISATIONAL CHART

FRESHWATER FISH CULTURE DIVISION
(Officer-in-Charge : Senior Fishery Scientist)

Pond Culture Research Sub-Station
(Cuttack, Orissa)

- Pond Culture Section
- Fish Breeding Section
- Exotic Fish Culture Section
- Weed Control Section
- Soil Chemistry Section
- Frog Culture Section
- Fish Farm Engineering Section
- Fish Pathology Section

SEWAGE-FED FISHERIES UNIT (West Bengal)

CENTRAL EXPERIMENTAL FRESH WATER FARM (Dhauli, Bhubaneswar)

ESTUARINE FISHERIES DIVISION
(Officer-in-Charge : Senior Fishery Scientist)

Estuarine Fisheries Research Sub-Station
(Barrackpore, West Bengal)

- Estuarine Fisheries Section
- Hilsa Fisheries Section
- Water Pollution Section
- Statistical Section
- Plankton Culture Section

SURVEY CENTRES

- Ulluberia
- Kolaghat
- Hasnabad
- Kalna
- Diamond Harbour
- Port Canning
- Raidighi
- Kalinagar
- Namkhana

FISH CULTURE UNIT IN PENINSULAR INDIA

BRACKISHWATER EXPERIMENTAL FISH FARMING UNIT (Kakdwip, W. Bengal)

PRAWN BREEDING UNIT (Kakinada, A. P.)

PULICAT LAKE UNIT (Tamil Nadu)

SURVEY CENTRES

- Pulicat
- Arambakkam

RIVERINE & LACUSTRINE FISHERIES DIVISION
(Officer-in-Charge : Senior Fishery Scientist)

Riverine Fisheries Research Sub-Station
Allahabad. U. P.)

- Riverine Fisheries Section
- Hilsa Fisheries Section
- Reservoir Fisheries Section
- Statistical Section
- Water Pollution Section

SURVEY CENTRES

- Buxar
- Lalgola

TANK FISHERIES UNIT (Bangalore)

LOWER GANGA UNIT (Bhagalpur)

KRISHNA GODAVARI UNIT (Tadepalligudem)

BRAHMAPUTRA SURVEY UNIT (Gauhati)

COLD WATER FISHERIES UNIT (Harwan, Srinagar)

RESERVOIR FISHERIES
(Project Co-ordinator : Senior Fishery S

Main Centre
(Hazaribagh, Bihar)

SUB-CENTRES

- NAGARJUNASAGAR (A. P.)
- BHAVANISAGAR (Tamil Nadu)
- RIHAND (U. P.)
- RANCHI (Bihar)
- BILASPUR (H.P.)
- GUJARAT ...

BARRACKPORE

DIRECTOR

.....CENTRALLY SPONSORED CENTRE

tist)

AIR BREATHING FISH CULTURE IN SWAMPS
(Project Co-ordinator : Senior Fishery Scientist)

Main Centre
(Barrackpore, West Bengal)

SUB-CENTRES

- GAUHATI (Assam)
- DARBHANGA (Bihar)
- BANGALORE (Karnataka)
- PALAIR (Khamman, A. P.)
- KALYANI (W. Bengal)

COMPOSITE FISH CULTURE & FISH SEED PRODUCTION
(Project Co-ordinator : Senior Fishery Scientist)

Main Centre
(Barrackpore, West Bengal)

SUB-CENTRES

- KALYANI (W. Bengal)
- BADAMPUDI (A.P.)
- BHAVANISAGAR (Tamil Nadu)
- JAUNPUR (U.P.)
- KARNAL (Haryana)
- POONA (Maharashtra)
- RANCHI (Bihar)
- GAUHATI (Assam)
- GUJARAT (2 Centres)
- COIMBATORE
- ORISSA
- MADHYAPRADESH

BRACKISH WATER FISH FARMING
(Project Co-ordinator : Senior Fishery Scientist)

Main Centre
(Kakdwip, West Bengal)

SUB-CENTRES

- GOA
- MAHARASTRA
- COCHIN (Kerala)
- KAKINADA (A.P.)
- MADRAS (Tamil Nadu)
- CHILKA (Orissa)

es Economics Unit
(Barrackpore))

Library & Documentation Unit
(Barrackpore)

Stores Section
(Barrackpore)

Audit Section
(Barrackpore)

Administrative and Accounts Section
(Barrackpore)