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CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE
BARRACKPORE

ANNUAL REPORT



CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE

ANNUAL REPORT

for the year

1972

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

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DOCUMENTATION SERVICE

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

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ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES
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1. DIRECTOR'S INTRODUCTION

History : The Central Inland Fisheries Research Institute was set up in March, 1947 at Calcutta, under the Ministry of Food and Agriculture, Government of India. The Institute's headquarters shifted in June, 1959 to its own buildings at Barrackpore situated on the left bank of the river Hooghly. The administrative control of the Institute was taken over by the Indian Council of Agricultural Research on October 1, 1967.

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

Organisational structure : The above stated three divisions of the Institute with their units; *viz.*, the Reservoir Fisheries Unit at Hazaribagh, Small Reservoirs Unit at Rewa, Tank Fisheries Unit at Bangalore, Lower Ganga Unit at Bhagalpur, Cold Water Fisheries Unit at Srinagar, Krishna Godavari Unit at Rajahmundry, Sunderbans Survey and Brackish Water Fish Farm Units at Kakdwip, Pulicat Lake Fisheries Research Unit at Madras and Fisheries Economics Unit at Barrackpore, continued to function as in the previous years. Soil Chemistry and Weed Control Units in Calcutta, and Documentation and Extension Units at Barrackpore functioned under the direct control of the Director. The Brahmaputra Survey Unit, under the control of the Riverine and Lacustrine Division, was established at Gauhati in October, 1972. Four All India Co-ordinated Research Projects; *viz.*, (i) Ecology and Fisheries of

Freshwater Reservoirs (with main Centre at Hazaribagh and Subcentres at Bhavanisagar, Nagarjunasagar and Rihand), (ii) Composite Culture of Indian and Exotic Fishes (with main centre at Barrackpore and subcentres at Kurnool, Bhavanisagar, Kalyani, Jaunpur, Karnal and Poona), (iii) Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps (with main centre at Darbhanga and subcentres at Bhadra and Gauhati), and (iv) the Investigations on Riverine Carp Spawn Prospecting (with main centre at Allahabad and subcentres at Barrackpore, Gauhati and Patna), since their initiation in mid-1971, continued to function under the control of the Director.

Library and Documentation : During the year under report, 167 books, 168 reprints, 60 miscellaneous publications and 1,175 issues of periodicals were added to the library of the Institute. 37 Indian and 45 foreign journals were continued to be subscribed. The Institute obtained, either as free gift or in exchange, 136 Indian and foreign journals. The present library holdings, inclusive of the year's arrivals, comprise 2,630 books, 1,522 bound periodicals, 3,175 reprints and 1,390 miscellaneous publications, excluding the stock of loose issues of journals, pamphlets, maps, departmental publications etc. Besides maintaining exchange relationship with 264 institutions and organisations, 20 new exchange relationships were established during the year. Accession lists for July-December, 1971 & January-June, 1972 and the 4th supplementary list of publications of the staff of CIFRI were brought out and circulated for the benefit of the staff of the Institute.

As many as 49 technical and non-technical enquiries from India and abroad were attended to by the Documentation Unit. The Institute supplied a number of its publications to the Institute of Library Information Service (Calcutta); University of Agricultural Sciences (Mangalore); Sub-Divisional Fisheries Officer (Motihari Sadar); Andhra Pradesh Agricultural University (Hyderabad); Bihar Prantiya Matsyajibi Sahyog Sangh Ltd. (Patna); National Commission of Agriculture (New Delhi); Jawaharlal Nehru Krishi Vishwa Vidyalaya (Jabalpur); Marketing Statistics and Survey of Government of West Bengal (Calcutta); National Committee on Environmental Planning Co-ordination (New Delhi); Maharashtra State Fisheries Department (Bombay); Haryana State Fisheries Department (Chandigarh) and Tamil Nadu State Fisheries Department (Madras) on inter library loan basis.

During the year, 125 reports on Progress of Research were compiled and sent to the Indian Council of Agricultural Research. "Bibliography of Indian Fisheries" Vol. 10(2-4), 1971 and Vol. 11(1 & 2), 1972, "Miscellaneous Contribution" of the CIFRI No. 7 & 8 entitled "Report on training in principles of gear fabrication at CIFT Substation, Burla" and "Methodology for Pre-impoundment Survey Techniques for Preparation of Reservoirs for Fish Culture" and the Half-yearly Technical Progress Report, January-June, July-December, 1971 and January-June 1972 were brought out. The proceedings and discussion papers of "Seminar on Quality Fish Seed for Fish Culture" were published. The annual report of the Institute for the year 1971 was brought

out in printed form. Besides the above, 250 sketches/diagrams, 75 posters/charts and 1,050 photographs on research findings were prepared.

Honours, Awards etc. : Dr. V. G. Jhingran, Director of the Institute was nominated Chairman of the I.P.F.C. Working Party meeting on Coastal Aquaculture and Environment held during October 14-17, 1972 at Wellington, New Zealand. He was also nominated Chairman for the session on Scientific and Technical Discussions on Coastal Aquaculture and Environment which took place in the I.P.F.C. meeting on October 23 and 24, 1972.

Shri G. N. Srivastava, Research Assistant has been awarded Junior fellowship of the ICAR for post-graduate study during the year under report.

Distinguished visitors : The following scientists and distinguished persons visited the Institute and its various establishments during the year under report : Mr. Leonard Ejsymont, Faculty of Marine Fisheries Agricultural College, Szezein, Poland ; Mr. P. N. Harton, Second Officer, British Council, New Delhi ; Mr. M. S. Lekis, Assistant Representative, British Council, Calcutta ; Mr. T. Wyatt, Fisheries Laboratory, Lowestoft ; Mr. F. A. Petrasidle, Senior Seminar in Foreign Policy, U.S. Department of States, Washington D.C. ; Mr. Ponciano C. Gutierrez, Supervising Fishery Biologist, Philippine, Fisheries Commission, Manila ; Mr. Helmut Morsbach, Department of Social Psychology, Glasgow University, Scotland ; Mr. Bessarabov with Mr. Macutia and Mrs. Popova, Institute for Fish Industry, Moscow, USSR ; Mr. & Mrs. J. C. Fraser, Department of Fish, California, U.S.A. ; Shri Fakhruddin Ali Ahmed, Hon'ble Union Minister for Agriculture (Government of India) with Begam Yusuf Khan ; Shri Santosh Kumar Roy, Hon'ble Minister for Fisheries (Government of West Bengal) ; Mr. C. N. Penn Antony, Secretary, Department of Fisheries and Forest (Government of West Bengal) ; Mr. K. P. A. Menon, Agriculture Commissioner (Government of West Bengal) ; Dr. M. S. Swaminathan, Director-General, Indian Council of Agricultural Research, New Delhi with Dr. R. Raghu Prasad, Assistant Director-General ; Shri J. V. A. Dixitulu, Assistant Commissioner, Ministry of Agriculture (Government of India) ; Professor W. Macnae, WW Rand University, Johannesburg, S. Africa ; Dr. E. Woynarovich, FAO/UNDP (TA) from Kathmundu Nepal ; Mr. Stephen E. Craford, American Peace Corps Volunteer, Kota, Rajasthan ; Mr. K. C. Pradhan, Conservator of Forest Sikkim ; Mr. H. D. Naithani, Agricultural Advisor (Government of Sikkim), Gangtok ; Ch. Randhir Singh, Member National Agricultural Commission (Government of India), New Delhi ; Shri Rajani Kanta Das, M.L.A. (West Bengal) ; Dr. D. R. Bhatia, Dr. P. N. Ganapati and Dr. B. S. Bhimachar, Members of Achievement Audit Committee of the ICAR ; Shri B. Sivaraman, Vice-Chairman, National Agriculture Commission, New Delhi ; Shri Sakti Sarkar Member of the parliament and Mr. K. T. Rathod, Minister of State for Fisheries (Government of Mysore).

Important events of the year—Glass jar hatchery : For seed production of quality fish involving injection of pituitary gland extract to breeders,

considerable mortality of developing eggs takes place in the commonly followed practice of hatching the eggs in *hapas* made of cloth fixed in the open ponds. Introduction of glass hatching jars with circulation of water, for hatching carp eggs in temperature controlled hatchery has given highly satisfactory results. These seek to revolutionise fish breeding and hatching techniques. Nearly cent per cent eggs hatch out in the specially designed jars. The hatchery ensures greater production of stocking material in a limited area under controlled conditions and opens up avenues for intensive fish culture in India.

Fry-raising in pond fish culture : In Indian freshwater pond fish culture shallow nurseries are used for raising carp spawn into fry. Unprepared nurseries may lead to total mortality of the stocked spawn. The development of rearing carp spawn into fry resulting in a survival of over 50% as against hardly 2-10%, obtained by adopting traditional methods, was one of the major achievements in Indian fish culture until the past. More recently, in carp fry raising experiments, the survival rate has been raised from 50% to as high as 70-75%. Concomitantly, the stocking rate of spawn has been increased from 1 million/ha to as high as 3.75 million/ha. The combined result of enhanced stocking and high survival is that 4 to 5 million fry/ha can be produced in a single crop of 15 days' duration as against 20,000 to 40,000 obtained by adopting conventional methods. These developments have greatly enhanced the profitability of fry raising in pond fish culture.

Composite fish culture : Through composite culture experiments at the Freshwater Fish Culture Substation, Cuttack a production of over 3,000 Kg/ha within a period of 8 months has been obtained by stocking hybrids of catla and calbasu and acclimatised fry of *Mugil cephalus* (70 mm) along with the Indian and exotic carps. *M. cephalus* cultured with the carps has shown an average growth of 286 mm within a period of 5½ months.

Under the All-India Co-ordinated Research Project on Composite Fish Culture of Indian and Exotic fishes, certain significant production results have been obtained at the Kulia Subcentre (West Bengal) where ponds are located on gangetic aluvial soil. The grass carp *Ctenopharyngodon idella* when stocked with *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Hypophthalmichthys molitrix* and *Cyprinus carpio* in the ratio of 1 : 1 : 3 : 1.25 : 2.25 : 1.25 respectively and at a stocking rate of 5,000 fingerlings/ha, has shown an average growth of 2.5 Kg in 5 months. Such a fast growth rate constitutes the highest record of this fish anywhere in the world. At Kulia excellent ecological conditions appear to have been found for the culture of grass carp. *C. carpio* has shown an average size of 256 mm/320 gm in 8 months. At the time of stocking, the fingerlings of *C. idella* and *C. carpio* were 122 mm/45 gm and 47 mm/1 gm respectively. At Kulia a pond 0.15 ha in area, when harvested after 6 months of rearing, gave a gross production of 3,232 Kg/ha/6 months. Significant results have also been obtained at the Gujartal Sub-centre of the Co-ordinated Project in Uttar Pradesh where *H. molitrix* stocked with *C. catla*, *L. rohita*, *C. mrigala*, *C. idella* and *C. carpio* in the ratio 2 : 1.5 : 3 : 1.25 : 1 : 1.25 respec-

tively and a stocking density of 5,000/ha, had grown to an average weight of 771 gm in 4 months.

Culture of Mugil parsia : In brackish water fish farming of *Mugil parsia* by adopting supplementary feeding, an annual production of about 2,400 Kg/ha has been achieved at the Brackish Water Experimental Fish Farm, Kakdwip, West Bengal.

Hybridization : Success has been achieved in producing hybrids of the common carp, *Cyprinus carpio* and the Indian major carp, *Catla catla*, for the first time. The hatchlings so produced, are being reared for further studies.

Control of Argulus infection in fishes : Dip treatment with 1 ppm aqueous solution of Benzene hexachloride has been found effective for the control of *Argulus* sp. infection in fishes in ponds.

Silver Jubilee celebrations : The Silver Jubilee of the Central Inland Fisheries Research Institute was celebrated on December 1, 1972 at the Headquarters of the Institute at Barrackpore. In the function organised on that occasion, Dr. M. S. Swaminathan, Director-General, ICAR welcomed the Hon'ble Union Minister for Agriculture, distinguished scientists and guests. He pointed out the great strides made by the Institute in the development of fresh and brackish water fish culture practices. He expressed the hope of achieving a production of well over 4,000 Kg/ha/yr by judicious combination of both indigenous and exotic fishes along with proper fertilization and supplementary feeding. Shri F. A. Ahmed, Union Minister for Agriculture, in his inaugural address, pointed out that the target for inland fish production at the end of the Fourth Plan was fixed at 7.97 lakh tonnes and still 1.0 lakh tonnes are required to be produced during the remaining period of the 4th Plan. Shri Ahmed was greatly impressed by the achievements of the Institute and laid stress on the importance of developing fisheries of inland waters, particularly the culture fisheries. Initiative taken by the Institute in the development of coastal aquaculture in the lower Sunderbans was greatly appreciated by the Minister as a step in the right direction towards the realization of the potentials of fish culture in coastal waters. Dr. V. G. Jhingran, the Director of the Institute, presenting a report on the symposium on "Aquaculture as an Industry", highlighted the recent breakthrough achieved through composite culture of Indian and exotic fishes. He emphasized the need of setting up fish farmers' development agencies and at least one fish farm to produce table size fish in each state.

An exhibition depicting progress of inland fisheries research through the media of live specimens, charts and models was held as a part of the silver jubilee celebrations of the Institute. A symposium on "Aquaculture as an Industry" was also organised to coincide with the Silver Jubilee function of the Institute.

Achievement audit : The Achievement Audit Committee appointed by the Indian Council of Agricultural Research, New Delhi, visited the Headquarters and various substations and units of the Institute for the purpose of assessing the progress made under various research programmes of the Institute.

Central Experimental Fish Farm, Dhauli, Orissa : The contour survey of the land at Dhauli near Bhubaneswar, the site selected for locating the Central Freshwater Experimental Fish Farm, has been undertaken by the CPWD and the master plan of the fish farm complex consisting of hatcheries, experimental ponds, laboratories, aquaria and residential quarters is being drawn by them.

Extension unit : An Extension Unit of the Institute with its Headquarters at Barrackpore was established in the year 1972, to carry the research results achieved by the Institute to the field for practical application by the fish farmers as well as to bring the problems of pisciculturist to the Institute for their suitable solutions.

Research collaboration with institutes, universities, colleges and other institutions at national level : In view of the increasing demand for fish seed for culture purposes, the Institute continued to help the State Governments in locating new spawn collection centres on the rivers of the country for the last eight years. During the year under report, the work was carried out through an All India Co-ordinated Research Project on Riverine Carp Spawn Prospecting and Collection Techniques, at Kishanpur on the river Yamuna in Uttar Pradesh, Circuit House Ghat on the river Brahmaputra in Assam, Manikchakghat on the river Ganga in West Bengal and Jahangira on the river Ganga in Bihar. Among the sites prospected Jahangira on the river Ganga in Bihar appeared to be a promising centre.

The Institute's joint programmes with certain State Governments in standardising breeding, rearing and culture techniques of air-breathing fishes in swamps and derelict waters was continued through the all India Co-ordinated Research Project on Propagation and Stocking of Seed of Air-Breathing Fishes for culture in Swamps at Balbhadrapur (Bihar), Bhadra (Mysore) and Gauhati (Assam). Limnological studies and investigations on the biology of air-breathing fishes were continued.

The State Governments continued to get assistance from the Institute in developing formulae of species combination of fishes whereby fishes feeding in different niches are cultured together leading to increased production in fish culture operations. The scheme is being implemented in different soil and climatic zones; at Kulia Fish Farm (West Bengal), Gujartal Fish Farm (Uttar Pradesh), Govt. Fish Seed Farm (Haryana), Sunkesula Farm (Andhra Pradesh), Hadapsar Fish Farm (Maharashtra) and Bhavanisagar (Tamil Nadu), through an All India Co-ordinated Research Project on Composite Culture of Indian and Exotic Fishes.

An Institute based All India Co-ordinated Research Project on Ecology and Fisheries of Freshwater Reservoirs is investigating the limnology, quantitative biology and methods of exploitation with a view to finding out suitable development and management procedures for fish stocks for obtaining maximum sustained yield in reservoirs under diverse geographic and climatic conditions with distinctive ecomorphological features. The reservoirs are the

Nagarjunasagar in Andhra Pradesh, Bhavanisagar in Tamil Nadu and Rihand in Uttar Pradesh.

The Indian Council of Agricultural Research has emphasized that co-operation among the Central Inland Fisheries Research Institute, Central Public Health Engineering Research Institute, Indian Institute of Technology, All India Institute of Hygiene and Public Health, Port Authorities and State Research Organisations is essential to tackle the problems on water pollution research in the country and to assign areas of responsibility. As such, a working group has been set up in the ICAR for an exchange of views.

The procedures for undertaking co-operative researches through collaborating between Zoological Survey of India, Botanical Survey of India and the Central Inland Fisheries Research Institute were outlined in a meeting held on November 3, 1971. Likewise interorganisational collaboration between Central Inland Fisheries Research Institute, Central Marine Fisheries Research Institute, National Institute of Oceanography and Bhaba Atomic Research Centre for co-operative programme on the studies on primary production was felt necessary.

Research collaboration at international level with FAO, Ford Foundation etc.: Significant results on culture fisheries investigations achieved at this Institute are regularly sent for publication in the Aquaculture bulletin of the FAO.

New exchange relationships for the exchange of research publications of the Institute, have been established with Tropical Fish Culture Research Centre, Malacca, West Malaysia; Atomic Energy Centre, Dacca, Bangladesh; Philippines Fisheries Commission, Manila, Philippines; Finnish Game and Fisheries Research Institute, Helsinki, Finland; University of East Manila, Philippines; Oregon State University Library, Corvallis, Oregon U.S.A. Centre de Investigaciones Marinas, University of Habana, Habana, Cuba and Bangladesh Agricultural University, Mymensingh; Bangladesh.

Fellowship and Studentship: (Nothing to report)

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

The Institute continued to have institutional membership during the year in the following societies and associations.

Indian:

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

Foreign

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

Advisory service received and provided : Information pertaining to the publications on "Freshwater Fishes of South India", "Introduction of *O. goramy* in India" and the environmental pollution were supplied to the educational and research Institutes and laboratories.

Important aspects of information passed on to the different Government Departments in India were on "activities of the Institute in the field of science and technology"; "statistics on fish catch from the Bay of Bengal"; "literature on fish culture"; "brackish water fish farming investigations conducted by the Institute" and "the lowest altitude recorded for the occurrence of trout in Haryana". Comments for the modification of the draft of "Indian standard on treatment of effluents from electroplating industry", prepared by the Indian standard Institute, were sent to the Ministry of Agriculture, Govt. of India. A report on the fisheries of the Ganga river system along with suitable suggestions and recommendations for the development of the Ganga fisheries, has been submitted to the Indian Council of Agricultural Research, New Delhi.

A number of private organisations and enterprises in India sought technical advice and information from the Institute on various aspects of inland fish and fisheries. The Hindustan Steel Ltd., Bhilai were given technical advice on the management of the reservoir of the steel plant and the Agricultural Finance Corporation Ltd., Calcutta were provided with data on fish culturing.

The Institute helped an appreciable section of the public in the country by furnishing information ; like, "available literature on fisheries", "details of research findings in frog culture", "production of fish in the states of West Bengal, Uttar Pradesh and Kerala", "details about industries on frogleg and shrimp" etc. during the course of the year.

Technical information supplied to various foreign agencies were on : merits and demerits of paddy-cum-fish cultural trials made in India to Dr. Antonio Moroni, University of Parma, Italy ; details regarding components and coverage of the "Bibliography on Indian Fisheries" to the Director, Commonwealth Bureau of Pastures and Field Crops, England ; details of frog farming to Mr. Win Kyi, Deputy Director, Veterinary & Animal Husbandry Department, Burma and to Dr. Eduardo Chiaradia of Argentina ; supply of harpacticoid copepods of the Chilka lake to Dr. Hamond of Australia ; use of fibre-glass in research to Indian Market Research Bureau, London ; utilisation of wastes products from prawn and fish dressing to M/S Alibhai Essa & Co. Ltd., Kenya ; publications on sperm preservation to Agricultural Economics Library, Argentina ; literature on Ophiocephalidae to Zoological Research Laboratories, Dacca ; and ecology of shallow and small estuaries of south India to Dr. R. Lenanton, Western Australian Marine Research Laboratories, Australia.

Extension and nation building activity : Laboratory and field demonstrations, library facilities and training in various aspects of fish and from culture were given to 43 trainees of 1971-72 session (during January to May) and 39 trainees of 1972-73 session (during June to December) of Inland Fisheries Training Unit of the CIFE, Barrackpore; 22 and 40 trainees of the Regional Training Centres for Inland Fisheries Operatives, Hyderabad and Agra respectively and 33 trainees of the Central Institute of Fisheries Education, Bombay.

To promote and facilitate country wide adoption of the techniques of induced breeding for the production of quality fish seed for fish culture, 94 ampoules containing pituitary extract were supplied to various state agencies, agricultural universities and private pisciculturists.

With a view to boost composite culture and control of aquatic weeds by grass carp, the Institute supplied and sold spawn, fry, fingerlings and adults of Indian major carps and exotic carps to various agencies as per details given in table 1.

Finance : The provision of funds for the Institute for the financial year April, 1972 to March, 1973 was :

Non-Plan	Rs. 26,69,000
Plan	Rs. 15,00,000
Total	<u>Rs. 41,69,000</u>

Against the above provision the expenditure from 1.1.72 to 31.12.72 was as follows :

Non-Plan	Rs. 19,93,352
Plan	Rs. 10,26,689
Total	<u>Rs. 30,20,041</u>

2. PROGRESS OF RESEARCH

The Institute continued its research investigations as per programmes prepared under 18 projects. Each project has several problems and subproblems to be worked out on the basis of priority. Investigations on 21 problems were completed by the end of the year while work on the remaining problems is being continued.

(a) *Research completed*

Researches on the following twentyfour problems, including problems 1.8 on "Algae in relation to fish nutrition" and 13.3 on "Standardisation of trout culture techniques" work on which was completed in the year 1971, were concluded and the final reports are presented below in brief :

Table 1. Spawn, fry and fingerlings of fish and prawns sold/distributed to various agencies during the calendar year 1972.

Agencies	Spawn (lakh)				Fry & Fingerlings (lakh)				Large Fish & Prawns (Kg)				
	Silver carp	Grass carp	Common carp	Indian major carps	Silver carp	Grass carp	Common carp	Indian major carps	Indian major carps	Mullets	Miscellaneous	Prawn	
<i>Supplied to :</i>													
Bihar Fisheries Dept.	0.00110	...	...	...	...	...	...
Steel Plant, Bhilai	0.10600	...	...	...	...	...	...
Orissa Fisheries Dept.	0.30000	...	2.00000	40.00000	0.01898	0.02250	...	5.93000	...	...	...	...
Chambal Development Project, Rajasthan	0.70000	...	...	...	...	...	...
Andhra Pradesh Fisheries Dept.	0.00500	0.00500	...	...	...	...	...	...
Gujarat Fisheries Dept.	0.00630	0.00700	...	...	...	...	...	...
Himachal Pradesh Fisheries Dept.	0.00250	0.00250	...	...	...	...	...	...
Madhya Pradesh Fisheries Dept.	0.01200	0.00200	...	...	...	...	...	...
Tamil Nadu Fisheries Dept.	0.00500	...	...	...	...	...	...
Uttar Pradesh Fisheries Dept.	0.00500	0.00500	...	...	...	...	...	...
U.P. Agriculture University	0.00500	0.00600	0.00400	...	...	...	...	...
Wild Life Conservation Dept., Orissa	0.00400	...	...	...	...	...	...
West Bengal Fisheries Dept.	0.06000	...	...	...	...	...	...	...
Arunachal Pradesh Fisheries Dept.	0.01050	0.00750	...	...	...	...	...	...
Tripura Fisheries Dept. ...	0.30000	...	...	...	0.02400	0.01050	...	...	...	...	...	...
All India Co-ordinated Project on Composite Fish Culture	0.11615	0.05235	...	0.00500	...	...	...	...
CIFRI Substation, Cuttack	2.59000	4.55500	1.25000	16.11500	0.18900	0.21740	0.16100	0.69000	...	...	...	...
<i>Sold to :</i>													
Private Parties/public	0.26580	0.03050	0.00775	0.23100	66.450	42.500	10.950	1.800	

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

- Problem : 1.3 Use of growth promoting substances
Personnel : P. R. Sen, M. T. Philipose (1968 only), G. V. Kowtal (1968 only), A. David (1969 only), D. P. Chakraborty (1970 only), D. S. Murthy (1970 only) and M. A. V. Lakshmanan (1970 only)
Duration : January, 1968 to January, 1973

Best survival and growth of fry of *Labeo rohita* and *Cyprinus carpio* were obtained with cobalt chloride used @ 0.01 mg/day/fish along with feed from amongst a number of growth promoting substances tried in jar and yard experiments. The next best results obtained were with starch provided @ 3.44 mg/day/fish.

In field trials with spawn of *L. rohita* stocked in nurseries at 25.0, 37.5 and 62.0 lakh/ha respectively and provided with cobalt chloride @ 0.01 mg/day/fish along with supplementary feed, survival obtained were 87, 74 and 62% as against 60, 66 and 45% in the controls.

In field trials conducted with fingerlings of *Catla catla* and *L. rohita*, 2½ times higher production was achieved with cobalt chloride supplied @ 0.01 mg/day/fish along with the feed, than that obtained in the controls.

Suggestions for future work : The use of cobalt chloride supplied along with the feed as a growth promoting substance may be tried in the case of fingerlings and large fish in ponds.

- Problem : 1.4 Relative efficiency of different nitrogenous fertilisers in relation to soil types
Personnel : G. N. Saha, K. Raman, S. R. Ghosh (1967-68 only), D. K. Chatterjee (1969 onwards) and C. Selvaraj (1972 only)
Duration : January, 1967 to December, 1972

During the project period 1967-72, a detailed study was made on the relative efficiency of the three nitrogenous fertilisers such as urea, ammonium sulphate and calcium ammonium nitrate in different soil types being moderately acid to slightly alkaline in reaction. In laboratory, the fertilisers at various doses (20, 50 and 80 Kg N/ha) were screened and the optimal dose of each fertiliser selected was tried in yard and plastic pools, using the same soil types. The study revealed that the response of nitrogenous fertilisers was significant. The fertilisers enhanced primary production, plankton density and survival and growth of fry. The dose 80 Kg N/ha was found to be more effective in moderately acid (pH 5.0), slightly acid (pH 6.2) and neutral soil (pH 6.8) whereas 50 Kg N/ha was relatively the best in alkaline soil (pH 8.0) in regard to survival and growth of fry. Among the fertilisers, calcium ammonium nitrate gave best results in moderately acid soil, urea in slightly acid to neutral soils and ammonium sulphate in alkaline soil. The same trend of results was noticed

by using the above fertilisers in rearing early fry to advanced fry.

Field trial with these fertilisers in neutral soil showed very encouraging results at 80 Kg N/ha. Urea gave the maximum survival (76%) of fry of *L. rohita* followed by calcium ammonium nitrate (67%) and ammonium sulphate (48%) as against control (13%). Urea was found very efficient in enhancing large scale production of zooplankters. In fingerling rearing experiment, net yield of 1,537 Kg fish/ha/yr was obtained when the pond was manured with only urea without any supplementary feeding.

Suggestions for future work: Three nitrogenous fertilisers were tried under different soil types. There are other kinds of slow and fast acting fertilisers which need evaluation in regard to their efficacy in pond productivity.

Problem : 1.6 Crude culture of fish food organisms
Personnel: M.T. Philipose, S. C. Banerjee (1967-68 only), D. S. Murthy (1967-68 only), A. C. Nandy, G. V. Kowtal (1969 onwards) and D. P. Chakraborty (1969 onwards)
Duration : June, 1967 to June, 1972

Experiments conducted in jars with pond water using NPK in various ratios at 230 ppm revealed that the most ideal ratio for crude culture of diatoms, particularly *Nitzschia* sp. and *Navicula* sp. was 5 : 15 : 3. Other fertilisers; like, ammonium sulphate, ammonium chloride and ammonium phosphate also gave identical results. Bonemeal, however, encouraged better growth of diatoms than superphosphate. Field trials confirmed the above observations.

As regards production of zooplankters, mahua oilcake, poultry droppings, cow-dung and calcium ammonium nitrate at 300-900 ppm in their order of performance were found suitable. Combination of mahua oilcake, cow-dung and poultry droppings in the ratio of 6 : 3 : 1 at 1,000 ppm was observed suitable in the field experiments for the production of zooplankters.

The project has been suspended due to the retirement of the Project Leader and the transfers of the associates to other units of the Institute.

Suggestions for future work: As common zooplankters can be produced with fertilisers—mahua oilcake : cow-dung : poultry droppings (6 : 3 : 1 at 1,000 ppm, there is need for further trials for the mass culture of phytoplankters.

Problem : 1.8 Algae in relation to fish nutrition
Personnel: C. S. Singh (upto 1970) and K. K. Bhanot (Mrs.)
Duration : November 1968 to November 1971

Artificial feeds with filamentous algae (*Zygnema* sp., *Mougeotia* sp., *Sirogonium* sp. and *Spirogyra* sp.) were prepared by mixing with potato-starch, Terramycin, yeast and salt in the ratio 40 : 58 : 0.5 : 1 : 0.5 to conduct feeding trials of carp against the feed prepared with fish meal instead of algae and also against plankton as control. Comparative study for moisture, protein, fat, carbohydrate and ash content of the fish fed with different feeds and similar studies for the faeces and the feeds were done.

After laboratory trials, the fingerlings of *Cyprinus carpio* were found to show a growth with feeds prepared from *Mougeotia* sp. and *Spirogyra* sp. which could be compared with those fed with plankton.

Suggestions for future work : Since the growth with feeds prepared from *Mougeotia* sp. and *Spirogyra* sp. were more or less comparable to that with plankton for *Cyprinus carpio*, the same can be used in carp culture practices to compensate a part of the deficiency of plankton as fish food. The use of dried algal powders as an ingredient in pelleted feeds will be economical.

- Problem : 1.9 Response of unproductive pond soils to different inorganic manurial combinations
- Personnel : S. M. Banerjea, B. R. Dutta (1971 only), E. Mitra (Miss) (1968-71 only), S. R. Ghosh (1969-70 only) and R. K. Banerjee (1968 only)
- Duration : Since June, 1968 the research on the problem was to continue till May, 1972, but was terminated in December, 1971 for the retirement of the Project Leader

Two soil types, one highly acidic and one near neutral from fish farms of (1) Lembuchara (Tripura) and (2) Lingipur (Orissa), have been studied. The experiment was set up in 12 plastic cisterns with 6 replicates for each soil type. Soil substratum was 5 cm deep and soil water ratio was 1 : 20. Ammonium sulphate and superphosphate were used as inorganic fertilisers. The doses of application were 80 Kg N + 40 Kg P₂O₅, 40 Kg N + 40 Kg P₂O₅ and 40 Kg N + 80 Kg P₂O₅/ha. Both the soils showed marked response to the fertiliser combinations as measured by primary productivity. The nutrient levels of added fertiliser (N P) also showed an increase in the treated cisterns and N₈₀ P₄₀ has been found to be relatively more efficient and the response of fertiliser application on acidic soil of Lembuchara is more marked. This is probably due to the fact that under highly acidic condition the rate of mineralisation of organic nitrogen in bottom soils and fixation of nitrogen by different agencies will be very low and so the response to nitrogen addition from external source is more marked.

Suggestion for future work : As acid soils, though primarily unproductive due to poor availability of nutrients, respond satisfactorily to inorganic fertiliser, the manures with preferably high nitrogen may be applied to unproductive ponds in acid soils before stocking fish for culture.

- Problem : 1.10 Factors responsible for low and high productivities of fish ponds in acid soils of Tripura
- Personnel : S. M. Banerjea, S. R. Ghosh (1969-70 only) and R. K. Banerjee (1968 only)
- Duration : Since December, 1967 the investigations on the problem were to continue till June, 1972, but were terminated in December, 1971 because of the retirement of the Project Leader

Two fish farms (three ponds in each farm), one highly productive and one highly unproductive, both in acid soil zones of Tripura, were studied. They were stocked with fingerlings of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* @ 5,000/ha in the ratio 1:1:1. The observations indicated that the two water areas had different characters. The soluble organic content and different forms of soluble nitrogen and phosphorus were markedly different in the two farms. The productive water had a markedly high organic content and dissolved phosphorus both in organic and inorganic forms and due to the high organic content, nitrogen was also relatively high. Primary productivity and fish growth were markedly high in productive waters.

Suggestions for future work : As high nitrogen and phosphorus in soluble forms indicate high productivity of fish ponds in acid soils, the chemical test of the pond waters in acid soils of Tripura may be done to assess quickly the productivity of such ponds.

Problem : 1.11 Remedial measures for preventing seepage in fish ponds by physico-chemical treatment of soil
Personnel : S. M. Banerjee (1968 & 1970-71 only), S. C. Banerjee (1969 onwards), P. Ray (1969 only) and B. B. Ghosh (1968 only)
Duration : May, 1968 to April, 1972

Laboratory experiments were only conducted. A standard seepage testing apparatus was designed and a model was fabricated to allow 20 cm column of test soil over a bed of sand and gravel 6 cm deep. A total vertical column of 110 cm water/salt solution (leaching agent) was allowed to permeate through the soil substratum. Treatment with dilute salt solution in combination with dilute alkali, 0.6% and 0.1% respectively, reduced the seepage rate to the extent of 95% in Barrackpore soils.

Using saline sticky soil as the covering materials on two types of soil (1) Orissa and (2) Barrackpore, the seepage rate through Orissa soil was noted to be 0.1 cm/hr and that through Barrackpore soil was 0.12 cm/hr. Application of bentonite (Rajasthan) @ 0.1% reduced the seepage rate further to 0.03 cm/hr in Barrackpore soil. Application to Lingipur soil (Orissa) gave slightly better results. Soap lye either alone or in combination gave no satisfactory results. Under semifield condition, using bentonite, the seepage rate was reduced to 0.04 and 0.06 cm/hr for Barrackpore and Lingipur (Orissa) soils respectively. Pretreatment/combination with common salt solution gave no better results.

Suggestions for future work : Though the application of bentonite clay reduces the seepage rates to a great extent in soils which are incapable of retaining water column, the soil thus treated with bentonite for prevention of seepage can only be suitably used for irrigation purposes and not for piscicultural practices, since the residual seepage would be still quite high for fish ponds.

Problem : 1.13 Estimation of fish population by capture and recapture method

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

Duration : September, 1967 to September, 1972

The experiments were carried out in water areas of 0.12, 0.13, 0.15, 0.4 and 0.7 ha in Killa Fish Farm with known and unknown fish populations. Representative samples of fishes were collected by taking two hauls and anal/pectoral fins of fishes were clipped. Subsequently fishes were captured and the number of marked and unmarked fishes collected were noted. One to three recovery samples were taken and the corresponding one-sample, two-sample and three-sample estimates were calculated. It was observed that the two sample estimate with ± 2 standard error for lower and upper limits fairly covered the actual population. Marking by fin clipping was distinct up to two weeks and the recovery samples were taken within this period. After clipping, all the fishes were given Acriflavin bath and then released in the pond. Within the period of marking and recapturing, mortality of fishes was not observed. The chi-square test was used to test the uniformity of capture probability in different size classes and it was found that the rate of increase in size among marked and unmarked fishes during recapture did not differ significantly.

The conventional drag net was tied with iron sinkers at the bottom rope and detachable floats to the head rope. By the operation of this net with 0.7 hanging co-efficient, representative samples of bottom feeders were collected which led to the calculation of the estimates for various species with more degree of accuracy. From the number of studies in different water areas conducted in Killa farm, it was revealed that the difference between the estimated and actual population was 2.9% for surface feeders, 3-13% for column feeders and 5-23% for bottom feeders. This will give clear indication of species composition of fish present in the pond having unknown fish population.

Suggestions for future work : Further research may be undertaken to develop a technique for effective sampling particularly of bottom dwelling fishes in ponds.

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

Personnel: R. D. Chakraborty and D. K. Chatterjee (1972 only)

Duration : August, 1968 — December, 1972 (the analysis of the data continued till 1972)

Fish in the age group 1, 2 and 3 were examined. Due to dearth of ponds the fish had to be stocked in a pond with an area of 0.2 ha. One year old fish, both males and females with average length 250 mm and average weight 170 gm numbering 300 were stocked in the pond in August, 1968.

First time when the fish matured, they were 1 year 11 months old weighing on an average 460 gm in case of females and 400 gm in case of males. However, all the fish were not found to be matured by this time. In late September, the females were seen to be in the resorbing stage. Freely oozing males were observed as late as in early September. Females in the process of recovery/stage II of maturity were observed even in early November-December. All the fish about 2 years 10 months old when examined were found to be fully mature in early June.

The largest specimens studied were males 3+ in age measuring on an average 425 mm and weighing 870 gm. The largest females studied were 910 gm in weight and 390 mm in length and 2 years 11 months of age. The fish did not grow well.

That the growth was not satisfactory could be realised from the fact that average growth of 0.5 Kg or more in fish of 1½ years of age is usual in case of *L. rohita* in experimental ponds, whereas the average weight of the experimental fish was well below 300 gm for fish of similar age in this experimental pond. It needs to be pointed out, however, that the fish were healthy in appearance and did not present any abnormal stunted look.

In scales examined, growth checks appeared to be more in number than the years in the fishes' life and as such they could not be considered as 'annulii'.

Growth checks did not appear to be clear in otoliths. On the opercular bones transparent rings could be seen but did not correspond to years of life of the fish. This was also the case with the vertebrae.

The dark bands concentric with the rim of the vertebrae were found to be more in number than the age in years of the donor. Thus it would appear from the hard parts examined that the appearance of so-called 'annulii' in pond grown *L. rohita* is not the regular event that the name implies.

Suggestions for future work : An intensive experimental study of the factors which cause the markings to appear on the scales or other hard parts of the body and the physiological factors responsible for the formation of growth rings is required to be undertaken.

Project 2 : Induced fish breeding

Problem : 2.3 Extraction, preservation and ampouling of fish pituitary hormones and setting up of "pituitary bank"

Personnel: H. Choudhury (up to 1968), K. H. Ibrahim (from January, 1969 to July, 1970) and R. M. Bhowmick

Duration : June, 1967 to June, 1972

Several preservatives were tried for storing the carp pituitary extract of which propylene glycol and glycerine were found suitable. When tested for efficacy, the extracts in glycerine medium gave positive results even after 3 months of storage and the propylene glycol extract gave positive results when

tried after 71 days. This suggested that the pituitary extract could be prepared in distilled water (1 part) and stored in glycerine (2 parts) well in advance of the breeding season and could be used with ease during the season, saving time in preparing extract every time before injection as also having readily available extracts for fish breeding work.

To facilitate the storage of pituitary extract in glycerine more effectively, the same was ampouled (1 ml=40 gm). During the course of the project, large number of such ampoules were made and used regularly for fish breeding work. Potency tested ampoules were also supplied to various induced fish breeding centres of State Fisheries Departments, Agricultural Universities and also to private fish farmers. The efficacy of hormones stored in ampoules was tried under different environmental conditions. The results obtained at different centres as reported by the Departments/Agencies were both positive as well as negative, the former being reported in majority of the cases demonstrating the usefulness of the preservation technique. Detailed information on the techniques of preservation was supplied to various State Fisheries Departments. There has been heavy demand for the supply of these ampoules during the period under report which justifies the need for the establishment of a "pituitary bank".

Suggestion for future work : Extracts made from pituitary glands of *Cyprinus carpio* may be ampouled and the efficacy of the same tested by the Institute as well as through distribution to other agencies in the country.

Project 3 : Reservoir fisheries

Problem : 3.1 Fisheries of the Tilaiya reservoir
Personnel: Y. R. Tripathi (1972 only), A. V. Natarajan (up to 1970), B. V. Govind (up to 1970), S. Parameswaran Ayar (1970 only), M. Ramakrishna, S. K. Sarkar (1970 onwards), B. Ray (1970 onwards), B. K. Banerjee (1970 onwards) and M. A. Khan (1970 onwards)
Duration : April, 1968 to December, 1972

Physico-chemical conditions, plankton and bottom biota of the reservoir have been studied sector-wise to find out the productive areas. Zooplankton has been found to dominate over the phytoplankton. At 10 m depth, the maximum concentration of bottom biota was found to occur.

Age composition of various major carp species was determined from commercial catches. A consistent decrease in the major carp catches was observed throughout the period of investigation. This may probably be attributed to the lack of recruitment. In spawn surveys within the reservoir it was found that the breeding of major carps was very little. The minnows and other minor carps were observed to breed successfully in the reservoir. The stocking of the reservoir was of low magnitude. A significant decrease in the catch of *Catla catla* was observed though marginal increase in catches

of *Labeo rohita* and *Cirrhinus mrigala* were noticed. Among catfishes *Wallago attu* predominated the catches.

Experimental fishing has shown that gill nets of 30-60 mm mesh bar were found suitable for *L. rohita* and *L. calbasu*, and 100 mm mesh bar nets for *C. catla*.

15,018 major carp fingerlings were fin-clipped and released into the reservoir during 1968-70. Only fingerlings of *C. catla* have so far been recovered.

Suggestions for future work : There is need to stock the reservoir with advanced fingerlings of major carps and to control minnows which compete for food with the major carps. This will lead to an increase in the per hectare production of fish from the reservoir.

Problem : 3.2 Fisheries of the Konar reservoir
Personnel: Y. R. Tripathi (1972 only), A. V. Natarajan (up to 1970), B. V. Govind (up to 1970), S. Parameswaran Ayar (1970 only), M. Ramakrishna, S. K. Sarkar (1970 onwards), S. L. Kar (1970 onwards), B. K. Banerjee (1970 onwards) and M. A. Khan (1970 onwards)
Duration : April, 1968 to December, 1972.

Physico-chemical conditions, plankton and bottom biota of the Konar reservoir have been studied in detail. A decrease in the plankton volume was noticed during 1970 as compared to the previous year.

From the commercial catches, age, food and fecundity of major carps were studied. As observed in case of the Tilaiya reservoir, in this reservoir too, a decrease in the total catch was observed during the years of investigation. Lack of recruitment appeared to be the reason for decline in the catch of almost all the four major carp species.

Suggestions for future work : There is need to stock the reservoir regularly with advanced fingerlings of major carps. As the phytoplankton niche in the reservoir is not fully utilised by any of the fishes present therein, a suitable phytoplankton feeder; viz., the silver carp (*Hypophthalmichthys molitrix*) may be planted in the reservoir to make use of the unoccupied food niche.

Problem : 3.3 Fisheries of the Loni reservoir
Personnel: Y. R. Tripathi (1972 only), D. V. Pahwa, S. N. Mehotra, B. Singh (1969 onwards), A. C. Nandy (1972 only), R. Chandra, M. R. Sinha (up to March 1972), S. C. Pathak, P. M. Mathew (1969 onwards), K. P. Srivastava (1969 onwards), V. R. Desai (1969 onwards), R. K. Saxena, H. P. C. Shetty (up to 1971), S. Jani (up to 1971), S. D. Gupta (up to 1971), A. G. Jhingran (up to 1971), A. G. Godbole (up to 1971), S. K. Das (1970 only), J. C. Malhotra (1968 only), K. K. Ghosh (1968 only), P. K. Mathur (1968 only) and M. Y. Kamal (1968 only)
Duration : November, 1967 to November, 1972

The hydrological studies revealed that the water is quite rich in nutrients, pH ranged between 7.52 and 7.90, carbonates between 3.6 and 9.8 ppm and DO between 6.71 and 7.49 ppm. The primary productivity ranged between 516.47 and 713.54 mg C/m³/6 hr. The soil analysis showed that alkalinity ranged between 0.235-0.628 m e%; chloride, 8.9-13.6 m e%; nitrate, 0.11-0.16 ppm; phosphate, 0.09-0.14 ppm; and organic matter, 1.84-4.30%.

The average number of plankton ranged between 39-166 u/l during 1968-72. Macro-benthos comprised molluscs, insect larvae and annelids, the total average production being 594, 449 and 605 u/m² during 1968-70 respectively. Among macro-vegetation, *Vallisneria spiralis* and *Hydrilla verticillata* were predominant in shallow regions while *Najas* sp. predominated in deeper waters.

Biological studies for *Catla catla*, *Cirrhinus mrigala*, *Labeo rohita*, *Labeo calbasu*, *Labeo bata*, *Puntius sarana*, *Mystus seenghala* and *Wallago attu* have been carried out. Food studies indicated that *C. catla* is the only zoophagous fish while other fishes mostly subsist on decayed organic matter. *P. sarana* consumes mostly molluscs. The phytoplankton niche remains mostly unutilized.

Experimental fishing was carried out with 12 gill nets of 60, 75, 95 and 155 mm meshes. During 1968-70 the fish catches were 333.88, 204.35 and 337.51 Kg respectively. With the introduction of new nets in 1971, the catches improved in 1971 and 1972 and the new nets caught 992.00 and 490.48 Kg respectively. The average per hectare production during the years 1968-72 has been calculated to be 14.16 Kg.

Suggestions for future work : The reservoir may be stocked with major carps while conservation of the fishery and eradication of unwanted fishes will be required. A study on the fish food resources may also be carried out for optimum utilisation by the fish stocks.

Problem :	3.4 Fisheries of the Govindagarh lake
Personnel :	S. J. Karamchandani, M. D. Pisolkar (excluding 1971), D. N. Misra (1970 onwards), S. Prakash (1970 onwards), H. C. Joshi (1970 onwards), D. N. Srivastava (1972 only), P. M. Mathew (up to 1969), S. Jena (up to 1970), S. N. Mehrotra (up to 1969), G. K. Bhatnagar (up to 1968), B. Singh (up to 1968) and R. K. Diwedi (up to 1968)
Duration :	November, 1967 to November, 1972

The hydrological studies showed the alkaline nature of water (pH 7.85-8.20) and relatively low concentration of P₂O₅, NO₃ and SiO₂. DO fluctuated between 6.22 and 11.46 ppm while CO₂ between 1.42 and 4.27 ppm. The net organic production fluctuated between 128.50 and 532.88 mg C/m₃/6 hr. The soil was sandy and acidic (pH 5.8-6.0) while the organic matter ranged from 1.33 to 2.25%; CaCO₃, 1.782-5.670%; available phosphorus, 0.11-0.17 ppm; and iron, 3.43-5.06%.

The reservoir was rich in plankton production, average number being 1,029, 1,185, 805 and 765 u/l during 1968-71 respectively. Phytoplankton

(88.43%) always dominated the zooplankton (11.57%). The macrobenthos were made up of chironomid larvae (63.3%), other insect larvae (16.7%) and oligochaetes (20.0%). Aquatic vegetation was totally absent in the reservoir.

Biological studies of six commercially important species; viz., *Catla catla*, *Labeo rohita*, *Tor tor*, *Cirrhinus mrigala*, *Wallago attu* and *Labeo gonius* have been completed. The food studies revealed that phytoplankton remained mostly unutilized.

In experimental fishing, gill nets of different mesh sizes with various combinations of floats and sinkers were operated. The total catch during 1968-71 was 359.89, 191.13, 86.66 and 327.17 Kg respectively. *C. catla* dominated the catches during 1968 and 1969 (72.6 and 48.9% respectively), while in 1970 and 1971, *L. rohita* dominated (21.0 and 50.7% respectively) the catches.

Suggestions for future work: The reservoir may be stocked with major carps while conservation of the fishery and eradication of unwanted fishes will be required. A study on the fish food resources may also be carried out for optimum utilisation by the fish stocks.

Problem :	3.5	Fisheries of the Kulgarhi reservoir
Personnel :		D. N. Misra (1969 onwards), S. J. Karamchandani, H. C. Joshi (1970 onwards), P. N. Jaitly (1972 only), D. N. Srivastava (1972 only), G. K. Bhatnagar (up to 1971), R. K. Diwedi (up to 1971), J. B. Rao (1970 & 1971 only), S. N. Mehrotra (up to 1969), S. Jena (up to 1970), M. D. Pisolkar (up to 1968), B. Singh (up to 1968) and P. M. Mathew (up to 1968)
Duration :		November, 1967 to November, 1972

The hydrological studies indicated the water to be moderately alkaline (pH 8.0-8.3), concentration of silicates ranged from 2.45-30.15 ppm; nitrate, traces-0.15 ppm; total alkalinity, 35.64-108.16 ppm; DO, 5.88-11.46 ppm and free CO₂, nil-6.25 ppm. The loamy type of bottom soil was acidic (pH 6.3-6.8) with low organic carbon content (0.307-1.760%).

The plankton population was observed to be poor with average numbers of 403 u/l in 1968-69, 407 u/l in 1969-70, 355 u/l in 1970-71 and 60 u/l in 1971-72. The phytoplankton (68.38%) exhibited dominance over zooplankton (31.62%). The standing crop of bottom organisms ranged between 37-122 u/m². The macrofauna was made up of insect larvae 83.2% (chironomid larvae 36.0%), ologochetes 16.6% and molluscs 0.2% respectively. The aquatic vegetation was totally absent in the reservoir.

Biological studies of six species; viz., *Labeo boggut*, *Cirrhinus mrigala*, *Tor tor*, *Ompok bimaculatus*, *Catla catla* and *Labeo rohita* have been completed.

In experimental fishing, the gill nets of various mesh sizes were operated. The year-wise catch during 1968-71 was 363.15, 506.44, 174.55 and 483.01 Kg respectively. The percentage composition by weight was 75.6 for *C. catla*, 11.5 for *C. mrigala*, 6.3 for *L. rohita* and 2.5 for hybrids of major carps.

Suggestions for future work : The reservoir may be stocked with major carps while conservation of the fishery and eradication of unwanted fishes is required. A study on the fish food resources may also be carried out for optimum utilisation by the fish stocks.

Project 5 : Brackish water fish farming

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Problem : 5.4 Salinity tolerance of major carp fingerlings
Personnel: A. N. Ghosh, S. R. Ghosh (up to 1971) and P. R. Das (up to 1970)
Duration : August, 1969 to December, 1972

The normal salinity tolerance of major carp fingerlings has been determined by setting up statistically designed experiments with salinity grades at 'traces', 1, 2, 3, 5, 8, 11 and 15‰. Experiment with early fry (average size—17.6 mm) and advanced fry (average size — 26.5 mm) indicated 75% mortality at 11‰ salinity and with further rise to 15‰, a total mortality occurred soon after the fry were introduced (within 2 hours). In another experiment with the salinity grades at 10, 11.5, 12, 12.5, 13 and 13.5‰, it was observed that 50% mortality occurred at 10‰, 75% mortality was observed in each of the grades from 11 to 12.5‰. At 13‰ and beyond, total mortality occurred immediately after release, indicating thereby that the lethal tolerance limit for the major carp fry of the above stated size is between 12.5 and 13‰. In case of major carp fingerlings (*Labeo rohita* and *Catla catla* : average size 62 mm), it was observed that up to 8‰ no mortality took place. This experiment corroborated the results obtained during 1970. In acclimatization experiments in shallow ponds (70-80 cm depth) with salinity ranging between 0.39 and 6‰, *C. catla* achieved the maximum growth of 460 mm (1.3 Kg) in a period of 11 months while *L. rohita* and *C. mrigala* attained 444 mm (900 gm) and 352 mm (400 gm) during the same period.

In cement cisterns (2.4 m × 1.5 m × 0.9 m) the growth pattern under different salinity levels, 2, 3, 4, 5 and 6‰ was observed. The best growth was obtained at 5‰ (*L. rohita*, 14-15 mm/week ; *C. catla*, 18-20 mm/week ; and *C. mrigala*, 2 mm/week).

Specimens of these three species which were gradually acclimatized in the pond (0.02 ha) up to 6‰ during the years 1970 and 1971 were subjected to further rise in salinity up to 10.5‰. No mortality was observed. Growth rate for *L. rohita* was observed to be 7 gm/day for *C. catla* 1 gm/day and *C. mrigala* 0.25 gm/day at this salinity which changed to 2, 5 and 4 gm/day respectively at 4.72‰ indicating that *L. rohita* alone exhibited better growth at higher salinity level.

Suggestions for future work : Carp culture can be undertaken in brackish water farms provided the salinity level of the pond is restricted up to 10.5‰ and the fish for stocking are acclimatized for a long period to gradual increase in salinity up to the level found in the ponds.

Problem : 5.5 Nursery management in brackish water ponds
 Personnel: A. N. Ghosh, P. B. Das (1972 only), P. K. Pandit (1971 onwards), M. K. Mukhopadhyay (1972 only), S. R. Ghosh (up to 1971), N. K. Das (1971 only), L. K. Das (1971 only), P. R. Das (up to 1970), H. S. Mazumder (up to 1970) and A. R. Paul (up to 1970)
 Duration : January, 1969 to December, 1972

At a stocking density of 30,000/ha, *Mugil parsia* (average size—17 mm) achieved an average growth of 127.7 mm in 240 days, where uneconomic varieties like, *Gerres satifer* were removed, in contrast to an average growth of 97 mm in corresponding period without any eradication. Carnivorous fish like, *Lates calcarifer* (average size —17 mm) and *Eleutheronema tetradactylum* (average size— 50 mm) followed identical pattern of growth with or without eradication of uneconomic varieties (average growths achieved during the same period were 323 and 310 mm respectively). In monoculture, *M. parsia* (17 mm) achieved an average length of 90 mm in 110 days (stocking density being 2,00,000/ha) and 100 mm in the same period when provided with mustard oilcake and rice-bran mixture as supplementary feed (2: 1, 50 mg/fry). For *Penaeus monodon* (stocking rate 40,000/ha) and *Penaeus indicus* (stocking rate 20,000/ha), the average growth was observed to be 49 and 45 mm/month during summer and 55-58 and 54-64 mm/month during monsoon respectively.

The reaction of the virgin soil of Kakdwip farm has been found to be alkaline and the release of N : P to the water phase was estimated to be 10.2 : 1. Treating with mustard oilcake plus superphosphate and urea plus superphosphate at $N_{90}P_{40}$ Kg/ha, it has been observed that the maximum plankton production (694 u/ml) was obtained in low salinity (below 6‰) when the N/P was 40 in case of mustard oilcake treatment, while urea plus superphosphate gave the maximum production of 390 u/ml with N/P at 3.75.

Mixed culture of *Lates calcarifer*, *Megalops cyprinoides*, *Eleutheronema tetradactylum*, *Mugil tade*, *Mugil parsia*, *Lutianus argentimaculatus*, *Elops saurus* and *Liza troschellii* had indicated the maximum growth of 405, 376, 385, 319, 210, 235, 540 and 280 mm respectively in a period of three months at the stocking density of 12,500/ha. Similarly in another experiment with *Mugil cephalus*, *Mugil tade*, *Liza troschellii*, *Mugil parsia*, *Penaeus indicus* and *Lutianus argentimaculatus*, the maximum growth recorded were 304, 153, 248, 190, 200 and 183 mm respectively during the same period.

Monospecies culture of *M. parsia* (40,000/ha) gave an estimated production of 480 Kg/ha/180 days without any supplementary feed as against 750 Kg/ha/180 days with supplementary feed containing 21.68% of protein food of vegetable origin (rice-bran + mustard oilcake) and 800 Kg/ha/140 days with supplementary feed having 26.25% of protein from vegetable and animal origin (rice polish + vegetable peelings + mustard oilcake + fish meal).

Lates calcarifer (average size—56 mm), at a stocking density of 3,500/ha exhibited a growth of 24, 50 and 67 mm during the 1st, 2nd and 3rd months res-

pectively. In 4th and 5th months, growth rate reduced to 8 and 10 mm/month respectively warranting reduction in stocking density. At reduced stocking densities of 500/ha with fry of average size 220 mm, 1,000/ha with fry of average size 134 mm and 1,100/ha with fry of average size 158 mm, the fish exhibited an average growth of 0.27, 0.20 and 0.11 mm/day respectively. Grown up *L. calcarifer* (average size—345 mm) at a stocking density of 300/ha, exhibited different growth pattern (1 gm/day in January, 2 gm/day from February to June) during winter and summer. The stocking density was increased to 600/ha in July. No appreciable increment in weight was discerned indicating that at this stocking density the available pond food was just sufficient for maintenance.

Culture of *Penaeus monodon* (40,000/ha) indicated a growth pattern of 0.25 and 0.78 mm/day during summer and monsoon respectively without any supplementary feed as against 0.27 and 0.91 mm/day respectively when provided with clam meat.

At the same stocking density, *Penaeus indicus* exhibited growth of 0.95 and 0.63 mm/day during summer and monsoon respectively without supplementary feed while with the provision of same supplementary feed, a growth of 1.06 and 0.64 mm/day during respective seasons were observed.

Through regulated diet and increase in the water depth it has been possible to induce gonadal development in the farm reared *Lates calcarifer* up to III/IV stage of maturity in 3 years old specimens.

Phosphorus as superphosphate when added to the farm soil and stocked with water at different salinities (from trace to 30‰) was found to rapidly dissipate from the water phase. In contrast, nitrogen when applied in the form of urea (700 ppm of N) released 180 to 190 ppm N in the water phase immediately on water logging, which declined to 152 to 159 ppm in a period of 40 days. The position was found to improve again after a lapse of 55 days of treatment with the available nitrogen in water phase recording between 612 and 180 ppm. This trend was more evident in the higher levels of salinity (15‰ and above).

Suggestions for future work : Based on management practices developed, monoculture of mullets, prawns and perches are to be intensified.

Problem : 5.6 Brackish water fish farm management techniques
Personnel : A. N. Ghosh, P. B. Das (1972 only), P. K. Pandit, M. K. Mukhopadhyay (1972 only), S. R. Ghosh (up to 1971), H. S. Mazumder (up to 1971), N. N. Sarkar (1971 only), P. R. Das (up to 1970) and A. R. Paul (up to 1970)

Duration : January, 1960 to December, 1972

Survey of seed collection centres and determination of other methods of brackish water fish and prawn seed collection have been in progress at the Kakdwip Fish Farm. Scooping of intertidal pits appears to be a better collection device for collection of mullet fry as compared to the method of collection by shooting net from the estuary. Respective collections by scooping and shoot-

ing nets were 8,729 numbers for 31 days and 544 numbers for 66 days. In contrast, shooting net appears to be a better collection gear for young prawns. Composite culture of *Lates calcarifer* & *Scatophagus argus* (1:4), and *L. calcarifer* & *Mugil parsia* (1:14) indicated that the growth of herbivorous fish was good (*M. parsia*, 7 mm/month and *S. argus*, 8 mm/month) in contrast to *L. calcarifer* (2 mm/month).

Further surveys of the seed collection centres for *L. calcarifer* have revealed that the seed were available during the period April to August with the peak period of abundance being in the 1st week of August with water salinity at 16.19‰, temperature at 30.4°C and silt content at 963 ppm. Shooting nets failed to collect any fry and the scooping of marshy intertidal pits or depressions was found to be the best method of collection.

Mugil tade seed were available from July to October with the peak in September (salinity 5.35‰, temperature 30.0°C and silt content 520 ppm). Excepting for the months of August to November, seed of *Mugil parsia* were available during the rest of the months. Scooping of intertidal pits appeared to be a better collection device than shooting nets (605/net/hr and 2/net/hr respectively).

Seeds of *Penaeus monodon* and *P. indicus* were available almost throughout the year with the peak period of abundance during August and March respectively. The relative conditions of salinity, temperature and silt content of the estuary during these two months were 16.19‰, 30.4°C and 963 ppm; and 20.58‰, 27.2°C and 535 ppm respectively. Shooting net was found to be a better collection device for prawn seed.

Suggestions for future work : Based on management practices developed, monoculture of mullets, prawns and perches are to be intensified so that the entire project becomes production oriented.

Project 9 : Selective breeding and hybridisation

Problem : 9.2 Storage of fish sperm
Personnel: R. M. Bhowmick and M. M. Bagchi (up to 1971)
Duration : April, 1968 to April, 1972

Samples of milt from *Labeo rohita* and *Cyprinus carpio* were collected at room temperature (22° to 33°C) taking care that they were free of urine, faecal matter, blood and water as far as practicable. These were then mixed with various dilutents and kept at 0° to 5°C under refrigeration. They were taken out from the refrigerator after specified periods and kept at room temperature for about 5 to 10 minutes for thawing, before microscopical examination.

The diluents tried were egg yolk citrate (M/15 and M/7), sodium citrate (M/7), phosphate buffer, Holtfreter's solution and Frog Ringer's solution. Of these, the first 3 extenders proved unsatisfactory. Holtfreter's solution containing 1% glycerine gave encouraging results. When diluted with this solution, sperms of *G. carpio* and *L. rohita* were observed to exhibit mobility

up to 50 hr at 0° to 9°C. In water medium, they remained active for about 2 minutes only. When treated with frog Ringer's Solution containing 1% glycerine, sperms of both the species remained motile for 72 hr at 0° to 5°C. However, at room temperature (28° to 33°C), they were active only for 4½ to 6 hr when mounted on slides in the solution. Extenders containing 2 to 6% glycerine were found to be less effective. When no glycerine was added the sperms died earlier.

In an attempt to study the fertilising capacity of preserved sperms, samples of milt collected from *L. rohita* were preserved in frog Ringer's solution containing 1% glycerine at an air temperature of 28°C for 4 hr. Eggs obtained by stripping female of *L. rohita* were fertilised by the preserved spermatozoa. The fertilised eggs developed thereby indicating the viability of preserved sperms and as a result 10,000 fry were obtained. Preservation of sperms of carps in coconut milk also gave encouraging results.

Suggestion for future work : Liquid nitrogen and allied substances may be tried for storage of fish sperms as ready stock to conduct experiments on artificial fertilisation of fish eggs.

Project 12 : Exotic fish culture

Problem : 12.3 Food preferences of grass carp
Personnel : S. B. Singh, D. S. Murthy (1972 only), M. D. Rout, G. N. Saha (1971 onwards), P. C. Chakraborti (up to 1971) and K. K. Sukumaran (up to 1968)
Duration : March, 1967 to September, 1972

Experiments were conducted in protected ponds in Killa and Chaudwar and a few private ponds. The density and species composition of weed infestation was estimated statistically. In certain cases, the desired species of weeds were introduced in known quantities. Grass carp (*Ctenopharyngodon idella*) of known size and number were introduced and observations on weed clearance, final growth and survival were made.

Advanced fry and early fingerlings (27-40 mm) of *C. idella* accepted *Wolffia* sp. and bigger ones took *Lemna* sp. and *Spirodela* sp. However, at this stage zooplankton was the preferred food. *C. idella* weighing 62 gm and above were found effective against duck weeds and submerged weeds.

In a pond which had a weed infestation density of 7,440 Kg/ha with *Hydrilla* sp., *Najas* sp. and *Nymphoides* sp., fingerlings (average weight 62 gm) of *C. idella* were stocked at 5,200/ha. In the first week, the rate of consumption appeared slow but later the clearance was quick. In 18 days, the pond was cleared of submerged weeds. *Nymphoides* sp. was not consumed. Fishes grew to an average size of 113 gm and the survival rate was 86.54%.

The same fish were transferred into another pond with a weed density of 68,460 Kg/ha having the same type of weeds. The weeds were almost

completely cleared in 42 days by *C. idella* stocked @ 650/ha. The fishes grew to an average size of 322 gm. In this pond also *Nymphoides* sp. was not utilised by the fish.

In a pond infested with 8,500 Kg/ha of *Ceratophyllum* sp., *C. idella* stocked @ 1,250/ha (average weight 600 gm) brought about a complete clearance of the weed in 20 days.

In addition, other weeds such as, *Utricularia* sp., *Myriophyllum* sp., *Ottelia* sp., *Spirogyra* sp., *Lymnophila* sp., *Pithophora* sp., *Vallisneria* sp. and *Azolla* sp. were also effectively cleared.

Suggestions for future work : Difficulty was experienced at times in maintaining the stock of *C. idella* when suitable types of weeds were not available in the vicinity. Hence, finding suitable alternative of the preferred weeds for *C. idella* in the form of supplementary feeds emerges as an important problem.

Project 13 : Cold water fish culture

Problem : 13.3 Standardisation of trout culture techniques
Personnel: K. L. Sehgal, K. V. Ramakrishna, C. B. Joshi (1969 onwards), S. Sunder (1969 onwards) and K. Kumar (1971 only)
Duration : November, 1968 to October, 1971

During the year 1970-71 after segregation of *Salmo trutta fario* breeders, feed was given @ 2% of body weight with partially boiled fish. 27,819 and 35,304 green eggs were stripped at Harwan and Laribal Fish Farms respectively. The percentage of fertilisation as calculated by acetic acid method was 90.5% at Harwan and 93.0% at Laribal. The green eggs were arranged @ 3,000, 2,000 and 1,000 per tray in replicates of 3, 4 and 4 at Harwan and 2, 7 and 6 at Laribal respectively. The Malachite Green treatment was given at a dose of 1 : 40,000 for 2 minutes and dead eggs were picked once a week. The thinning was carried out in March at Harwan and in January at Laribal. The cumulative percentage of survival from green egg to fry stage was 52.3 in treated against 5.1 in control at Harwan and 62.7 against 60.0 in control at Laribal respectively. After initial feeding with yolk of hen's egg, 10,176 fry from Harwan and 16,800 fry from Laribal were handed over to the State Fisheries Department, Jammu and Kashmir.

Regarding rainbow trout (*Salmo gairdnerii*) the breeders were segregated at Harwan and fed @ 2% of body weight with partially boiled fish. A total of 8,038 eggs were stripped and were arranged @ 3,000, 2,000 and 1,000. The average number of eggs per Kg body weight was 1,657. The average percentage of fertilisation was 98.2. Malachite Green treatment was given @ 1 : 40,000 for 2 minutes. The cumulative percentage of survival from green eggs to fry stage was 46.60 in treated as against 38.56 in control. 4,000 fry were handed over to the State Fisheries Department, Jammu and Kashmir.

Suggestion for future work : The techniques for trout culture developed by the Institute may be employed for better production of the trout in cold water regions of the country.

Problem : 13.5 Assessment of production potential of high altitude lake

Personnel : K. V. Ramakrishna, C. B. Joshi, S. Sunder and M. J. Bhagat (1972 only)

Duration : January, 1969 to September, 1972

During the first two years, two centres were selected at Saidakadal and Hazratbal in the Dal lake for investigation. The physico-chemical factors of the lake at Saidakadal between 08.00 and 10.00 hours during April, 1968 to June, 1971 were : depth, 1.69-3.54 m ; turbidity, 98-296 cm ; water temperature, 3.0°-28.9°C ; total alkalinity, 75.0-141.7 ppm ; and silicates, 0.388-1.000 ppm. At Hazratbal, the values were : depth, 3.41-4.67 m ; turbidity, 55.5-225.0 cm ; water temperature, 3.5°-26.6°C ; pH, 7.5-8.7 ; DO, 8.6-12.0 ppm ; total alkalinity, 93.0-163.0 ppm and silicates, 0.340-1.281 ppm. The surface plankton sampled by nets with bolting silk No. 21 ranged from 1-4,333 u/l at Saidakadal as against 23-35,183 u/l at Hazratbal. The predominant forms encountered in the plankton were *Amphora* sp., *Navicula* sp., *Gomphonema* sp. and *Cymbella* sp. among phytoplankton and *Brachionus* sp., *Polyarthra* sp. and *Cylops* sp. among zooplankton. Analysis of bottom mud has shown that forms belonging to the families Naidiae, Tubificidae and Chironomidae were dominant, their percentage of occurrence being 22.96, 40.88 and 28.45 respectively in total biota by number at Saidakadal as against 76.31, 16.47 and 4.99 respectively at Hazratbal. The catch/man/hr during April, 1969 — June, 1971 ranged from 156-700 gm at Saidakadal as against 117-589 gm at Hazratbal. The species composition of the fish catches at the two centres were : *Cyprinus carpio*, 24.05-100.00% ; *Crossocheilus latius*, nil-74.88% ; *Schizothorax* spp., nil-44.74% ; and miscellaneous, nil-14.23%. The vegetation of the lake mainly consisted of *Myriophyllum* sp., *Potamogeton* sp., *Salvinia* sp., *Nymphaea* sp., *Ceratophyllum* sp. and *Hydrilla* sp. The fauna inhabiting the vegetation was dominated by Nematoda, Cladocera, Copepoda and larvae of Diptera.

During the third year, lake was sampled at 48 stations covering the whole lake in a criss-cross manner in three seasons, i.e. summer, autumn and winter. This was done to determine the various ecological niches available in the lake. The factors studied were the same as at the two centres mentioned above.

The net productivity of the lake was 20.996-32.227 mg C/m³/hr based on dark and light bottle method.

The analysis of periphytic organisms on vegetation has shown Bacillariophyceae, 88.64% ; Myxophyceae, 4.31% ; Desmidiaceae, 3.16% ; Chlorophyceae, 2.78% ; Protozoa, 0.52% ; Rotifera, 0.35% and others, 0.24%.

Suggestions for future work : Management of the fisheries of high alti-

tude Dal lake is to be taken up for obtaining the maximum yield and the policies for such management are to be oriented on the basis of nutrient levels and available food resources of the lake.

Project 14 : Riverine and estuarine fish catch statistics

- Problem : 14.4 Fish catch statistics of the Hooghly-Matlah estuarine system
- Personnel: P. Dutta (up to July, 1972), G. C. Laha, P. Mitra, A. Chowdhuri, R. N De, B. K. Saha, P. B. Das (up to August, 1971), A. R. Choudhury, R. K. Chakraborty (up to May, 1970), N. D. Sarkar, G. P. Bhattacharya (up to June, 1969), A. K. Namasudra, D. K. De (excepting January, 1969 to June, 1970), N. C. Mondal, S. P. Ghosh, P. K. Pandit, K. Algaraja (February to September, 1970 only), H. S. Mazumder (August, 1971 onwards) and A. R. Paul (from May, 1970)
- Duration : April, 1967 to November, 1971 (but the analysis of the date was continued till 1972)

Fishing in the estuary continues all through the year, although the catches begin to increase from August and reaches a peak during November to January. Besides prawns, 25 fish species are mainly represented in the commercial catches. The annual landings from the estuarine system vary between 6,000 and 11,000 t. A bumper crop of *Hilsa ilisha* (5,741.4 t) during monsoon of 1971 was an unprecedented record. The bulk of the catch was constituted by *Harpodon nehereus* (14.27%), *H. ilisha* (14.22%), prawns (14.17%), *Setipinna phasa* & *S. taty* (5.9%) and *Trichiurus savala* & *T. pantului* (3.5%). The major part of the catch is made with bag-nets (50.65%) followed by seines, drift-nets, hooks & lines, twawls and set-berriers in order mentioned. Based on the ecological conditions, the estuarine system has been divided into five fishing zones; viz., Nabadwip-Khusigali stretch (Zone I), Khusigali-Diamond Harbour stretch (Zone II), entire estuary in the lower Sunderbans below Diamond Harbour on the main channel (Zone III), Rupnarayan stretch (Zone IV) and Matlah stretch (Zone V). The yield from Zone III was found to be the maximum (70.80%) followed by Zone I (9.5-13%), Zone IV (6.5-12%), Zone II (2.5-5%) and Zone V (1.3%).

Suggestions for future work : As natural mortality rather than fishing mortality is more responsible for the fluctuation in the fishery of the estuarine system, the habitat for the fish is to be improved, preferably by increasing the volume of water discharge. To prevent fishing of the young ones of *Hilsa ilisha*, *Pama pama*, *Eleutheronema tetradactylum* and *Polynemus paradiseus*, size limit at capture may be imposed. To promote fishing, the West Bengal Government should come forward to protect the fishermen from

the exploitations by the *Arathdars*. Since, the present exploitation in the estuarine system is less than 50% of the stock complex, a scope for increased fishing effort exists up to an extent beyond which the chances of biological over fishing lie.

Project 19 : Hilsa fisheries

- Problem : 19.1 Hilsa fisheries of the middle stretch of the Ganga river system
- Personnel: R. Chandra, V. R. Desai (1969 onwards), S. K. Das (1971 onwards), B. Singa 1969 onwards), J. C. Malhotra (up to 1968), P. K. Mathur (up to 1968) and S. C. Pathak (up to 1968)
- Duration : April, 1967 to April, 1972

During 1967, 134 Km stretch of the Ganga river system from Mahewa on the Yamuna above the confluence to Chunar on the Ganga below the confluence was taken up to study the larval abundance. Observations revealed that though the fish breeds throughout the stretch, the concentration of larvae was more between Sindhoraghat and Chunar in the Ganga and at Mahewa in the Yamuna. The peak breeding was in October. Morphometric measurement-data indicated that 'slender' variety breeds at Lawain while both 'slender' as well as 'broad' varieties breed at Vindhyachal.

During 1968, a 60 Km stretch of the river Ganga downstream of the stretch investigated in 1967, between Narayanpur and Saraswatighat was taken up. The spawning in this stretch was found to extend from September to October, with peak breeding during mid and later half of September.

During 1969, 4 centres; *viz.*, Vindhyachal, Sindhoraghat, Agiabirghat and Sujabad on the Ganga and Mahewapatti on the Yamuna were selected for quantitative estimation of larval abundance. During 1970, Agiabirghat centre was dropped and instead Sirsa was selected.

Observations were continued at 4 centres; *viz.*, Vindhyachal, Sindhoraghat, Sujabad and Sirsa on the Ganga and Mahewapatti on the Yamuna. Examination of the material collected revealed that profuse breeding had taken place in both the rivers during October and that it was of higher magnitude than during 1969.

The studies indicated that in the selected stretch the larval concentration was more at Sindhoraghat than at other centres. The centres in order of larval abundance were Sindhoraghat, Sirsa, Sujabad and Vindhyachal. The intensity of breeding was the maximum during 1967 and it progressively declined during the subsequent two years but was again found to improve in 1971 breeding season.

Observations made during the late winter and post-winter months have confirmed that the *Hilsa ilisha* breeds during this period as well, though the intensity of breeding is low. Winter spawning of hilsa was observed at all the centres but was very poor.

Collections of *H. ilisha* larvae during post-monsoon and early winter were continued from September to November and peak period was found to be in the middle of October at all the centres except Mehewapatti where the breeding was observed in September and in the first week of October. The maximum breeding was observed at Vindhychal centre. *H. ilisha* catch was very poor all along the stretch. The comparative abundance of hilsa larvae during 1971 and 1972 revealed that the breeding was much heavier during 1971 as compared to 1972.

The studies on the bathymetric distribution of larvae of *H. ilisha* have indicated that the larvae prefer surface waters (up to 50 cm depth) and are less abundant in deeper zones.

Suggestions for future work : Suitable conservation measures are to be formulated on the basis of the assessment of hilsa fishery already made, so that the fishery of the middle stretch of the Ganga can be improved. Moreover, similar assessment of the fishery is required to be conducted in the stretch between Buxar and Allahabad.

(b) *Research in hand*

Researches on 18 projects were continued during the year under report. The progress achieved under each project, during 1972, is outlined in the following pages.

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

Problem : 1.1 Composite culture of Indian and exotic species
Personnel: H. Chaudhuri, P. R. Sen, R. D. Chakraborty, D. S. Murty, M. A. V. Lakshman and M. D. Rout
Duration : Continuing

In a three month experiment conducted in two 0.08 ha ponds for raising fingerlings from fry of the Indian major carps in association with the fry of *Ctenopharyngodon idella*, aggregate survivals of 75.00 and 89.21% respectively for the fingerlings were recorded. The stocking density was 2.07 lakh/ha and the species ratio was *Catla catla* 3.6 : *Labeo rohita* 3.6 : *Cirrhinus mrigala* 1.6 : *Ctenopharyngodon idella* 1.2. The average percentage survival/growth (gm) were, *C. catla*, 50.00/8.00 ; *L. rohita*, 92.00/23.50 ; *C. mrigala*, 77.00/31.50 ; and *C. idella*, 81.00/19.50 in one pond ; and *C. catla*, 62.51/6.00 ; *L. rohita*, 98.86/19.50 ; *C. mrigala*, 95.50/34.25 and *C. idella*, 100.00/14.60 in the other. The gross weight of fingerlings produced during three months duration, worked out to be 3,108 and 3,163 Kg/ha respectively.

Composite culture experiments to raise large fish in three 0.14 ha and one 0.4 ha ponds, were concluded at the end of one year in December, 1972. The species ratio tried was *Hypophthalmichthys molitrix* 2 : *Catla catla* 1 : *Labeo rohita* 3 : *Cirrhinus mrigala* 1.5 : *Cyprinus carpio* 1.5 : *Ctenopharyngodon*

idella 1 and a few miscellaneous fishes with a stocking density of 5,000/ha. In one experiment in a 0.4 ha pond where there was harvesting at the end of one year's rearing, the average survival percentage and growth (Kg) recorded were *C. catla*, 100.0/0.79; *H. molitrix*, 95.5/1.56; *C. idella*, 100.0/1.34; *C. mrigala*, 100.0/0.55; *L. rohita*, 99.0/0.72; *C. carpio*, 98.0/1.04; hybrid (*Catla catla* ♂ x *Labeo calbasu* ♀), 40.0/0.43; *Cirrhinus reba*, 40.0/0.13 and mullet (*Mugil cephalus*), 38.0/0.47. The gross/net production of fish estimated was 5,096/4,874 Kg/ha/yr. In the other experiment where intermittent harvesting was practiced but without replenishment, a gross/net production of 5,109/5,000 Kg fish/ha/yr was estimated. The average percentage of survival and growth (Kg) recorded were *C. catla*, 54.00/1.240; *H. molitrix* 93.33/1.480; *C. idella*, 48.00/2.120; *C. mrigala*, 85.31/0.660; *L. rohita*, 65.88/1.148; *C. carpio*, 46.98/2.643; hybrid (*C. catla* ♂ x *L. calbasu* ♀), 50.00/0.620 and mullet (*M. cephalus*), 38.00/0.311.

In the third experiment in two ponds with periodic harvesting and replenishment, gross/net productions of 5,604/5,440 and 3,889/3,770 Kg fish/ha/yr respectively were recorded. The low production in the latter pond was due to pouching. The average survival percentage/growth (Kg) of the fish in the ponds were *H. molitrix*, 88.00/1.460 and 62.00/1.129; *C. idella*, 52.74/1.659 and 45.33/1.496; *C. catla* 100.00/1.104 and 68.29/1.430; *C. mrigala*, 81.81/0.782 and 35.66/0.997; *L. rohita* 89.33/0.839 and 64.44/1.032; *C. carpio*, 91.56/1.650 and 44.57/2.373; hybrid (*C. catla* ♂ x *L. calbasu* ♀), 80.00/0.487 and 80.00/0.512; and mullet (*M. cephalus*), 37.83/0.496 and 51.35/0.290.

In two properly fertilised ponds (0.25 ha each) *C. catla*, *L. rohita*, *H. molitrix*, *C. idella*, *C. carpio*, *C. mrigala* and a small number of *Notopterus chitala*, *Mystus seenghala*, *Ompok bimaculatus* and *Pangasius pangasius* were stocked @ 10,500 fingerlings/ha, and provided with artificial feeding. A net production of 2,660 and 2,533 Kg/ha was estimated after two months of rearing.

A field experiment on rearing of fingerlings of *H. molitrix*, *C. idella* and *C. carpio* in two 0.08 ha ponds stocked @ 1 lakh/ha and with species ratio of 4 : 3 : 3 respectively was concluded after 6 months. The average survival (%) and growth (mm/gm) of the species were 98.4 and 209.0/68.0; 88.6 and 166.9/44.0; 79.9 and 131.0/35.4 respectively, the over-all survival being 90%.

Another experiment of 6 months' duration initiated in the later part of 1972 in which fry of the three exotic fishes; viz., *H. molitrix*, *C. idella* and *C. carpio* were stocked @ 2.5 lakh/ha, is in progress.

The experiment on raising of large fish initiated in 1972 is in progress. Fingerlings of *H. molitrix*, *C. catla*, *L. rohita*, *C. idella*, *C. mrigala* and *C. carpio* in the ratio of 2 : 1 : 3 : 1 : 1.5 : 1.5 respectively were stocked at a density of 5,000/ha.

Experiment initiated in 1971 to study the comparative growth and production of carps when reared for two consecutive years is still in progress. 4 ponds were stocked @ 4,250 major carps and 1,500 minor carp fingerlings per hectare in the ratio of *C. catla* 1 : *L. rohita* 2.5 : *C. mrigala* 1.3 : *H. moli-*

trix 2 : *C. idella* 0.75 : *C. reba* 0.75. In 2 ponds, fertilisers were applied and the fish were provided with artificial feeds while in the remaining two ponds no facilities; like, fertilisers and feed were provided to the fish and were treated as control. After one year's rearing, one control and one treated ponds were completely harvested. The average growth of carps in the treated and control ponds were 1,324 and 257 gm respectively. However, survivals in the harvested ponds were low due to which the production rate also fell to 2,418.50 Kg in the treated and 450.21 Kg in the control pond. In the other two ponds, rearing continued for second year. The estimated per hectare production in the second treated pond was 5,176.80 Kg and in the untreated control pond 628.45 Kg. The initial weight of fish stocked ranged between 32 and 35 Kg/ha.

Problem : 1.2 Evolving a balanced fish diet and to improve feeding techniques

Personnel: M.A.V. Lakshman, M. D. Rout and D. R. Kanujia

Duration : Four years

Yard experiments on supplementary feeds of fry and fingerlings of cultivated carps indicated low nutrition efficiency of prawn waste powder and a mixture of the same with plant material. A mixture of fish meal with plant material had better food value though it was found to be only slightly less efficient than a mixture of rice-bran and ground-nut oilcake. Rice-bran proved superior in food value than ground-nut oilcake. A high protein level of 53% is less effective in comparison to one of a lower level of 26.67%.

Problem : 1.3 & 1.4 (Research work completed in 1972)

Problem : 1.5 (Research work completed in 1970)

Problem : 1.6 (Research work completed in 1972)

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

Personnel: K. K. Bhanot (Mrs.) and M. M. Bagchi

Duration : Six years

Mass culture of plankton was done in plastic cisterns of 200 litre capacity under natural light and temperature (20°-24°C) conditions, with a view to assessing the comparative efficiency of the different nutrient solutions used. The results obtained are summarized below :—

The Bristol's nutrient solution proved efficient in promoting the growth of organisms. Production of *Chlorella* sp. in terms of u/ml of Bristol's solution, Tamiyas and tap water (control) as media was 0.150-0.250, 0.075-0.150 and 0.250-0.350 lakh cells respectively while the same for diatoms in Chu-10 was 0.055-0.120 lakh cells. The dry matter produced from *Chlorella* sp. cultured in Bristol's solution, Tamiyas and tap water (control) and diatoms in Chu-10 was

8.00-10.00, 4.00-4.50, 0.15-0.65 and 5.00-6.70 gm/m² while the respective carbon production was 28.32, 16.42, 3.12 and 11.37 mg C/m³/day.

Nutrient solutions containing more of phosphate and nitrate had an edge over others.

Cell production in the first 10 days was 500 cells/ml/day which increased to 1,000 cells/ml/day within one month and finally reached a growth rate of 3,000-4,000 cells/ml/day in the period of 50-60 days. Most of the nutrients get used up within a period of 60 days and thus act as the limiting factors for the enhanced growth as is evident from the preceding para.

Culture of Bdelloid rotifer *Philodina* sp. were done in filtered and boiled pond water, tap water and distilled water by adding wheat infusions in petri dishes. Number of organisms developed around the wheat grains were 500-700/cc/week.

Laboratory cultures of *Chlorella* sp. and diatoms were maintained in the laboratory at controlled temperature of 25°C ± 1° where illuminations of 100, 200 and 500 lux were provided.

Problem : 1.8 (Research work completed in 1971)

Problem : 1.9, 1.10 & 1.11 (Research work completed in 1972)

Problem : 1.12 Evaluation of indigenous plants as fish poisons

Personnel: H. Chaudhuri and S. Jena

Duration : Four years six months

Unripe fruit powder of a locally available plant 'Kakhada' (*Caesaria gravaolens*) was found to kill *Channa marulius* within 6 to 8 hr after treatment at 10-25 ppm. In laboratory experiments, dried and powdered 'Mahua' (*Bassia indica*) flower residue tried at different concentrations of 10, 25, 50, 75, 150 and 300 ppm indicated that only at 300 ppm fishes were in distress after 24 hr.

Problem : 1.13 (Research work completed in 1972)

Problem : 1.14 Qualitative segregation of fish seed

Personnel: R. D. Chakraborty, K. Janakiram and D. K. Chatterjee

Duration : Four years

Neither positive nor negative response was exhibited by fish seed to illumination of different colours and intensities tried. This together with experiments carried out in the previous years would suggest that colour and light intensity variations may not be effective in the segregation of spawn of major carps, species-wise.

Similarly, clear cut differences in behaviour, which might be utilized to segregate the major carp species from one another, were not noticeable either under DO stress or differences in temperature in the same container.

Problem : 1.15 Selective capture of predators and unwanted fishes from carp culture ponds

Personnel: A. David, S. L. Raghavan and M. F. Rahman

Duration : Three years

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

Problem : 1.16 (Research work completed in 1972)

Problem : 1.17 Effect of irradiation on fish

Personnel: R. D. Chakraborty and P. R. Sen

Duration : Three years

Developing eggs of *Catla catla* and *Labeo rohita*, in which twitching movement had started, were exposed to ultra-violet irradiation. It was observed that the exposures of more than 30 seconds caused deformity of the fish and exposures of more than one minute proved to be lethal.

Fertilised eggs of *L. rohita* and *C. catla* were exposed for 5, 10, 20, 30, 45, 60, 120 and 180 seconds to the same intensity of ultra-violet irradiation. In exposures over 5 seconds, it was observed that yolk absorption was much slower than in the control. The effect of this delayed absorption of yolk was the prevention of normal development of the larvae which exhibited disbalanced movements. The development of the eye and fin rays was also adversely affected.

Problem : 1.18 Role of some trace elements in pond fertilisation

Personnel: G. N. Saha, D. K. Chatterjee, K. Rahman and C. Selvaraj

Duration : Five years

In laboratory and yard experiments, molybdenum and zinc appeared to have some useful role as trace elements when applied at 0.05 ppm to low nutrient and slightly acid soil. The survival and growth of spawn of *Labeo rohita* (90%, 14.7 mm/34.90 mg) was better in treatments with molybdenum than with cobalt (90%, 14.0 mm/27.00 mg), boron (67.5%, 9.9 mm/8.12 mg) and zinc (65%, 9.0 mm/8.50 mg) as revealed in laboratory experiments. The growth and survival of fry of *L. rohita*, in yard experiments, was observed to be better with zinc (80%, 35.51 mm/0.826 gm) than with cobalt (83%, 29.56 mm/0.689 gm). The experiments are being repeated for further confirmation of results.

Problem : 1.19 Conversion ratio of selected feed into fish flesh
Personnel : R. D. Chakraborty, P. R. Sen, N. G. S. Rao and D. K. Chatterjee
Duration : Four years

Experiments to determine the comparative merit of different fish feed were carried out with spawn and fry of *L. rohita*, *C. catla*, *C. mrigala* and *C. carpio*. Experiments with spawn were conducted in glass jars and with fry in plastic pools. The former were of 15 days' duration and the latter of one month's duration. The feeds tried were zooplankton, silk-worm pupae, soyabean, mixture of ground-nut oilcake : wheat-bran (1:1 by weight) and mycelium of *Penicillium* sp. with five replicates. Water in the jars was not changed. Finely powdered feed, equivalent to 10% of the initial body weight, were provided to the fry whereas in case of spawn, the daily feed was equivalent to the initial body weight.

Considering both, the survival and growth increment, zooplankton proved to be the best food for the spawn of *L. rohita* and *C. catla*. It is interesting to note that higher growth increments of *C. mrigala* were obtained with soyabean, wheat-bran + ground-nut oilcake and silk-worm pupae in that order than with zooplankton.

In the case of fry of *C. catla*, the feed, ground-nut oilcake + wheat-bran, appeared to have been the best utilized and except mycelium of *Penicillium* sp. all other feeds were well taken.

No mortality of fry of *C. mrigala* was noticed during the experiment. Silk-worm pupae, soyabean and ground-nut oilcake + wheat-bran mixture were better utilized by the fry than zooplankton. Mycelium of *Penicillium* sp. did not prove to be a useful feed either for fry or spawn. However, *C. mrigala* fry utilized it better than *C. catla* fry.

In experiments with fry of *C. carpio*, the feed containing higher proportion of carbohydrates proved somewhat better than other two feeds tried, containing varied proportions of carbohydrate and protein.

Problem : 1.20—1.24 (Research work contemplated)

Project 2: Induced fish breeding

Problem : 2.1 (Research work 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 : Six years

Pituitary glands of catfishes (*Pangasius pangasius*, *Silonia silonia*, *Bagarius bagarius* and *Mystus seenghala*), sciaenids, *Tilapia mossambica*, *Notopterus chitala* and amphibians were tried for induced breeding of carps. Of these, successful results were obtained with pituitary glands of catfishes confirming the results obtained last year.

Problem : 2.3 (Research work completed in 1972)

Problem : 2.4 Hatching of eggs of major carps in newly designed hatching jars under controlled conditions

Personnel: R. M. Bhowmick

Duration: Five years

Installation of a mechanical hatchery complex for the major carps was completed during the year. In all, 40 hatchery jars have been installed and 20 lakhs of developing eggs could be released into them.

Six experiments were carried out in the hatchery. 50 to 75 thousands of developing eggs were released in each jar and hatching took place within 12 to 15 hr, as compared to 15 to 18 hr in conventional 'hapa' fixed in ponds. A total of 10 lakh spawn was produced out of 19.8 lakh eggs released in the hatchery, the percentage of hatching and survival being always higher in the hatchery than in 'hapa'.

Problem : 2.5 (Research work suspended for lack of facilities)

Problem : 2.6 Experiments on the production of multiple broods for the same individual of major carp in the course of one year

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

Duration: Three years

Results obtained in the previous year have been confirmed by successfully breeding two specimens of *Labeo rohita* and one *Catla catla* for the second time in the same season, thereby increasing the production of fish seed. 5.95 lakh spawn were produced from two fish for the second time being nearly the same, as obtained when the fish bred for the first time.

Problem : 2.7 (Research work contemplated)

Project 3: Reservoir fisheries

Problem : 3.1 — 3.5 (Research work completed in 1972)

Problem : 3.6 Fisheries of Peninsular tanks : Assessment of biological productive potentialities

Personnel: A. David, S. L. Raghavan, M. F. Rahman and S. A. S. Kumar

Duration : Three years

Primary production : Light and dark bottle technique in the assessment of primary productivity was employed and the ranges of primary productivity ($\text{mg C/m}^3/\text{day}$) for different tanks were 175.0-275.0 (Arsikere), 300.0-693.7 (Nidige), 125.0-450.0 (Milghatta), 237.0-602.4 (Hutcharayankere), 125.0-324.9 (Madaga) and 300.0-500.0 (Anjanapur). Higher values were noticed during April, 1972 when light intensity was more. Low values, observed during June-September, may be due to the decrease of plankton concentration added to the cloudy weather. But the values showed an increasing tendency during October-December along with an increase in the standing plankton.

Bio-mass production—settled organisms : Extent of settled particulate organic matter, assessed by slide submersion experiment, indicated a carbon production range of 3.0 to 20.8 mg on 30 sq cm slide area (36.08 to 462.4 mg $\text{C/m}^2/\text{day}$) in these tanks. With the increase in turbidity, there was a corresponding rise in the values of the settled organic matter.

Plankton : The plankton density ranged from 20 to 1,370 u/l in all these water sheets. The phytoplankters encountered in these water sheets were *Anabaena* sp., *Oscillatoria* sp., *Phacus* sp., *Astasia* sp., *Chlamydomonas* sp., *Microcystis* sp., *Volvox* sp., *Sphaerocystis* sp., *Schizodictyon* sp., *Chlorococcum* sp., *Actidesmium* sp., *Euastropsis* sp., *Pediastrum* sp., *Pachycladon* sp., *Ankistrodesmus* sp., *Nephrocytium* sp., *Mesotaenium* sp., *Closterium* sp., *Cosmarium* sp., *Arthodesmus* sp., *Cosmocladium* sp., *Desmidium* sp., *Chaetophora* sp., *Spirogyra* sp., *Mougeotia* sp., *Ulothrix* sp., *Oedogonium* sp., *Ceratium* sp., *Botrydiopsis* sp., *Fragillaria* sp., *Pinnularia* sp., *Navicula* sp., *Cymbella* sp. and *Rhizosolenia* sp., the zooplankters being *Diffugia* sp., *Trinema* sp., *Holophyra* sp., *Prorodon* sp., *Didinium* sp., *Colpoda* sp., *Frontonia* sp., *Keratella* sp., *Trichocerea* sp., *Castropus* sp., *Euchlanis* sp., nauplii, *Daphnia* sp., *Bosmina* sp., *Cypridopsis* sp., copepods (calanoids and cyclops), nematodes etc. There was a general tendency of phytoplankton dominating over the zooplankton in all the tanks. Only during September-December in Anjanapur and Madaga tanks zooplankton dominated over the phytoplankton.

Littoral and Benthic Organisms : The organisms encountered in the littoral and benthic zones in the tanks were chironomid larvae, gastropods (*Amnicola* sp., *Gyraulus* sp., *Limnaea* sp., *Melanoides* sp., and *Viviparus* sp.),

bivalves (*Corbicula* sp.), insects (*Nepa* sp., *Corixa* sp., *Plea* sp., *Ranatra* sp., *Notonecta* sp., *Belostoma* sp., may-flies and dragon-flies) and prawns (*Macrobrachium idae*, *M. scabriculum* and *Caridina* spp.). The density of organisms in these zones ranged from 1 to 624 u/m² by numbers and from 0.060 to 1,863.0 gm/m² by weight.

Fish stocking : 8,000 and 1,600 fingerlings of *Cyprinus carpio* were stocked in Madaga and Hutcharayankere tanks respectively during this year.

Fish production : 700 Kg of *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, and *Cyprinus carpio* and 500 Kg of miscellaneous fishes; like, *Ompok bimaculatus*, *Puntius* spp. and minnows were caught in Arsikere tank in April, 1972. Among the carps, *L. rohita*, *C. catla* and *C. mrigala* dominated over *C. carpio*.

Regular fishing conducted in Madaga tank by 'Killa ketha' revealed only local species; like, *Puntius sarana*, *Notopterus notopterus*, *Ompok bimaculatus*, *Channa striatus*, *Channa gachua* and rarely *Puntius pulchellus*. The average catch was reported to be 5 to 10 Kg/day.

In Anjanapur reservoir, no regular fishing was done. During July, 1972, the catches consisted mainly of *Puntius pulchellus*. In 11 days of observation, 258.130 Kg of *P. pulchellus* were caught with an average catch of 23.466 Kg/day. Very rarely *Labeo fimbriatus*, *Labeo calbasu* and *Wallago attu* were encountered in the catches.

Physico-chemical conditions of water and soil : The physico-chemical conditions of water and soil in the tanks during the period were : temperature, 24.90°-30.55°C; turbidity, 100 ppm; pH, 6.9-9.6; DO, 3.28-10.08 ppm; total alkalinity, 24.0-212.0 ppm; hardness, 22.0-146.0 ppm; specific conductivity, 72.0-983.0 x 10⁻⁶ mhos; nitrate, 0.209-0.610 ppm; phosphate, 0.12-1.00 ppm; silicate, 22.05-59.35 ppm and iron, 0.06-0.64 ppm in water phase and pH, 7.5-8.5; calcium, 400-1,200 ppm; magnesium, 8-25 ppm; phosphorus, 3-5 ppm and ammonia, 3-15 ppm on soil phase.

The water was clear in all these tanks even during monsoon months, turbidity being less than 100 ppm. Higher values of nutrients were noticed during April, 1972, which may be due to evaporation and concentration. Dilution in the nutrients, during monsoon months, was also in evidence. Arsikere tank exhibited a high pH value of 9.6 (April, 1972). It also exhibited higher values in alkalinity, hardness, specific conductivity, nitrate and phosphate than in other tanks while iron was present in lowest quantity. Silicate and iron were present slightly in higher concentration during July-December than January-June months. Free carbon dioxide was present in all the tanks up to 30.00 ppm.

The bottom soils of these tanks were alkaline in nature with pH ranging from 7.5 to 8.5. Phosphorus, magnesium and ammonia were found to be present in low quantities in these ponds.

Problem : 3.7 (Research work completed in 1970)

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

Personnel: A. David, S. L. Raghavan, M. F. Rahman and S. A. S. Kumar

Duration : Three years

Oozing and milting *Puntius pulchellus* (nearly 1,000 fish weighing about 3.5 to 6.5 Kg on one day only and on an average 100-150 fish per day) were reported in commercial catches at the tail end of Bhadra reservoir in September, 1972. At the end of October and beginning of November, 1972, no oozing specimens were available. But milting males of *Tor khudree* (Sykes) numbering nearly 30-40/day were observed at the same spot.

Breeding and nursery grounds of mahseer — *T. khudree* (Sykes) were successfully located near the sanctuary of Sringeri temple in the Tunga river. 1,320 postlarvae/fry/early fingerlings were collected during November-December, 1972, 86, 34 and 128 of them were kept in the Krishnarajasagar Fish Farm, aquarium at Bangalore and Vanivilassagar Fish Farm respectively for rearing and further observations. Out of 1,200 postlarvae/fry/fingerlings of *T. khudree*, mainly collected along with *Puntius pulchellus* during December, 1972, only 160 survived due to lack of adequate facilities.

Fingerlings of *Puntius pulchellus* (40-60 mm), stocked in Byramangala Fish Farm, were found to have attained the maximum size of 181 mm in 8 months. They had fed on algal filaments, higher plant parts, insects and diatoms.

A total of 50 fingerlings of *P. pulchellus* (94-130 mm) reared in Byramangala Fish Farm were stocked in the Kanwa reservoir while 60 and 23 fingerlings (135-181 mm) reared in the same fish farm were stocked in Kunirkatte tank in Chennapatna and Byramangala reservoirs respectively.

Fingerlings of *P. pulchellus* (40-90 mm) stocked in Vanivilassagar Fish Farm have attained the maximum size of 230 mm in the range of 170-230 mm within 13 months.

Studies on the food and other biological characteristics such as length, weight etc. of *P. pulchellus*, available in the commercial catches in the Anjanapur and Bhadra reservoirs and in the Tunga and Bhadra rivers and also available in the fish markets of Shimoga and Bhadravathi, were done. Gut contents of the fish caught from the Anjanapur reservoir indicated the presence of terrestrial grass only, while the fishes from the Tunga river showed algal and vascular plant parts and those from Bhadra reservoir showed grass and disintegrating tree bark pieces.

Problem : 3.9, 3.10 & 3.11 (Research investigations contemplated)

Project 4 : Riverine carp spawn prospecting and collection techniques

Problem : 4.1, 4.2 & 4.3 (Research work is being done under a Co-ordinated Project)

Problem : 4.4 Comparative growth rate of spawn from different sources

Personnel: Y. R. Tripathi, B. Singa, P. M. Mathew, G. N. Mukherjee and R. N. Seth

Duration : Three years

Spawn samples from the river Kosi from Rampur-diera (Sahibganj) and from the river Ganga from Purani-Sahibganj (Sahibganj) were obtained for experimental rearing in plastic pools up to fry stage. The rate of stocking was 300 spawn/pool, each measuring 120 cm x 90 cm. The spawn in all the pools were given identical quantities of plankton and artificial feed (rice-bran and mustard oilcake in 1 : 1 proportion) as was done in 1971.

After 20 days' rearing, the number of surviving spawn at fry stage and their size range (mm) were recorded as 81 and 9.34 (average 23.01) for spawn from the river Kosi (Rampur-diera), 162 and 12.36 (average 20.70) for spawn from the river Ganga (first spurt at Purani-Sahibganj), and 143 and 14.29 (average 23.62) for spawn from the river Ganga (third spurt at Purani-Sahibganj).

The details of the species-wise survivals (no./%) of fry, during the rearing experiments of the spawn samples from various sources, were : *Catla catla* (12/14.20); *Cirrhinus mrigala* (14/17.29); *Labeo rohita* (14/17.29); *Cirrhinus reba* (10/12.96); *Labeo bata* (7/8.65) and miscellaneous fishes (24/29.61), with over-all survival of 81/27.00 for the spawn from the river Kosi, the respective survivals for spawn from the first spurt in the Ganga river being : 12/7.40, 16/9.90, 23/14.20, 41/25.30, 11/6.80 and 59/36.40 with 162/54.00 and from the third spurt, 10/7.00, 17/11.90, 16/11.20, 11/7.69, 89/62.21 and nil/nil with 143/47.66. Major carps contributed 13.16, 17.00 and 14.33% in the spawn from the river Kosi and the river Ganga (spurts I and III) respectively.

In the second phase of experiment, fry raised from spawn from different sources were reared up to fingerling stage to study their comparative growth rate. These experiments were conducted with one replicate of each species combination since the entire stocking had to be done only from the surviving fry available at hand. The rate of stocking was 30 fry/pool. The fry, in all the pools, were given identical quantities of plankton along with artificial feed consisting of rice-bran and mustard oilcake in 1 : 1 proportion as was given in the first phase of the experiment.

The number/size (mm) of fry released, and the number/size (mm) of fingerlings harvested were : *C. catla* — 12/20-30 (average 23.91) and 11/26-39 (average 30.45), *C. mrigala* — 9/19-29 (average 22.11) and 9/37-55 (average 49.11), *L. rohita* — 9/16-34 (average 30.44) and 9/26-39 (average 34.22) for

pool I with the fry from the river Kosi, the respective figures being 10/19-28 (average 23.50) and 9/28-33 (average 30.40), 10/25-32 (average 27.70) and 9/44-47 (average 44.33), 10/17-25 (average 21.70) and 10/26-36 (average 32.70) for pool II also with the fry from the river Kosi; 10/18-26 (average 20.00) and 10/27-36 (average 30.10), 10/20-32 (average 25.20) and 10/35-47 (average 39.40), 10/16-26 (average 19.10) and 10/21-29 (average 22.80) for pool III with the fry from the spurt I in the Ganga river; and 10/17-24 (average 19.70) and 8/22-36 (average 28.75), 10/24-35 (average 28.60) and 8/31-46 (average 37.50), 10/16-23 (average 18.70) and 10/21-31 (average 24.30) for pool IV with the fry from the spurt III in the Ganga river. In the first three pools, *C. mrigala* and in the fourth pool, *C. catla* showed the maximum growth, while *L. rohita* in pools I, III and IV and *C. catla* in pool II recorded the poorest growth.

Problem : 4.5 Yearly variation in quality and quantity of spawn in the river Ganga
Personnel: Y. R. Tripathi, S. C. Pathak, G. N. Mukherjee and B. D. Saroj
Duration : Five years

With a view to assessing the quality of spawn availability, three centres, one at Kishanpur on the river Yamuna and two; viz., Buxar and Sahibganj on the river Ganga were prospected in monsoon months of 1972.

Kishanpur : Work at Kishanpur was carried out in collaboration with the technical staff of the Co-ordinated Project and a total quantity of 460 ml of spawn was collected. The percentage of major carp spawn was found to range between 26 and 80. The indices of spawn quality and quantity were estimated to be 73.9% and 100 ml respectively.

Buxar : Spawn prospecting was carried out for 16 days at Buxar and 430 ml of spawn was collected. It was interesting to note that all the collections were made in receding phases of the second and third floods. Major carp spawn was found to range between 8 and 34% and the average for the entire collection was estimated to be 27.15%. The average percentage of major carps in nursery rearings was 9.49.

Sahibganj : At Sahibganj, spawn collection was carried out for 28 days and a total of 5,389 ml of spawn could be collected. Bulk of the spawn was collected in 3 days. Percentage of desirable spawn in the total catch ranged between 40 and 95.

Project 5 : Brackish water fish farming

Problem : 5.1 Productive potential of polyculture in the lower Sunderbans

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

Duration: Four years

During the year under report, the total rainfall was only 113.25 cm as against 254.8 cm in 1971. The maximum depth of the two stocking ponds 'K' and 'R' was 250 and 150 cm respectively. The salinity in 'K' pond came down from 2.7‰ in March to 0.77‰ in October, the minimum salinity recorded in 1971 being 1.26‰. The NO₃-N ranged between 0.02 and 1.30 ppm while PO₄-P showed a range of 0.02 to 0.19 ppm.

Fish from 'K' pond were harvested in May at the end of 15 months' rearing and the average sizes (mm/gm) attained by the various species with initial sizes indicated within brackets were: *Catla catla*, 229.3/248.3 (151.3/45.4); *Labeo rohita*, 325.9/512.7 (126.5/33.4); *Cirrhinus mrigala*, 229.7/163.6 (110.6/12.4); *Hypophthalmichthys molitrix*, 399.9/693.8 (148.5/30.3); *Ctenopharyngodon idella*, 213.1/98.5 (140.3/32.6); *Cyprinus carpio*, 240.9/277.0 (45.1/8.9); *Mugil cephalus*, 426.6/873.8 (252.6/236.1); *Mugil tade*, 286.2/191.0 (203.3/144.3); *Mugil parsia*, 196.1/111.2 (52.5/2.0); *Chanos chanos*, 455.3/557.1 (283.0/193.6) and the prawn, *Penaeus monodon*, 211/75 (25/0.05). The average survival was 49.27% with a production of 800 Kg/ha.

'K' pond was stocked afresh with 325 *C. catla* (91.9 mm/10.0 gm), 235 *L. rohita* (74.1 mm/4.9 gm), 200 *C. mrigala* (97.6 mm/11.6 gm), 300 *H. molitrix* (189.3 mm/65.8 gm), 163 *M. tade* (151.3 mm/53.8 gm), 682 *M. parsia* (73.7 mm/5.6 gm) and 464 *P. monodon* (92.5 mm/6.4 gm) by the end of October and with 150 *C. carpio* (63.9 mm/4.2 gm) in December, the over-all stocking rate being 7,270/ha.

The growth increments in two months' rearing were: 51.9 mm/28.9 gm for *C. catla*, 73.1 mm/59.1 gm for *L. rohita*, 18.3 mm/7.8 gm for *C. mrigala*, 138.8 mm/179.2 gm for *H. molitrix*, 85.5 mm/77.5 gm for *M. tade*, 51.8 mm/15.9 gm for *M. parsia* and 84.2 mm/46.9 gm for *P. monodon* when rice-bran and mustard oilcake were given as supplementary feeds.

In 'R' pond, stocking was done with 238 *C. catla* (92.8 mm/11.8 gm), 148 *L. rohita* (78.9 mm/5.41 gm), 182 *C. mrigala* (128.1 mm/19.8 gm), 304 *H. molitrix* (97.9 mm/10.5 gm), 70 *C. carpio* (62.6 mm/3.7 gm), 183 *M. tade* (110 mm/18.0 gm) and 613 *M. parsia* (90.1 mm/8.92 gm) in December, 1972.

Studies on the phreatic line indicated that the average hydraulic gradient for the puddle core at Bakkhali is 1 in 3.5. These data have a bearing on the size and slope of the dykes in the terrain obtaining at Bakkhali. The total subsidence of the dykes was found to be 90 cm.

Problem : 5.2 Detailed survey of islands in the lower Sunderbans for designing brackish water fish farm (400 ha)

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

Duration: One year nine months

Reconnaissance survey of Dhanchi island has been completed. Detailed contour survey of Mahisani island in an area of 120 ha of the forest land has been completed. Regular observations on inundation of the island at fixed points were made, along with tidal amplitude in the Mahisani creek.

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

Personnel: B. B. Pakrashi, A. B. Mukherjee, N. C. Basu and R. K. Banerjee

Duration : Three years six months

The pH of the brackish water ponds ranged from 7.4 to 8.6 while the alkalinity, $\text{PO}_4\text{-P}$ and $\text{NO}_3\text{-N}$ fluctuated from 76 to 160 ppm, 0.02 to 1.50 ppm and 0.02 to 0.80 ppm respectively.

For selective stocking, experimental trials on the ingress of brackish water seed through the secondary sluice with adjustable valve-shutter, permitting water flow at different velocities, indicated that the maximum ingress occurred at velocities of 1.22 to 1.26 Km/hr.

After nine months of rearing, the average sizes (mm/gm) attained by the stocked fishes and prawns were: *Mugil parsia*, 124.6/21.6; *Mugil cephalus*, 287.8/294.8; *Mugil tade*, 251.0/150.0; *Penaeus monodon*, 138.8/26.4; *Penaeus indicus*, 113.0/10.0; *Metapenaeus monoceros*, 67.1/3.3 and *Metapenaeus brevicornis*, 73.7/2.9.

Problem : 5.4, 5.5 & 5.6 (Research work completed in 1972)

Problem : 5.7 Culture of brackish water fish food organisms

Personnel: K. K. Bhanot (Mrs.) and A. N. Ghosh

Duration : Five years

Studies on primary productivity and periphytic organisms were continued into ponds at the Brackish Water Fish Farm, Kakdwip. Average biomass production of both the ponds ranged from 0.941 to 2.730 gm/m²/day between May and July and from 0.815 to 1.001 gm/m²/day between August and October.

Mass culture of a mixture of food organisms, *Cymbella* sp., *Pleurosigma* sp. and *Chlorococcus* sp. was done in Miquel's solution.

Cultures of diatoms (*Cymbella* sp. and *Amphora* sp.) were maintained in the laboratory in Miquel's solution and pond soil extract.

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

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

Duration : Three years

7 out of 13 sets of *Mugil cephalus* were bred by hypophysation and a large number of hatchlings were obtained. The survival of larvae was better

than that of the previous year's due to favourable weather conditions. The larvae survived for 23 days in field conditions at Chilka lake-mouth and rearing is now in progress. Suitable food items; like, veligers and trochophores of molluscs and rotifers collected from the plankton from the lake-mouth, were used for feeding the larvae of *Mugil cephalus*.

Problem : 5.9 Response of different fertilisers both inorganic and organic, on fish productivity

Personnel: R. S. Panwar, B. B. Pakrasi and N. C. Basu

Duration : Two years

The effect of compost of mangrove leaves (*Avicennia officinalis*), straw, cattle-dung, urine and superphosphate was studied in an experimental pond 'E,' measuring 15 m², with pond 'J' of identical size as control. The PO₄-P and NO₃-N of the water in pond 'E' rose from traces to 0.36 mg/l and traces to 0.12 mg/l respectively, while in the control pond the above nutrients ranged from 0.04-0.08 mg/l and 0.04-0.06 mg/l respectively. In the soil phase, the available nitrogen and phosphorus in the experimental pond increased from 11.2 to 16.8 and 13.5 to 20.8 mg/100 gm soil respectively, as against the respective ranges of 9.3 to 9.6 and 11.5 to 13.2 mg/100 gm in the control pond. The primary productivity in pond 'E' rose from 38.8 mg C/m³/hr before manuring to 417.0 mg C/m³/hr after manuring, in comparison to 46.2-120.0 mg C/m³/hr in the control. *Catla catla* and *Cirrhinus mrigala* were stocked at a density of 30 in each pond. After 44 days, it was found that in the experimental pond, the growth was 49.54 mm/9.90 gm, while it was 36.78 mm/6.93 gm in the control pond. The survival was 38.28% in pond 'E' while it was 14.28% in pond 'J'.

Problem : 5.10 Detailed surveys of Lothian and Prentice islands for designing brackish water fish farms

Personnel: A. Sengupta, B. B. Pakrasi, R. S. Panwar, A. B. Mukherjee and P. N. Bhattacharya

Duration : One year six months

Survey of Lothian and Prentice islands could not be taken up as the contour survey of Mahisani island was not completed.

Project 6 : Freshwater prawn culture

Problem : 6.1 Freshwater prawn culture techniques

Personnel: K. Raman

Duration : Six years six months

In 1972, further work on the project could not be taken up since the Project Leader was transferred and no substitute was available in his place.

Problem :	6.2	Propagation and culture of <i>Macrobrachium malcolmsonii</i>
Personnel:		T. Rajyalakshmi, Y. Ramarao, T. S. Ramaraju, K. S. Rao and D. R. Rao
Duration :		Five years

Culture : Monoculture of *Macrobrachium malcolmsonii* was taken up in 4 ponds at Katheru Fish Farm. Each pond was manured with cow-dung 12.5 Kg + lime 0.2 Kg every quarterly for two quarters. The prawns, stocked at 5,000/pond, were fed at 3 days intervals with 3 Kg of rice-bran + broken rice + oilcake + processed liver (8 : 8 : 8 : 1) per month. Rearing was done for 5½ months excepting in the fourth pond where experiment continued for 3½ months. Total production (per hectare) and average growth of prawns attained were : 414 Kg and 121.0 mm/26.9 gm, 195 Kg and 127.4 mm/28.6 gm, 80 Kg and 118.7 mm/18.8 gm, 63 Kg and 121.3 mm/25.6 gm respectively.

Mixed culture of *Macrobrachium malcolmsonii* and carps was taken up in 4 ponds at Kadiam Fish Farm. Each pond was manured with cow-dung 168 Kg + lime 0.75 Kg quarterly for 3 quarters and the stocking rate for prawns was 20,000/pond. The first and third ponds were harvested after 10½ months and the second and fourth ponds were harvested after 6½ months. The total production (per hectare) of prawns and the size at capture were : 86.22 Kg and 94.1 mm/8.9 gm, 228.0 Kg and 88.6 mm/11.7 gm, 43.0 Kg and 84.6 mm/6.5 gm, nil and nil respectively.

The dissolved oxygen values in Katheru Fish Farm were comparatively higher (7.6-13.6 ppm with an average of 10.6 ppm) throughout the season than in Kadiam Fish Farm (3.8-10.1 ppm with an average of 6.6 ppm), probably due to very frequent supply of freshwater. However, in the Kadiam Farm, the DO values were low only in June and July in two ponds. The primary productivity values were high throughout the season of work (5,377-11,279 mg C/m³/6 hr for Katheru and 2,785-14,622 mg C/m³/6 hr for Kadiam).

In the Katheru Fish Farm, phytoplankton was found to dominate over zooplankton. The density of plankton and the percentage contribution of the phytoplankton to the total plankton production were : 0.0061-0.0194 ml/l and 61.5-97.8, 0.0068-0.0164 ml/l and 80.5-96.9, 0.00080-0.3280 ml/l and 14.9-96.0, 0.0156-0.0325 ml/l and 64.2-79.4 in the four ponds respectively.

Artificial propagation in laboratory : Due to failure of rainfall during the months, July to September, the number of berried females in the catches was very poor (1-5%) and as such no sample could be obtained for breeding purposes.

Abundance of juvenile prawns : In order to study the availability and abundance of juvenile *Macrobrachium malcolmsonii*, sampling by using drag-

net, was extended up to sea-mouth in the Gautami estuary. Juveniles in the size range 2.0-6.0 mm (carapace length) were obtained throughout the stretch in low tide collections only and their number ranged from 2,000-3,000/hr in the months of October and early November.

Pure seed of *Macrobrachium rude* were also obtained at Kotipalli and Yanam centres in bottom drag-net operations during the same period.

Collections of *Macrobrachium malcolmsonii* at Dowlaishwaram anicut during November, 1971 to February, 1972, ranged from 0.250-14.000 Kg/night. During 1972-73 season, the collections further declined and ranged between 0.025 and 8.000 Kg/night during October to December.

10,000 juvenile prawns were transported to Hesarghatta Fish Farm, Bangalore. 1.25 lakh were utilized by the CIFRI unit at Rajahmundry for experimental studies.

Tagging and marking trials : Tagging operations were carried out at Rajahmundry and Sithanagaram, the later being located 20 Km upstreams of the former. Prawns were tagged using Peterson's double disc numbered tags with nylon tagging material. 2,320 and 1,680 prawns were tagged and released and 213 (9.2%) and 136 (8.1%) recoveries respectively were made at the two centres. The maximum recoveries were made during one month after tagging and were confined to a distance of 3-5 Km of the release-spot. No intermixing of populations of the two centres was observed. An increase in carapace length by 1-2 mm and 1-2 gm in weight was observed in prawns recovered within 15 days to one month after tagging.

Biological studies : Investigations on metabolic rate at varying temperatures of size-graded prawns were conducted. The metabolic rate decreased with increase in size. Due to total lack of rainfall in the period March to early June, the gonads of prawns did not show any ripening till late June. No barried female was, therefore, recorded till late June unlike 1971 season.

Catch statistics : The yield of *Macrobrachium malcolmsonii* particularly in the months of peak landing; viz., February to June, 1972, was low as compared to the corresponding period of 1971. The total monthly landings of *M. malcolmsonii* at Rajahmundry area were : 4.4 (January), 9.7 (February), 11.9 (March), 10.4 (April), 11.9 (May), 14.2 (June), 0.5 (July), 0.7 (August), 0.4 (September), 0.3 (October) and 2.0 (November) tonnes.

Problem : 6.3 (Research work contemplated)

Project 7 : Murrel and live fish culture

(Investigations are being conducted under a Co-ordinated Project)

Project 8: Estuarine and brackish water lake fisheries

Problem : 8.1 Brackish water fish seed prospecting
Personnel : V. Gopalakrishnan, Apurba Ghosh, K. K. Bhanot
and P. R. Das
Duration : Five years

At Diamond Harbour centre, important prawn seed encountered (number/net/hr) were: *Penaeus monodon* 996, 432 and 167 and *Penaeus indicus* 227, 111 and nil in the months of March, April and May respectively. The post-larvae of the prawns ranged from 9 to 13 mm in length. Fry of *Mugil parsia* were few in number (3-11/net/hr) in shooting nets during the pre-monsoon months.

At Namkhana centre, the important prawn seed encountered were—*P. indicus*: 5,271, 11 and 1,764/net/hr during March, April and May respectively. *M. parsia* was available in poor numbers (2-13/net/hr) during the same period.

At Lot No. 8 (near Kakdwip), fry of *M. parsia* were available in large numbers during high tides in the months of March (170/net/hr), April (141/net/hr) and May (109/net/hr). The beginning of high tide was the best period for the collection of mullet fry by operation of hapa-net. Among prawns, *P. monodon* was dominant in the catches in the months of March (106/net/hr) and May (60/net/hr) and *P. indicus* in the month of March (80/net/hr).

Fish and prawn seeds were also collected from Port Canning during April to November. The abundance of the commercially important species were recorded and the catch/net/hr in ml/no. were noted as: 1.30/3, 0.55/3, nil/nil, 1.45/nil, 0.60/6, 0.64/5, 0.32/3 and 2.47/18 for *Palaemon styliferus*; 9.50/70, 5.95/101, 12.00/114, 3.40/28, 1.08/10, 0.62/9, 0.12/4 and 1.18/9 for *P. indicus*; 3.10/15, 0.85/3, 1.85/3, 2.75/5, 1.22/3, 2.02/6, 2.18/11 and 0.50/3 for *Metapenaeus brevicornis*; 2.30/14, 2.15/8, 1.85/8, 2.85/7, 3.07/12, 0.90/5, 1.17/7 and 0.90/6 for *Metapenaeus monoceros*; 0.10/2, nil/nil, 0.15/1, 0.45/2, nil/nil, nil/nil, nil/nil and nil/nil for *P. monodon*; 0.71/3, nil/nil, nil/nil, 0.16/2, nil/nil, nil/nil, nil/nil, and nil/nil for *M. parsia*; and 0.05/1, nil/nil, nil/nil, 2.00/3, 10.00/3, 0.30/1, 0.20/1 and nil/nil for *Eleutheronema tetradactylum* during April, May, June, July, August, September, October and November respectively.

Problem : 8.2 Prawn fishery of the Hooghly-Matillah estuarine system
Personnel : M. Subrahmanyam, V. Gopalakrishnan and R. K. Chakraborty
Duration : Five years

Breeding and rearing : The larvae of *Macrobrachium rosenbergii* could be reared up to the ninth stage at Junput on the Contai coast, employing

diluted sea water (12‰ salinity). The remaining two stages could not be reared due to the prevailing heat wave and non-availability of breeders. No breeder of *Macrobrachium malcolmsonii* was available during the season at Barrackpore and hence no rearing study could be done.

Seed prospecting : Brackish water prawn seed investigations were conducted at Uluberia on the Hooghly estuary. The seeds of *Penaeus indicus* were available in considerable numbers during March and July while those of *Penaeus monodon* were found commonly during the period March-June.

Problem : 8.3 Fisheries of the Pulicat lake
Personnel : V. Gopalakrishnan, S. Radhakrishnan, G. Ramamohana Rao, M. Kaliyamurthy, C. P. Rangaswami, S. Srinivasagam and K. Gopinathan
Duration : Five years

Larvae and juveniles : Larvae and juveniles of fishes and prawns were available throughout the year except in the months of October and November when the lake-mouth was closed.

The incursion of postlarvae and juveniles of economically important species of *Mugil*, *Gerres*, *Elops* and *Anchoviella* was continuous throughout the year. Of these, *Mugil* spp. formed the major recruits (monthly average — 75.6/net/hr) followed by *Gerres* spp. (monthly average — 27.5/net/hr), *Elops saurus* (monthly average — 26.4/net/hr) and *Anchoviella* spp. (monthly average—25.6/net/hr).

Among the postlarvae of economically important species of prawns, *Penaeus indicus* was the most dominant (monthly average—1,663/net/hr) followed by *P. semisulcatus* (monthly average — 167/net/hr) and *P. monodon* (monthly average—65/net/hr). *Metapenaeus dobsonii* was the next in importance (monthly average—25/net/hr). *M. monoceros* was the least abundant (monthly average — 16/net/hr).

Food preference of mullets : Seven pelleted feed mixtures were prepared in different combinations with mustard oilcake, wheat-bran, ragi, ground-nut oilcake, prawn powder, sago, Bengal gram, peanut, weeds and algae. Three years experiments were carried out in earthenware tubs with mullet fry (27-110 mg) stocked @ 400/m³. Feeding was done @ 25 and 50% of body weight/day and the left over feed removed daily and water changed once in three days. From the results so far obtained, some of the feed mixtures gave very encouraging results 159% (increase in weight in 30 days). The studies are being continued.

Bottom biota : Polychaetes, amphipods, tanais, chaetognaths, bivalves, gastropods, copepods, nematodes, hermit crabs, protochordates and mysids were encountered in the southern sector of the lake while in the northern sector,

tanaids, amphipods, gastropods, bivalves, sea anemones, nematodes, isopods etc. were collected.

A general survey of the lake has been initiated with a view to studying the physico-chemical features, bottom fauna, vegetation and the fauna inhabiting therein. For the purpose, 32 sampling stations have been selected covering the entire lake and the pre-monsoon survey was completed.

Hydrography, plankton and primary productivity : Details of observations on various hydrographic factors, studied at the Pulicat lake, are given in table 2.

The total number of phytoplankters per haul varied from 700 (September) to 15,313 (June) with an average of 4,154 at lake-mouth ; from 66 (January) to 2,833 (July) with an average of 1,329 in the southern sector and from 66 (May) to 1,233 (June) with an average of 324 in the northern sector. The fluctuations of zooplankters by number/haul recorded were as follows : 100 (November) to 31,604 (May), average 6,756 at lake-mouth ; 200 (August) to 68,345 (May), average 8,341 in the southern sector and 101 (January) to 6,600 (April), average 1,309 in the northern sector. The volume of total plankton ranged from 0.1 (November—lake-mouth) to 20.0 cc (April—northern sector).

The rate of primary production varied from 0.18 (January) to 1.73 gm C/m²/day (April) with an average of 0.81 gm C/m²/day during the year.

Food habits of Penaeus indicus : Experiments on feeding trials of *Penaeus indicus* using artificial feeds singly and in combination failed to give any definite conclusions on account of high mortality in plastic troughs due to high temperature and oxygen depletion. Attempts at providing aeration also did not succeed. The experiments are proposed to be reset.

Induced breeding of mullets : 28 sets of *Liza macrolepis* and 2 sets of *Liza parsia* injected with homo- and heteroplastic pituitary extracts, did not spawn, probably due to the females not being in ripe condition. As breeders in good condition could not be procured because of the closure of the lake-mouth and reduced fishing activity, the attempts to produce hatchlings by stripping method also did not succeed.

Flora of the Pulicat lake : The macrovegetation varied in number from 164 (January) and 665 (June) with an average of 283/m² in the southern sector while the range in the northern sector was from 72 (August) to 862 (April) with an average of 324/m². The dominant forms recorded were *Halophila* sp., *Polysiphonia* sp., *Hypnea* sp., *Enteromorpha* sp., *Ulva* sp. etc.

Oyster culture : Experimental rafts with lime and cement coated tiles and empty oyster shells as cultch material were set up in April at three places in the lake with a view to selecting a suitable place and cultch material on the basis of spat fall. All the animals and algae that got attached

Table 2. Physico-chemical factors observed in the Pulicat lake during 1972

Factors	Lake-mouth		Northern sector		Southern sector	
	range	average	range	average	range	average
Air temperature (°C)	24.1 (Jan)— 29.4 (May)	27.5	26.8 (Mar) — 33.0 (Aug)	29.7	24.3 (Feb)— 31.6 (Jul)	28.5
Water temperature (°C)	24.7 (Jan)— 29.3 (Apr)	27.6	25.9 (Jan) — 30.5 (Apr)	29.1	23.4 (Jan)— 29.7 (May)	28.1
Water depth (cm)	42 (Sep)—250 (Jan)	112	92 (Aug) — 150 (May)	115	127 (Sep)—254 (Aug)	183
gr Transparency (cm)	24 (Nov)— 63 (May)	46	22 (Apr) — 59 (Jan)	41	37 (May)— 60 (Oct)	51
pH	8.1 — 8.4	8.3	8.1 — 8.4	8.3	8.1 — 8.4	8.3
DO (ppm)	6.1 (Apr)— 7.8 (Nov)	6.9	6.2 (Jul) — 8.5 (Jan)	7.0	5.9 (Jun)— 7.7 (Jul)	7.1
Salinity (‰)	15.7 (Nov)— 38.8 (Aug)	34.3	24.2 (Nov) — 53.8 (Aug)	40.3	33.0 (Jan)— 39.3 (Aug)	37.0
Phosphate (mg/l)	0.60 (Nov)— 0.85 (Feb & Aug)	0.79	0.40 (Oct) — 0.71 (Jan)	0.61	0.55 (Sep)— 0.78 (Jun)	0.68
Silicates (mg/l)	2.5 (Aug)— 12.0 (Nov)	5.3	2.0 (Aug) — 15.7 (Nov)	6.1	3.0 (Oct)— 8.7 (Jan)	5.1

to the cultch were periodically removed. Spat falls occurred from early September and they were found to grow best (length 36 mm — width 26 mm/month) on empty oyster shells when compared to lime coated tiles (length 10 mm — width 9 mm/month) and cemented tiles (length 3 mm — width 5 mm/month).

All the cultch strings from Alithurai (Station I) and Ice Plant (Station III) were transferred to the raft at Light House (Station II). New cultch materials with empty shells strung on wire were fixed on them for collecting more spat for culture.

Veliger larvae were observed in the plankton only once in November, 1972. Physico-chemical conditions at the three stations were recorded.

Ecology of ponds in the Adyar Farm : The ranges of the various hydro-biological parameters studied were : water temperature—52.1°-33.3°C, transparency—6.2-48.0 cm, DO—3.0-9.9 ppm, salinity—21.7-37.0‰, pH—7.9-8.8, phytoplankton—8-13,291 u/l, zooplankton—10-6,624 u/l, bottom fauna—82-30,589 u/m² and bottom flora—371-1,698 u/m² for the fish-pond in the Adyar Farm.

Culture of fish food organisms : Four sets of yard experiments, each of one month's duration were conducted, using artificial brackish water (20‰) enriched with soil extract. Different doses of organic manures gave higher plankton crop than with NPK mixture. In the first two experiments where both organic and inorganic manures were applied, the maximum (23.45 ml/l) production of plankton was obtained with cow-dung followed by ground-nut oilcake (21.80 ml/l) and NPK—8:12:4 (7.70 ml/l). In the subsequent two experiments, various doses (0.01 to 0.15 gm/l) of NPK mixture alone were tried and it was noticed that plankton crop increased from (0.3 to 5.5 ml/l) with the increase in the NPK dose.

Project 9: Selective breeding and hybridization

Problem : 9.1 Biological and genetical features of Indian carp hybrids

Personnel : H. Chaudhuri and R. M. Bhowmick

Duration : Six years

Hybrids of *Cyprinus carpio* ♂ × *Catla catla* ♀ were produced for the first time. Most of them were deformed and died within a week. However, one specimen survived for 20 days. Hybrids of *C. catla* ♂ × *Labeo rohita* ♀ reared in a pond for four months, attained an average size of 130 mm. Hybrids of *L. calbasu* ♂ × *C. catla* ♀ and *L. rohita* ♂ × *C. catla* ♀ are being reared in nursery ponds for further observations.

Problem : 9.2 (Research work completed in 1972)

Problem : 9.3 Hybridization between silver, grass and common carp
Personnel: S. B. Singh, D. S. Murthy, R. K. Dey and P.V.G.K. Reddy
Duration : Five years

The two surviving hybrids of silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*), produced during 1970, were reared for about 17 months in plastic pools where they attained a size of 98 mm/14 gm and 106 mm/16 gm respectively inspite of regular supply of plankton. Further work on hybridization could not be taken up due to unfavourable weather conditions.

Project 10 : (Research investigations contemplated)

Project 11 : *Economics of fishery investigations*

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

During the year 1972, data pertaining to various economic aspects of fish culture operations were analysed for 68 fish farms in West Bengal and Orissa. Cost composition, net return per hectare and net return per fixed capital were worked out for each farm. A specimen farm in public sector yielded a net return of Rs. 5,549/ha and 18.3% net return per fixed capital. Its cost composition was 50% on spawn, 12% on fertiliser and feed, 35% on salaries and wages and 3% on micellaneous items. In private sector, a specimen farm yielded a net return of Rs. 6,238/ha.

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

Data were collected from 8 fish seed farms in public sector in Orissa and 4 fish seed farms in West Bengal for working out the producer's cost of fish seed through induced breeding.

Problem : 11.3 Economic evaluation of different weed control methods
Personnel: M. Ranadhir
Duration : Three years

Data on the economics of weed control by treatment with copper sulphate in mud-pellets were analysed. Total expenditure involved in removal of weeds by the above technique varied from Rs. 1,278 to Rs. 4,158 per hectare of weed infested area (average Rs. 2,810/ha). Dominant cost was on labour for application and clearance of weeds, which was about 60%.

Problem : 11.4 (Research work contemplated)

Project 12 : Exotic fish culture

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

Personnel: S. B. Singh, D. S. Murty, R. K. Dey and P. V. G. K. Reddy

Duration : Five years six months

30 sets of *Hypophthalmichthys molitrix* and 46 sets of *Ctenopharyngodon idella* were injected with fish pituitary hormones of Indian major carps, silver carp (*H. molitrix*) and grass carp (*C. idella*). As many as 16 *H. molitrix* and 25 *C. idella* specimens could be stripped. The selection of female breeders was done using a catheter. Majority of the stripped fish gave healthy fry. The dose of pituitary hormone varied from 10 to 14 mg/Kg of body weight for females and 2 to 4 mg/Kg of body weight for males. A total of 4.855 lakh grass carp and 2.62 lakh silver carp spawn were produced. The response of the breeders was very remarkable inspite of the adverse drought conditions during the year. The spawn were maintained in a good and healthy condition by constant care and adequate food.

Experiments on hypophysation could be taken up on 11 occasions only for want of favourable conditions. Induced breeding work was not possible after the middle of August owing to failure of monsoon.

Large quantities of fry and fingerlings reared out of the above spawn were supplied to different states and other organisations.

Problem : 12.2 Mono-culture of silver carp

Personnel: S. B. Singh, D. S. Murthy, R. K. Dey and P. V. G. K. Reddy

Duration : Five years

A gross production of 248.25 and 320.08 Kg of *Hypophthalmichthys molitrix*/ha/yr was realised from two ponds of 0.12 ha each by stocking with 3,000 fingerlings/ha. The survival figures in the two ponds were 37 and 92.8% and the final sizes of the fish were 397.46 mm/224 gm and 251.10 mm/115 gm respectively. The production in both the ponds was low inspite of regular manuring.

Problem : 12.3 (Research work completed in 1972)

Problem : 12.4 (Research work contemplated)

Project 13 : Cold water fish culture

Problem : 13.1 (Research work completed in 1970)

Problem : 13.2 Studies on the food and feeding habits of trout
Personnel: K. L. Sehgal and K. V. Ramkrishna
Duration : Four years

Trout fry at Laribal Farm, were fed on sheep liver + Aurofac in the ratio of 1:1 for 11 months. The percentage survival was 23 and the increase in growth rate was six-fold. The rate of feeding was 5% of body weight, 4 times daily. In the mean time, crumbled and pelleted feed of the sizes : 0.25-0.70, 0.83-1.30, 1.30-2.20, 2.20, 3.00, 4.50 and 7.50 were prepared for fish weighing from 0.12-0.25, 0.25-2.80, 2.80-10.00, 10.00-35.00, 35.00-80.00, 80.00-250.00 and above 250.00 gm respectively.

The composition of the pelleted feed No. 1 was : fish meal—380 gm, bone meal—50 gm, dried skimmed milk—55 gm, soyabean meal—150 gm, wheat middlings—220 gm, Brewer's yeast—100 gm, shark liver oil—30 gm, vitamin mixture—15 gm, along with thiamin chloride—20 mg, Riboflavin—66 mg, pyridoxine hydrochloride—20 gm, choline hydrochloride—3 gm, calcium pantothenate—100 gm, Inositol—500 gm, ascorbic acid—340 gm, folic acid—6 gm, dried skimmed milk—10.638 gm, ferric citrate—0.140 gm, calcium lactate—1.50 gm and sodium chloride—0.180 gm, while the quantities used for respective ingredients for feed No. 2 were : 458, 50, 50, 200, 120, 120, 50, 30, 15, 0.02, 0.066, 0.02, 0.003, 0.11, 0.5, 0.34, 0.006, 10.638, 0.140, 1.50 and 0.180 gm.

The nutritive values of the two feeds analysed at the Animal Nutrition Laboratory of the Animal Husbandry Department of Jammu and Kashmir, Srinagar, were : moisture—9.80%, ash—26.54%, protein—28.00%, crude fibre—0.60%, ether extract—7.53% and nitrogen free extract—27.53% for feed No. 1 and the respective quantities for feed No. 2 were 9.10, 32.60, 35.00, 0.80, 7.94 and 14.56%.

Due to lack of required ponds to be provided by the State of Jammu and Kashmir, further trials on this project were kept in abeyance.

Problem : 13.3 (Research work completed in 1971)

Problem : 13.4 & 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 Commercialisation of trout culture

Personnel: K. V. Ramakrishna, C. B. Joshi, M. J. Bhagat and Shyam Sundar

Duration : Three years

The artificial feeding and segregation of breeders one month prior to stripping gave 1,364 green eggs/Kg of body weight of trout. In all 136 breeders (250-260 mm/150-700 gm) were stripped. The total number of eggs stripped

was 60,720. The cumulative percentage of survival from green egg to fry stage was 80.9% by using Malachite Green at 1:200,000 for 30 minutes. Of the total of 49,132 fry, 14,000 fry were handed over to the State Fisheries. The remaining fry could not be stocked for want of suitable cemented tanks.

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

Due to certain practical difficulties experienced during the operation of a fixed type of gill net in the Chenab river system, the net is being redesigned to meet the requirements for its operation in the fast running pools.

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

During January — December, 211 specimens of brown trout (*Salmo trutta fario*) of which 106 from the Lidder, 86 from the Erin and 19 from the Sind stream were examined. The analysis of stomach contents has shown that larvae of Trichoptera ranked the first (58.61%) in the diet of *Salmo trutta fario* from the Lidder stream followed by the larvae of Diptera (8.44%) and nymphs of Ephemeroptera (7.48%) and respective composition of the insects in the stream being 47.55, 33.41 and 13.65%. In the Erin stream also, larvae of Trichoptera ranked the first (35.75%) in the diet of trouts followed by the larvae of Diptera (13.41%) and nymphs of Ephemeroptera (10.67%), the respective composition of insects in the stream being 34.72, 29.63 and 8.18%. In the Sind stream, nymphus of Ephemeroptera (39.00%) ranked the first in the diet followed by the larvae of Coleoptera (7.80%) and larvae of Diptera (5.05%) and the respective composition of the insects in the stream being 51.04, 1.54 and 11.71%.

Problem : 13.11 & 13.12 (Research investigation contemplated)

Project 14 : Riverine and estuarine fish catch statistics

Problem : 14.1 Fish catch statistics of the middle stretch of the Ganga river system
Personnel: Y. R. Tripathi, S. P. Singh, S. K. Wishard, G. N. Srivastava, N. K. Srivastava, R. K. Dwivedi and S. N. Mehrotra
Duration : Four years eight months

Fish landings : The total fish landings at Sadiapur and Daraganj situated on the banks of the Yamuna and Ganga rivers respectively, amounted to 99.02 and 49.75 t for the period February-November, 1972. Fish landings from the river Ganga were also estimated at Buxar from January-November, 1972 to be 24.90 t.

The estimated total landings in Kg and (%) for *Cirrhinus mrigala*, *Catla catla*, *Labeo rohita*, *Labeo calbasu*, *Mystus aor*, *Mystus seenghala*, *Wallago attu*, *Hilsa ilisha* and miscellaneous fishes were : 9,937.10 (10.04), 3,027.34 (3.06), 3,151.71 (3.18), 8,490.68 (8.57), 15,710.20 (15.86), 4,989.75 (5.04), 6,660.63 (6.73), 11,611.17 (11.73) and 35,439.62 (35.79) at Sadiapur ; 3,057.22 (6.14), 1,532.70 (3.08), 388.53 (0.79), 702.58 (1.41), 3,724.87 (7.49), 2,380.56 (4.79), 1,998.10 (4.01), 7,149.99 (14.37) and 28,817.20 (57.92) at Daraganj and 302.03 (1.21), 640.83 (2.57), 633.58 (2.54), 13.77 (0.06), 1,103.77 (4.43), 1,014.08 (4.08), 117.53 (0.47), (71,916.94 (71.94) and 3,163.55 (12.70) at Buxar respectively.

The maximum landing of *Hilsa ilisha* was recorded at Buxar. *Cirrhinus mrigala* dominated among carps at Sadiapur and Daraganj and *Catla catla* at Buxar. *Mystus aor* dominated the total catch of catfishes at each of the three centres.

During 1972, length measurement of eight commercially important species ; viz., *C. mrigala*, *C. catla*, *L. rohita*, *L. calbasu*, *M. aor*, *M. seenghala*, *W. attu* and *H. ilisha* in the commercial catches at Sadiapur fish assembly centre were recorded. The mean lengths of four of these species ; viz., *C. mrigala*, *L. calbasu*, *M. aor* and *H. ilisha* which formed the bulk of the catch, were calculated as 498, 428, 534 and 355 mm respectively showing an increase over those in the past five years.

Primary productivity : Studies on primary productivity of the Ganga river system in the vicinity of Allahabad were continued up to April, 1972 using light and dark bottle technique. Gross production for the Yamuna river varied from 50.0-100.0 mg C/m³/hr and for the Ganga river above the confluence, 112.5-300.0 mg C/m³/hr. Net production varied from 37.5-87.5 mg C/m³/hr for the Yamuna river, 100.0-125.0 mg C/m³/hr for the Ganga river above the confluence and 37.5-87.5 mg C/m³/hr for the Ganga river below the confluence. In the Yamuna river, respiration rate was found to be the maximum in April (45.0 mg C/m³/hr) and the minimum in January (15.0 mg C/m³/hr). The Ganga river above the confluence showed the highest respiration rate in April (210.0 mg C/m³/hr) and the lowest in January (15.0 mg C/m³/hr) whereas the Ganga river below the confluence indicated the maximum respiration rate in April and the minimum in January.

Plankton studies : Fortnightly observations on the plankton at three centres in the vicinity of Allahabad ; viz., the first in the Ganga river above the confluence, the second in the Yamuna river and the third in the Ganga river below the confluence, were made. The monthly fluctuations in the quantity of plankton (u/l) during January, 1971 to April, 1972 were : 7,245, 1,991, 1,311, 567, 870, 1,533, 229, 179, 384, 385, 549, 721, 5,178, nil, nil and 3,194 for the Ganga river above the confluence ; 1,734, 618, 444, 807, 533, 324, 437, 168, 268, 385, 194, 181, 1,787, nil, 642 and 568 for the Yamuna river and 2,251, 618, 778, 676, 586, nil, 344, 144, 419, 404, 332, 315, 2,735, nil, 858 and 1,016 for the Ganga river below the confluence. The average values of the respective centres were 1,738, 606 and 820 u/l.

Considering three centres as a whole, the plankton showed a gradual decline from 3,735 u/l in January, 1971 to 663 u/l in May, 1971 and then the value 928 u/l in June came down to the minimum of the year (163 u/l) in August. September showed a slight increase (356 u/l) and the quantity remained more or less the same up to December (406 u/l). January, 1972 also showed the maximum (3,232 u/l) quantity of plankton which decreased to 750 u/l in March recovering a little in April (1,593 u/l).

Phytoplankton (94.31%) constituted the major portion of the plankton and was represented by Chlorophyceae (17.91%), Bacillariophyceae (59.63%) and Myxophyceae (16.77%). Protozoa (0.68%), Rotifera (3.56%), and Crustacea (1.45%) formed the zooplankton.

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

Personnel: G. N. Mukherjee, S. N. Sar, R. C. Singh, B. L. Pandey and R. N. Seth

Duration : Four years

Fish catch statistics : The estimated fish landing for the first 11 months of the year, 1972 were 451.36 t as against 500.08 t recorded in the corresponding period of the preceding year, thereby registering a fall by 9.74%. The decline in the total catches was probably due to low landings of miscellaneous varieties at all the centres—mainly at Bhagalpur, Sahibganj and Lalgola. However, the catches of *Hilsa ilisha* showed an increase at Farakka and Lalgola.

The catches were highest at Lalgola forming 27.45% of the total production followed by Bhagalpur (21.61%), Dhulian (17.08%), Farakka (16.25%), Rajmahal (9.57%) and Sahibganj (8.04%). The estimated productions at individual centres were 123.90, 97.54, 77.10, 73.34, 43.20 and 36.28 t at Lalgola, Bhagalpur, Dhulian, Farakka, Rajmahal and Sahibganj respectively. *Hilsa ilisha* was the prime contributor forming 46.07% of the total fish catch followed by miscellaneous varieties (32.63%), *Wallago attu* (8.96%), *Catla catla* (3.75%), *Mystus seenghala* (2.43%), *Mustus aor* (2.31%), *Cirrhinus mrigala* (2.10%) and *Labeo rohita* (1.28%). *Labeo calbasu* formed only 0.47% of the total catch.

The percentage contribution of commercially important species and the miscellaneous species at the different assembly centres is presented in table 3.

Table 3. Percentage contribution of various species at different assembly centres in the lower stretch of the Ganga river system.

Centre	<i>L. rohita</i>	<i>C. catla</i>	<i>C. mrigala</i>	<i>L. calbasu</i>	<i>W. attu</i>	<i>M. aor</i>	<i>M. seenghala</i>	<i>H. ilisha</i>	Miscellaneous
Bhagalpur	3.51	9.62	6.41	1.19	23.22	5.36	6.21	1.84	42.64
Sahibganj	1.76	7.69	3.83	1.13	16.07	4.60	3.94	5.98	55.00
Rajmahal	1.23	2.41	1.29	0.76	9.07	3.43	3.01	22.11	56.69
Dhulian	0.74	2.58	0.79	0.18	6.95	1.39	1.35	43.71	42.31
Farakka	0.87	2.35	0.80	0.14	8.83	1.35	1.43	64.28	24.95
Lalgala	—	0.04	—	—	—	—	—	91.73	8.23

Primary productivity: The average values of gross and net primary productivity and respiration during the year, were 62.28, 29.58 and 40.70 mg C/m³/hr respectively. This showed a decline of 14.59, 19.77 and 12.13% respectively over the corresponding values of the previous year. Gross primary productivity was the maximum (62.82 mg C/m³/hr) in April and the minimum (17.19 mg C/m³/hr) in August. The maximum and minimum net primary productions were observed in January (28.44 mg C/m³/hr) and February (3.13 mg C/m³/hr) respectively, while the maximum respiration rate (46.08 mg C/m³/hr) and the minimum respiration rate (9.00 mg C/m³/hr) were observed in May and October respectively.

Plankton: The maximum density of phytoplankton (1,864 u/l) was observed in May and the minimum (183 u/l) in September. Phytoplankton mainly comprised *Microcystis* sp., *Gonatozygon* sp., *Navicula* sp., *Merismopodia* sp., *Oscillatoria* sp., *Pediastrum* sp., *Ankistrodesmus* sp., *Eudorina* sp., *Pandorina* sp., *Scenodesmus* sp., *Spirogyra* sp., *Characiopsis* sp., *Synedra* sp., and *Nitzschia* sp. The phytoplankton showed a decline by 62.57% when compared with the corresponding figure for the year 1971.

The density of zooplankton varied between 4 (July) and 67 u/l (January) and were the least abundant during July-September and November. The zooplankton density showed a decline by 55.01% over the corresponding figure of the year 1971. It comprised rotifers (*Keratella* sp., *Brachionus* sp., *Polyarthra* sp., *Trichocerca* sp., *Ploesoma* sp., *Asplanchna* sp. and *Noteus* sp.), copepods (nauplii of copepods, *Cyclops* sp., *Canthocamptus* sp. and *Diaptomus* sp.) cladocerans (*Daphnia* sp., *Ceriodaphnia* sp., *Sida* sp., *Bosmina* sp. and *Leptodora* sp.), protozoans (*Actinophrys* sp. and *Diffugia* sp.) and glochidium larvae of molluscs. Phytoplankton : zooplankton ratio was 1 : 0.039 for the

period of observation and it varied from 1.: 0.01 (July and November) to 1.: 0.12 (January) during different months.

Limnology : With the low water temperature during January (17.0°C), February (18.0°C), March (24.5°C) and November (24.0°C) the associated values of DO were : 7.61, 8.12, 7.30 and 6.57 ppm respectively. With the rise in temperature from April (27.0°C) to July (31.0°C) the values of DO declined from 6.88 o 5.74 ppm. Turbidity was the maximum (620.00 ppm) in August and the minimum in May (46.97 ppm). pH varied from 8.00 (November) to 10.00 (April). Air temperature was the maximum (29.5°C) during May to August and the minimum (15.3°C) in January.

Problem : 14.3 (Research work completed in 1969)

Problem : 14.4 (Research work completed in 1971)

Problem : 14.5 Fish catch statistics of the Pulicat lake

Personnel: V. Gopalakrishnan, S. Srinivasagam, K. Gopinathan and P. M. Abdul Khadir

Duration : Six years

The total landing from the Pulicat lake was estimated as 1,371.448 t showing an increase of 198.107 t (17.0%) over the previous year's. Prawns constituted 41.50% (569.307 t) of the total landings. *Penaeus indicus* was the most dominant species (40.53%) among prawns. Mulletts occupied the second place (382.344 t) forming 27.95% of the total landings. *Mugil cephalus* formed the bulk of the group (73.33%). Perches formed 9.87% and were the third in order of abundance. *Gerres oyena* (26.45%), *Sillago sihama* (25.62%) and *Lates calcarifer* (14.77%) dominated the group. Clupeids accounted for 8.34% (114.502 t) of the total landings. The important species encountered in the catch were *Nematolosa nasus* (63.09%), *Chanos chanos* (16.42%), *Thrissocles* spp. (11.94%) and *Elops saurus* (3.28%). The next in importance in the fishery were crabs, forming 5.26% of the total catch and *Scylla serrata* accounted for 55.33% and *Neptunus pelagicus* 44.67% in the group. Catfishes formed 2.18% of the total landings, *Tachysurus* sp. (77.41%) and *Plotosus canius* (22.59%) being the two contributors. Other important groups were Beloneformes (1.69%), sciaenids (1.68%) and threadfins (0.38%).

Problem : 14.6 Effect of major enviromental changes on the fisheries of commercially important stocks of the Hooghly-Matlah estuary

Personnel: P. Dutta (up to June, 1972), A. Choudhury, G. C. Laha, P. M. Mitra, A. R. Choudhury, D. K. De, H. S. Mazumder, R. N. De, P. K. Pandit, B. K. Saha, A. K. Namasudra, N. C. Mandal, S. P. Ghosh, N. D. Sarkar and A. R. Paul

Duration : Five years

15,692.1 t of fish accounted for the total catch from the Hooghly-Matlah estuarine system during November, 1971 to September, 1972 being in excess by 257.1 t over the corresponding period of the previous year. Zone III (i.e., the lower Sunderbans) accounted for 80% of the total catch, while Zone IV & I contributed 9.47 and 7.53% respectively.

The species which dominated the catches were *T. Jella* (3592.2 t), *H. neherus* (2927.6 t), prawns (1607.0 t) and *H. ilisha* (1367.4 t).

The gears yielding the maximum catches were bag-net and large seine. Bag-net contributed 7934.7 t (50.56% of the total landings) while large seine contributed 5070.6 t (32.31% of the total landings).

Problem : 14.7 Fisheries of the Brahmaputra river
 Personnel : R. Chandra, H. P. Singh, S. N. Upadhyaya and M. Choudhury
 Duration : Four years

Catch statistics : Fish landing data at Ujanbazar and Fancybazar landing centres were collected during the months November and December, 1972. Species-wise landing figures (Kg) were : *Labeo rohita*—1,097 (November) and 129 (December), *Labeo gonius*—2,050.5 (November) and 433 (December), *Labeo calbasu*—6 (November) and nil (December), *Labeo bata*—nil (November) and 205 (December), *Catla catla*—187 (November) and 42 (December), *Cirrhinus mrigala*—34 (November) and 29 (December), *Chela atpar*—10 (November) and nil (December), *Wallago attu*—8,195 (November) and 1,331 (December), *Clupisoma garua*—19 (November) and 50 (December), *Silonia silondia*—229 (November) and 159 (December), *Ailia coila*—56 (November) and 103 (December), *Eutropiichthys vacha*—35 (November) and 23 (December), *Ompok pabo*—179 (November) and 80 (December), *Mystus tengra*—nil (November) and 15 (December), *Mystus seenghala*—1,173 (November) and 608.5 (December), *Hilsa ilisha*—83 (November) and nil (December), *Gadusia chapra*—50 (November) and nil (December), *Setipinna phasa*—108 (November) and 24.5 (December), *Notopterus notopterus*—511 (November) and 78 (December), *Notopterus chitala*—970 (November) and 541 (December), *Macrognathus aculeatum*—6 (November) and nil (December), prawns—262 (November) and 75 (December), live-fishes—3,952 (November) and 1,065 (December) and miscellaneous fishes—11,173 (November) and 3,506 (December) at Ujanbazar and *Labeo rohita*—1,865 (November) and 3,921 (December), *Labeo gonius*—223.5 (November) and 1,106 (December), *Labeo calbasu*—70.5 (November) and 8 (December), *Labeo bata*—nil (November) and 198 (December), *Catla catla*—299 (November) and 1,896 (December), *Cirrhinus mrigala*—118 (November) and 667 (December), *Cirrhinus reba*—15 (November) and 24 (December), *Tor tor*—25 (November) and nil (December), *Barilius barilius*—nil (November) and 235 (December), *Barbus spp.*—nil (November) and 115 (December), *Wallago attu*—2,103 (November) and 3,049 (December), *Clupisoma garua*—163 (Novem-

ber) and nil (December), *Silonia silondia*—198 (November) and 462 (December), *Ailia coila*—nil (November) and 218 (December), *Eutropiichthys vacha*—nil (November) and 15 (December), *Ompok pabo*—nil (November) and 209.5 (December), *Mystus seenghala*—871 (November) and 1,178 (December), *Mystus aor*—78 (November) and 28 (December), *Mystus cavasius*—2 (November) and nil (December), *Rita rita*—18 (November) and 8 (December), *Bagarius bagarius*—12 (November) and nil (December), *Hilsa ilisha*—303 (November) and 611 (December), *Gadusia chapra*—30 (November) and 24 (December), *Setipinna phasa*—36 (November) and 14 (December), *Notopterus notopterus*—365 (November) and 485 (December), *Notopterus chitela*—1,181.5 (November) and 594 (December), *Nandus nandus*—nil (November) and 5 (December), *Mastocembalus armatus*—nil (November) and 84 (December), *Macrognathus aculeatum*—nil (November) and 15 (December), prawns—348 (November) and 395 (December), live-fishes—8,840 (November) and 6,984 (December) and miscellaneous fishes—3,618 (November) and 8,616.5 (December) at Fancybazar.

Survey of landing ghats : A rapid survey of the southern bank of the river Brahmaputra and its important tributaries, from Soikhawaghat to South Shalmara, a stretch of about 600 Km, was undertaken for the selection of centres for recording catch statistics. The prospected centres with their places of disposal of catch were : Sibsagar market (Jorhat and Dibrugarh), Boliaghat (Sibsagar and Jorhat), Dikhomukh (Sibsagar), Disangmukh (Sibsagar), Khakang (Dibrugarh and Morang), Dihingmukh (Dibrugarh), Dibrugarh market (Manipur, Dimapur, Luming, Hojai, Shillong and Tinsukia), Saikhawaghat (Dumduma, Tinsukia, Taju and Rohing), Mohanaghat (Dibrugarh), Nematighat/Kokilamugh (Jorhat), Neamatighat (Very poor landings), Jorhat market (Nagaland), Jajimukh (Jorhat), Dhansirimukh (Golaghat, Tezpur and Rangapara), Nikorighat (Golaghat and Jorhat), Silghat (locally), Nowgong market (poor catch—Brahmaputra catch is landed on Tezpur side for local use only), Dhing (catch is landed at Tezpur for local use only), Phurgaon (catch is landed at Tezpur for local use), Chaparmukh (Nowgong), Hariamukh (Nowgong), Phulbari (Dhubri), South Shalmara (Dhubri, Gauhari and North Bengal), Goalpara (local consumption and Dhubri) and Nagarbera (Gauhati and Barpetta).

The above centres, fall in the districts of Dibrugarh, Sibsagar, Nowgong, Kamrup and Goalpara. In each district, the river has been divided into different sections, which are leased out. As such, the landing ghats quite often change; as per the convenience of the lessee. The fishes landed at all these centres are transported to the market town, where either they are locally consumed or exported outside.

Local catch was also examined at all these centres. It was found that the major carps are abundant only in the lower stretch of the Brahmaputra river. The catch in the upper stretch mostly consisted of catfishes and other minor carps including *Labeo gonius*, which was found to be quite abundant at all the places. However, tributaries afford sufficiently good catch of major carps and other fishes.

Project 15 : Fish pathology

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

Personnel: A. K. Ghosh

Duration : Four years

Investigations on parasitic disease of freshwater fishes and their control were resumed in August after a suspension period from January to July for lack of staff.

Dip treatments in concentrations of 0.5 to 1.0 ppm of Gammexane (BHC 10%) proved effective in the control of *Argulus* sp. In the affected *Catla catla*, the common sites of infection were the buccal cavity, base of the fins and the body surface. Intensity of infection was less in *Labeo rohita*, *Cirrhinus mrigala* and *Notopterus chitala*. No re-infestation by the parasite among the treated fish was observed. 0.5 ppm of BHC 10% killed notonectids; but no adverse effect on plankton was noticed.

A study on the biology of *Argulus* sp. has been taken up.

Mortalities caused by infections of *Trichodina* sp. and *Dactylogyrus* sp. in *Ompok bimaculatus* could be checked by the treatment with a 1 : 4,000 solution of formalin.

Project 16 : Weed control

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

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

Duration : Five years

In a yard experiment with 10 Kg of water-hyacinth killed and disintegrated in 450 l of water by treatment with 2,4-D, an increase of 1 ppm in phosphate level in water was observed in treated pools as compared to traces or very low levels in untreated pools and in pools with plain water only. The production of fry of *Cyprinus carpio* stocked in the pools @ 2,17,000/ha was the highest (500 Kg/ha) with 100% survival in treated pools with killed and disintegrated weeds, compared to 93 Kg/ha with 100% survival in controls without weeds and 23 Kg/ha with 55% survival in pools with weeds but without treatment, in 4 months duration. In a field experiment also, production was higher (2,300 Kg/ha) in a pond after the death and disintegration of water-hyacinth by treatment with 2,4-D as compared to 900 Kg/ha in a manually cleared pond. The debris of rotting weeds at the end of the experiment in plastic pools was only 20% of the original weed mass as compared to 33% of debris shed in the pools with living weeds.

Ipomoea carnea and *Typha latifolia* were effectively controlled by treating with 2,4-D @ 2 and 5 Kg a.i/ha respectively in field trials. Regeneration *Ipomoea carnea* was so poor even after a long time that it did not pose a

problem. In the case of *Typha* sp., regeneration from underground rhizomes was not checked at the doses tried. 2,4-D 8 Kg. a.i./ha was found to be effective against *Jussiaea repens* also.

Lantana sp., a hardy weed of the shore infestations, was found to be susceptible to 2,4-5-T (20% amine salt) formulation @ 5 Kg a.i./ha.

Problem : 16.2 (Research suspended for lack of field facilities)

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

Duration : Continuing

Gramoxone (a.i. 20% paraquat) was found to be very effective against *Salvinia* sp. and *Spirodela* sp. at 1.0 and 0.2 Kg a.i./ha respectively in yard and field trials.

Tafazine-50 @ 0.3-0.5 ppm (a.i.) was found to control *Microcystis* sp. bloom in ponds effectively.

In laboratory experiments, Tok-E 25, a new weedicide formulation (a.i. 2,4-dichlorophenyl 4 nitrophenyl ether), was found to be effective against *Hydrilla* sp. above 4 ppm; but it was toxic to fish and uneconomical.

In yard trials, Stam-F 34 (a.i. 3,4-dichloropropionalids) was found to be effective against *Pistia* sp. and *Salvinia* sp. at about 1 Kg a.i./ha. In a large field infestation of *Pistia* sp. (area : 0.2 ha/density : 4 Kg/m²), 50% kill was obtained by treatment at a dose of 2 Kg a.i./ha. In another field trial, *Typha* sp. was not killed by the weedicide at 3.5 Kg a.i./ha.

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

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

Duration : Six years

In a field trial with different doses of aqueous ammonia, 1% ammonia combined with 0.25% wetting agent 'Surf' effectively controlled *Pistia* sp.

In a yard experiment in plastic pools, increase in phosphate level was noted after death and disintegration of *Hydrilla* sp. treated with ammonia. The yields of *Cyprinus carpio* (fry to fingerlings) in 3 months, were 200 Kg/ha in pools with killed and disintegrated weeds, 183 Kg/ha in the untreated pools, 90 Kg/ha in pools with plain tap water treated with ammonia and 83 Kg/ha in pools without weeds and any treatment.

Problem : 16.5 Eradication of weeds by chemical treatments

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

Duration : Two years for each field trial

Experiments in glass jars were conducted to find out the reaction of superphosphate (16%) when applied in solution in saline water. Three jars with

30, 5 and 0‰ salinity. The maximum phosphate concentration in respective jars treated with superphosphate was 110, 105 and 105 ppm in 6, 4 and 4 days respectively. The retention of phosphate in water phase was more in the first jar as compared to that in others.

Experiments with two replicates for each set were conducted in glass jars to find out whether the copper sulphate-pellets lose their effectiveness on storage or not. In five sets of jars, the bottom soil was treated with pellets immediately after preparation and after 7, 14, 30 and 60 days of storage. The maximum concentration of copper was 0.21, 0.19, 0.18, 0.17 and 0.16 ppm respectively on the second day of treatment for the first three sets, on the first day of treatment for the fourth set and the third day of treatment for the fifth set.

Experiments conducted in jars and earthen tubs have shown that free floating *Eichhornia* sp. can completely be destroyed by treating them directly with superphosphate (16%) @ 1,500 Kg/ha, in solution. The treated *Eichhornia* sp. die and decay within 40-45 days after treatment. In an aquarium, half of the plants were treated at the same rate and plants in the other half were left untreated. In water, the concentration of phosphate in the treated section rose to 120 ppm within 24 hr and in the non-treated section it rose to 20 ppm in 7 days time. But the plants in both the sections died and decomposed at the same time.

In glass jars, the rooted vegetation, *Hydrilla* sp. and *Vallisneria* sp., were treated with superphosphate @ 1,500 Kg/ha in solution. Within 30-35 days, all the plants died and decomposed and no regeneration was recorded.

In 10 l glass jars, *Vallisneria* sp. was grown for the last 6 months. Fernoxone when applied in solution in a jar @ 50 Kg/ha, killed nearly 50% of the plants completely in 48 days after treatment and the remaining plants were observed to be in decaying condition. In an other application @ 250 Kg/ha in a separate jar, all the plants lost their green colour in 40 days after the treatment, and decayed completely. No regeneration of plants was observed in either of the treated jars.

At Palta, the water of a pond, thickly infested with *Vallisneria* sp. (95%) and *Lagarosiphon* sp. (5%), was treated with 4 intermittent doses of copper sulphate solution in June, 1972. The intermittent doses were applied @ 2.5, 2.5, 1.5 and 1.5 ppm within a period of 26 days. Before applying the 4th dose, the half decayed plants were removed by manual labour. Fish were introduced on the 6th day after the application of the last dose and the pond was then manured in stages with cow-dung and mustard oilcake. Except for a few regrowth of *Vallisneria* sp. towards the margins, the pond has been completely weed free for the last 6 months and the growth of the fish has been satisfactory.

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

Water, soil and plant samples were collected from different areas and were separately analysed to correlate the various elements present within the body tissues of each plant species with those present in the soil and water of the respective areas from where the plants were collected.

Problem : 16.7 & 16.8 (Research investigations contemplated)

Project 17 : Frog farming

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

Personnel: A. K. Mandal, R. K. Jana, P. L. N. Rao and C. R. Das

Duration : Six years

In the pre-breeding and breeding seasons, 21 sets of *Rana tigrina*, 2 sets of *R. hexadactyla* and one set each of *R. crassa* and *R. limnocharis* were bred with homo- and heteroplastic pituitary gland extracts. The pituitary of *Bufo* sp. has been found to be effective in *R. tigrina* at high doses. A single subcutaneous injection of 2-3 mg of dried frog pituitary gland extract for the recipient female irrespective of the body size and weight, is recommended for general adoption.

The time lag between injection and final stripping has been reduced from 18 to 3-4 hr in *R. tigrina* and *R. crassa* and 6-7 hr in *R. hexadactyla*. Artificial fertilisation of eggs by dry method with sperm suspension yielded cent per cent results.

Induced hybridisation between *R. tigrina* and *R. crassa* and *R. limnocharis* were attempted with success and several hybrids were produced.

Fecundity studies of 7 *R. tigrina*, 14 *R. hexadactyla* and 2 *R. crassa* have shown that it varies from 2,939 to 19,864 in *R. tigrina* (length range 83-148 mm); 1,102 to 4,259 in *R. hexadactyla* (length range 92-125 mm) and 3,402 to 3,706 in *R. crassa* (length range 85-89 mm).

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

Personnel: A. K. Mandal, R. K. Jana, C. R. Das and P. L. N. Rao

Duration : Seven years

Incidental to induced breeding and hybridisation experiments, about 25,000 tadpoles of *R. tigrina*, 5,000 of *R. crassa*, 2,500 of *R. hexadactyla* and 1,000 of hybrid ones resulting from crosses between the former two species and *R. limnocharis* were produced.

Observations on the food of tadpoles of *R. crassa* revealed that like *R. tigrina*, they also prefer zooplankton, tubificid worms, earthworms and frog meat to other food items, and have cannibalistic habit.

High rate of cannibalism is prevalent amongst the tadpoles of *R. tigrina* and *R. crassa*. The cannibalistic habit of hybrid tadpoles produced from reciprocal crosses between the two species was, however, found to be much reduced than that of either parent species.

In the feeding experiments with tadpoles of *R. tigrina* and *R. crassa* in glass jars and plastic pools, frog meat/earthworms together with zooplankton gave increased survival. Provision of frog meat could remarkably reduce the cannibalism amongst these tadpoles.

In laboratory experiments conducted in glass jars, tubificid worms showed satisfactory growth and survival in soil base media treated with ground-nut oilcake + triple superphosphate + cow-dung + ammonium nitrate. In yard experiments, good growth and multiplication of tubificid worms were obtained in drainage silt treated with cow-dung only. Field culture of these worms has been initiated.

Two nurseries were stocked with 3 day old tadpoles of *R. tigrina* @ 3.0 lakh/ha. Survival and growth of advanced tadpoles were found to be quite satisfactory.

In a rearing experiment with tadpoles of *R. hexadactyla* (16-23 mm) along with the spawn of *Cyprinus carpio* (6-7 mm) and with/without food, no adverse effect on either case was noticed in 16 days even at high stocking densities.

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

Personnel: A. K. Mandal and R. K. Jana

Duration : Seven years

Two experiments, initiated in 1971, were completed during September, 1972 after one year's rearing. In one of the experiments, small frogs (average 46 mm/11 gm) of *Rana hexadactyla* were stocked @ 6,500/ha in a weed infested 0.04 ha pond, and a production of 685 Kg/ha of frogs was obtained. In the other experiments with *R. tigrina* (average 50 mm/18 gm) stocked @ 4,000/ha, a production of 214 Kg/ha was obtained. The final sizes attained by the frogs were 114 mm/179 gm (*R. hexadactyla*) and 109 mm/182 gm (*R. tigrina*) and the survival was 54.6% in the former and 29.4% in the latter species.

Two more experiments on productivity studies, stocking *R. hexadactyla* and *R. tigrina* separately @ 8,000 and 6,000/ha respectively, are in progress.

Problem : 17.4 Fish-cum-frog culture

Personnel: A. K. Mandal, R. K. Jana, D. K. Chatterjee,
P. L. N. Rao and C. R. Das

Duration : Seven years

The fourth experiment on joint rearing of fish and frog, initiated in three 0.08 ha ponds in 1971, was concluded in September, 1972 after completion of one year. Small frogs (45 mm/9 gm) of *R. hexadactyla* were stocked @

6,500/ha, along with fingerlings (91 mm/9 gm) of Indian major carps and exotic carps @ 4,500/ha in the ratio of *Catla catla* 2.75 : *Labeo rohita* 3.75 : *Cirrhinus mrigala* 1.50 : *Cyprinus carpio* 1.75 : *Ctenopharyngodon idella* 0.30, against suitable fish and frog controls. The frogs were found to grow to an average size of 118 mm/203 gm in the experimental pond, as against 114 mm/182 gm in the control. The fishes attained an average size of 333 mm/613 gm (*C. catla*), 433 mm/1,035 gm (*L. rohita*), 411 mm/716 gm (*C. mrigala*), 377 mm/1,190 gm (*C. carpio*) and 488 mm/1,646 gm (*C. idella*) in the experimental pond, as against 329 mm/572 gm (*C. catla*), 350 mm/509 gm (*L. rohita*), 406 mm/623 gm (*C. mrigala*), 445 mm/2,920 gm (*C. carpio*) and 488 mm/1,621 gm (*C. idella*) in the control pond. The final production of fish and frog was 3,145 and 418 Kg/ha respectively in the fish-cum-frog pond, as against a production of 2,245 and 489 Kg/ha respectively of fish and frog cultured separately in the control ponds.

The fifth experiment on the possibilities of joint rearing of *R. hexadactyla* and *C. idella* stocked at 4,000 and 2,000/ha respectively is in progress.

Problem : 17.5 Stock building of *Rana catesbeiana*
(No progress due to practical difficulties could be made)

Problem : 17.6 (Research investigation contemplated)

Project 18 : Sewage-fed fisheries

Problem : 18.1 Ecology of sewage-fed fisheries

Personnel: Apurba Ghosh, S. C. Banerjee and L. H. Rao

Duration : Two years

During 1972, ecological investigations were carried out in two private ponds (0.8 and 0.6 ha) at Khardah. The 0.8 ha pond was fed with 5.45 million litres of sewage water and the 0.6 ha pond with 2.13 million litres initially. The first pond was stocked with Indian major carps at a stocking density of 52,416/ha in the ratio of *C. catla* 1.8 : *L. rohita* 4.6 : *C. mrigala* 3.6 and the second with 74,000/ha. Out of the three species, *C. catla* has shown better growth (637 gm in 125 days) in the first pond.

Due to intake of more sewage in the first pond, plankton concentration was higher (8.80-10.00 cc/100 l) in the month of June which declined gradually in the subsequent months. The phytoplankton of the ponds was mainly represented by *Oscillatoria* sp., *Spirulina* sp. and *Ankistrodesmus* sp. Among zooplankton, *Moina* sp., *Cyclops* sp. and *Brachionus* sp. were dominant. Gastropod molluscs, annelid worms and chironomid larvae were the principal bottom biota encountered. Primary productivity values (gross) were as high as 739.58 and 942.70 mg C/m²/hr in the first and second ponds respectively. Chemical analysis (water phase) showed that the ranges of pH, total nitrogen, phosphate, alkalinity and chloride content were 7.3-8.3, 0.44-3.68 ppm, 0.01-2.4 ppm, 174-460 ppm and 110-340 ppm during the period from June to September.

Project 19 : *Hilsa* fisheries

Problem : 19.1 *Hilsa* fisheries of the middle stretch of the Ganga river system

Personnel: R. Chandra, V. R. Desai and S. K. Das

Duration : Six years

Observations on breeding of *Hilsa ilisha* were continued in the middle stretch of the Ganga river system at five selected stretches ; viz., Mahewapatti on the river Yamuna above the confluence and at Sirsa, Vindhyachal, Sindhoraghat and Sujabad on the river Ganga below the confluence during February, March, September, October and November.

Observations on winter spawning of hilsa : Breeding of *Hilsa ilisha* as observed during the winter months was very poor at all the centres. At Sirsa and Sindhoraghat, very few postlarvae of *H. ilisha* were encountered in shooting net collections during March. Migration of *H. ilisha* was also very poor in this season as compared to the previous year.

Observations on post-monsoon and early winter spawning : Field collections of larvae of *H. ilisha* were started in the third week of September and were continued till the third week of November at the selected centres (Table 4).

Table 4. Details of the number of *Hilsa ilisha* larvae encountered at different centres

Centres	Date	No. of Pro-larvae	No. of Post-larvae	Catch/hr Pro-larvae	Catch/hr Post-larvae
I	II	III	IV	V	VI
Mahewapatti	23. 9.72	9,100	—	1,516	—
	1.10.72	8,900	—	1,485	—
	8.10.72	—	—	—	—
	14.10.72	—	—	—	—
	20.10.72	—	—	—	—
	4.11.72	—	—	—	—
	14.11.72	—	—	—	—
	18.11.72	—	—	—	—
Sirsa	17. 9.72	—	14	—	2
	21. 9.72	—	20	—	3
	30. 9.72	—	4	—	—
	6.10.72	500	12	83	2
	12.10.72	1,600	6	266	1
	19.10.72	606	3	100	—
	2.11.72	—	20	—	3
	9.11.72	—	8	—	1
16.11.72	—	3	—	—	

Centres	Date	No. of Pro-larvae	No. of Post-larvae	Catch/hr Pro-larvae	Catch/hr Post-larvae
I	II	III	IV	V	VI
Vindhyachal	17. 9.72	—	—	—	—
	21. 9.72	217	36	37	6
	29. 9.72	897	97	149	16
	6.10.72	28,300	135	4,716	22
	12.10.72	23,200	242	3,866	57
	9.10.72	21,280	957	3,546	159
	2.11.72	348	34,200	58	5,700
	9.11.72	119	15,000	19	2,500
	16.11.72	—	3,100	—	516
Sindhoraghat	16. 9.72	—	12	—	2
	22. 9.72	—	6	—	1
	29. 9.72	200	6	33	1
	7.10.72	1,850	2	308	—
	13.10.72	23,400	6	3,900	1
	20.10.72	1,250	58	208	9
	3.11.72	—	162	—	27
	10.11.72	—	148	—	25
	17.11.72	—	133	—	22
Sujabad	16. 9.72	39	30	5	5
	22. 9.72	123	43	20	7
	27. 9.72	415	19	69	3
	7.10.72	10,800	25	1,800	4
	13.10.72	3,750	19	625	3
	20.10.72	12,300	38	2,050	6
	3.11.72	10,500	44	1,750	7
	10.11.72	576	39	96	6
	17.11.72	—	57	—	8

As evident from the above table, the breeding of *Hilsa ilisha* commenced from the first week of September and continued till the middle of November, the peak period being in the middle of October at all the centres except at Mahewapatti where the breeding was in September and the first week of October. The maximum breeding was observed at Vindhyachal centre; but in previous year, at Sindhoraghat centre. The catch of *Hilsa ilisha* was very poor all along the stretch in comparison to previous year's. Very few female specimens were noticed in the catches.

Studies on the bathymetric distribution of larvae of H. ilisha : The distribution of hilsa larvae in relation to water depth was studied by operating a specially designed net having three independent mouths and tail ends placed in vertical series. The tail end, designed in the fashion of a tow net, was provided with a cylindrical bucket, the rear end of which was blocked with a

piece of organdie cloth. Net-wise collections made on the peak days were examined and it was observed that the hilsa larvae prefer surface waters (10-30 cm depth).

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

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

Duration : Seven years

Appraisal of the fishery : The total estimated landings from the lower stretch of the Ganga river system were recorded to be 207.94 t against 165.16 t of the preceding year, thereby showing an increase by 25.90%. Farakka and Dhulian on the river Ganga and Lalgola on the river Padma accounted for 47.14, 33.71 and 113.65 t respectively and contributed 93.54% to the total catch. The production of *H. ilisha* at Bhagalpur, Sahibganj and Rajmahal were 1.71, 2.17 and 9.56 t respectively.

The month-wise production at individual centres during June to October, accounted for the bulk of catch from the entire stretch. *Hilsa ilisha* measuring less than 180 mm were conspicuous by their absence in catches at Sahibganj, Farakka, Dhulian and Lalgola. The production in the month of September (20.17%) at Bhagalpur, January (2.96%) and November (30.63%) at Rajmahal comprised juveniles mainly.

Fishing activity was perceptible in the 70 Km stretch between Sultanganj and Pirpainty. The main fishing grounds for *H. ilisha* which supplied the bulk of the catches to Bhagalpur fish assembly centre were Sultanganj, Barari-ghat and Colgong, while Sahibganj, Rajmahal and Farakka were fed by fish caught from within a 15 Km stretch around the assembly centres. Dhulian assembly centre was fed by the catches from Sabdalpur located at a distance of 10 Km on the western bank of the main stream. Kalitala to Dayarampur stretch of the river Padma was responsible for the landings at Lalgola.

Among the three sub-population of *H. ilisha*, the 'Slender' variety dominated at Bhagalpur, Sahibganj, Rajmahal, Farakka and Dhulian forming 55.62, 59.00, 55.53, 44.37 and 45.32% respectively by weight, where as 'Broad' and 'broader' variety dominated at Lalgola centre contributing 42.27 and 37.76% respectively to the total catch there.

The contribution of the 'Broad' variety to the total yield at Bhagalpur, Sahibganj, Rajmahal, Farakka and Dhulian was 25.81, 29.86, 31.16, 33.53 and 29.90% respectively, while the 'Broader' variety showed decreasing trend through the centres in the upstream upto Sahibganj forming only 11.14% against 18.57% at Bhagalpur.

The distributional pattern of individual variety in the fishery at these centres during different months showed that the 'Slender' variety dominated over the other two varieties throughout the year at Bhagalpur and Rajmahal. The Sahibganj centre showed a consistent dominance of 'Slender' variety throughout the year except in the month of November where 'Broad' variety

dominated in the catches (66.49% by weight). At Lalgola, 'Broad' variety formed the main stary throughout the year except in the month of July when 'Broader' variety contributed highest (43.51% by weight). At Farakka, the 'Slender' variety formed the bulk of the catches during monsoon months. The pre-monsoon and winter fishery comprised mainly the 'Broader' variety. Dhulian centre showed a high rate of intermingling of the three varieties. The 'Slender' variety dominated the catches during April and June to August, 'Broad' during January, September and November and 'Broader' during February, May and October.

Delimitation of spawning grounds : Independent spawning of *H. ilisha* at Bhagalpur, Rajmahal and Farakka sectors has been observed. Two separate spawning seasons, one during April and May and the other during July to October, as evidenced by the availability of spawn (4 mm) in the 1/16" meshed spawn net and 0.5 m organdie tow net collections have been observed. The intensity of spawning as adjudged by concentration of spawn per 1,000 m³ water filtered was found to be higher during the post-winter months at all the five centres of observations. The number of *H. ilisha* larvae per 1,000 m³ water varied between 0.52 in February and 1.04 in April at Bhagalpur, 1.80 in April and 16.55 in May at Sahibganj, 5.10 in April and 6.50 in May at Rajmahal, nil in April and 6.50 in May at Farakka and nil in April and 10.77 in May at Dhulian. During monsoon months the number of hilsa larvae per 1,000 m³ water varied between 2.00 in August and 134.50 in October at Bhagalpur and 2.40 in August and 21.21 in September at Rajmahal. In the monsoon months the spawning of *H. ilisha* was very poor at Dhulian, Sahibganj and Farakka centres. Two distinct spawning peaks were observed at Bhagalpur, Rajmahal and Farakka in the months of April and October, May and September, May and July respectively.

Problem : 19.3 Artificial propagation of the Godavari hilsa
 Personnel: T. Rajyalakshmi (Mrs.), P. L. N. Rao, L. H. Rao, T. S. Ramaraju, K. S. Rao, D. R. Rao and P. S. C. Bose
 Duration : Five years

Age-group composition : Samples of *Hilsa ilisha* were analysed at all the estuarine centres of the river Godavari and its branches. The ovaries in IV and V stages of the maturity were recorded but no oozing fish were available throughout the season. The total landings of *H. ilisha* in the season were not very high at the freshwater centres. The catches for the age-groups II, III, IV and V were : nil, 452.95, 317.30 and 15.50 Kg in July; nil, 752.01, 3,282.47 and 329.33 Kg in August; 796.99, 3,802.81, 4,216.49 and 829.61 Kg in September; nil, 1,547.74, 2,665.70 and 256.27 Kg in October; and nil, 35.33, 132.30 and 70.40 Kg in November. The size/age composition thus showed predominance of groups IV and III in the catches and there was considerable improvement in the catches of group V also over that of 1971 season.

Fecundity : The fecundity was estimated from samples collected from different centres of the river. For groups IV and V it was 8.34 and 9.43 lakh respectively. Average fecundity for group IV was thus higher than that in 1971.

Table 5. Details of stripping experiments of *Hilsa ilisha* carried out at Sirsa during 1972

Date	Time (hr)	Females		Males		Eggs stripped (lakh)	Fertilisation (%)	Hatching (%)
		Total length (mm)	Maturity condition	Total length (mm)	Maturity condition			
10. 3.72	18.30	265	oz	319	oz	0.60	80	60
				243	oz			
14. 3.72	17.00	377	VI	270	oz	no fertilisation		
				280	oz			
15. 2.72	18.00	400	ps	360	oz	0.40	90	70
				360	oz			
16.10.72	17.15	460	oz	385	oz	7.2	80	70
				348	oz			
				358	oz			
				353	oz			
19.10.72	18.00	470	VI	340	oz	no fertilisation		
				360	oz			
20.10.72	17.30	460	oz	347	oz	7.8	80	70
				324	oz			
				325	oz			
				340	oz			
				335	oz			
20.10.72	19.30	442	oz	317	oz	4.8	60	10
				365	oz			
				330	oz			

oz=oozing

ps=partly spent

The lengths of the females used during spring and post-monsoon periods were 265-400 and 442-470 mm and those of males were 243-360 and 325-385 mm respectively. During the above experiments, more than one males were used, as all the males were in oozing condition and yielded very little quantity of milt for the fertilisation of the eggs. Further, it was again observed that the fish in the right stage of maturity, suitable for stripping experiments, was available only in the afternoon between 16.00 and 22.00 hours.

Hatching of the fertilised eggs: Experiments to hatch the fertilised eggs, were carried out in 'hapa' made of 'markin' and nylon cloth of white, red, yellow and green colours fixed in the Ganga river close to the bank and the hatching percentage fluctuated between 10 and 7. The fluctuations in the values of pH, Ca and Fe were 8.0-8.2, 20.1-21.0 ppm and traces respectively. It was also observed that hatching was comparatively earlier in nylon 'hapa' as compared to 'markin hapa'.

Rearing of Hilsa ilisha hatchlings in confined freshwaters: 12,000

hatchlings (2.5-3.0 mm) produced through artificial fecundation during March, 1972 were stocked in one nursery pond (30.48 m × 15.24 m) at the Taraon Fish Farm on 13.3.72 and 18.3.72. The pond was manured with mahwa oilcake (150 ppm) and inoculated with trace elements; like, Co, Zn and Mn on 24.3.72. Total mortality was observed probably due to low depth of water in the pond and resultant high water temperature.

Hatchlings of *H. ilisha* produced during the post-monsoon run of the fish in the Ganga river at Sirsa, were stocked for the rearing experiments in five ponds at the Amreeha Fish Farm.

The manures and other ingredients applied in the ponds were : mahwa oilcake 200 ppm, lime 5 Kg, mustard oilcake 5 Kg, Yamuna-sand 1.350 m³, CoNO₃ 5 gm and MnSO₄ 5 gm for pond I; mahwa oilcake 200 ppm, lime 5 Kg, raw cow-dung 50 Kg, Yamuna-sand 1.350 m³, CoNO₃ 5 gm and MnSO₄ 5 gm for pond II; mahwa oilcake 200 ppm, lime 5 Kg, raw cow-dung 50 Kg, CoNO₃ 5 gm and MnSO₄ 5 gm for pond III; mahwa oilcake 200 ppm, lime 5 Kg, Yamuna-sand 1.350 m³, CoNO₃ 5 gm and MnSO₄ 5 gm for pond IV, and mahwa oilcake 200 ppm, Yamuna-sand 0.135 m³, CoNO₃ 5 gm and MnSO₄ 5 gm for pond V. The pond III was treated with soap oil emulsion to control the predatory insects at least 24 hr earlier to the release of the hatchlings. Mahwa oilcake was used for the eradication of all fish present in the pond and to serve as organic fertiliser thereafter, while CoNO₃ and MnSO₄ were added to make available essential trace elements; like, Co and Mn.

Pond I and V was stocked with 70,000 hatchlings (5-7 mm) each, on October 21, 1972 while pond II, III and IV were stocked with 50,000 hatchlings (5-7 mm) each on October 24, 1972. In pond II and III, the hatchlings had grown to 46-47 mm in 51 days. No hatchlings were noticed in ponds 1, 4 and 5 in the experimental nettings. While comparing the growth recorded during 1969, 1970 and 1971, it is observed that during the current experiment, it is less than that observed during 1969 but is higher than that in 1970 and 1971. In 1969, after 60 days of nursery rearing, 2.5-3.0 mm long hatchlings had grown to an average size of 47.5 mm in the length range of 46-52 mm in one pond and in the other, the average length attained was 53.0 mm in the range of 49-59 mm. During 1970, 5-9 mm long hatchlings grew to an average size of 27.4 mm in 43 days of nursery rearing while in 1971, the average size attained was 32 mm in the length range of 25-36 mm in 60 days of pond rearing. Hatchlings of *H. ilisha* stocked in October, 1971 in one nursery pond at Taraon Fish Farm grew to an average size of 33.7 mm in 75 days in the length range of 30-37 mm on January 6, 1972 and on January 8, 1972, total mortality was observed.

Plankton analysis : Analyses of the weekly plankton samples collected from ponds stocked with hatchlings of *H. ilisha* revealed that *Daphnia* spp. and *Ceriodaphnia* spp. amongst the cladocerans were the dominant zooplankton, while *Anabeanopsis* spp. and *Chlorella* spp. were the dominant phytoplankters.

Problem : 19.6 (Research investigation contemplated)

Project 20 : Water pollution investigation

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

Characterisation of the plant-wise waste waters discharged from Kesoram Rayon Industries was taken up with a view to locate the source of the maximum pollution and to treat the waste water contributing the maximum pollutional load in the combined waste. The waste water from rayon manufacturing unit showed a variation of nil-7.1 mg/l for DO, nil-72 mg/l for $\frac{1}{2}$ hr OC at 100°C, 50-195 mg/l for zinc and 400-9,641 mhos $\times 10^{-6}$ for specific conductivity, while pH ranged between 2.0 and 5.5. Waste from rayon grade transparent paper manufacturing unit indicated a variation of nil-5.2 mg/l for DO, 18-125 mg/l for $\frac{1}{2}$ hr OC at 100°C, 20-2,820 mhos $\times 10^{-6}$ for specific conductivity and 2.0-9.2 for pH.

The study on the extent of pollutional effects around the outfall of India Pulp Paper (sulphite) Tribeni Tissue (soda process), Kesoram Rayon Textile, Bhadrakali Distillery and Yeast, and Dunlop Rubber revealed that the adverse effect on plankton was most appreciable in the month of June during low water level under neap tide condition. The recovery of the chemical conditions was affected within 0.15-1.00 Km below the discharge points but the adverse effect on plankton was felt further below. Amongst all the outfall areas, Indian Pulp Paper was found to be badly affected and a large number of fishes were found at surface around the outfall in July. The affected area exhibited a pH range of 5.5-6.8 and DO between nil and 3.0 mg/l.

Preliminary cage experiments performed below the outfall of India Pulp Paper using spawn of major carps indicated that the pollution was mainly due to quick deoxygenation and sudden rise in temperature owing to discharge of hot effluent.

The hydrological study carried out in the Hooghly river during low and high water levels under neap and bore tide conditions indicated a variation of 8.0-8.3 for pH, 4.2-8.0 mg/l for DO, 0.8-37.2 mg/l for $\frac{1}{2}$ hr OC at 100°C, nil-6.4 mg/l for BOD and 48-129 mg/l for alkalinity as CaCO_3 . No significant changes in the chemical factors excepting a slight decline in BOD value during bore tide condition were noticed. In the main body of the estuary, a replenishment of plankton was apparent during bore tide as compared to neap tide condition while in the marginal areas the number of plankters were found to greatly reduced during bore tide conditions.

Problem : 20.2 Pollution study in different river systems of India caused by various sources with references to aquatic biomass

Personnel : R. S. Panwar, H. C. Joshi and D. Kapoor

Duration : Three years

Arrangements were made to obtain information from industries located near the important rivers, nature and quantity of wastes disposed, use of pesticides etc. from the Directors of Agriculture and Industries in different states of the country and Plant Protection Adviser, Government of India, to map the areas of pollution and the nature of pollutants discharged in various river systems.

Bio-assay experiments : Static bio-assay experiments were conducted with the help of Malathion E.C. 50 (insecticide) using weed fishes and insects as test animals for 24, 48, 72 and 96 hr respectively, in 10 l jars with proper control.

All the fishes (*Colisa* sp. — 20 mm in size) died in 24 hr at 5 ppm concentration of the insecticide, while nil, 50, and 95% mortality occurred in 24, 48, 72 and 96 respectively at 1 ppm concentration. In the second set of experiment, only 10% mortality in 96 hr was recorded at 0.5 ppm insecticide concentration. In the third trial, 40, 55, 80 and 90% mortality in 24 hr was recorded at 2, 3, 4 and 5 ppm of insecticide respectively. The fourth set of experiment showed that complete mortality of *Notonecta* sp. occurred at 1 ppm in 24 hr while 78 and 54% mortalities were observed at 0.5 and 0.1 ppm concentrations respectively

Weed fishes ; like, *P. sophore* and *Colisa* sp. were exposed to water collected from a pond (0.4 ha) which was treated with 110 Kg DDT and 55 Kg BHC for the purpose of protecting *Trapa* sp. 30 and 40% mortalities of *P. sophora* occurred in 24 and 48 hr respectively, while nil and 20% mortalities occurred within 24 and 48 hr in case of *Colisa* sp.

Project 21 : (Research investigations contemplated)

Project 22 : (Research investigations contemplated)

(c) *Research contemplated*

Over and above the problems on which work is continuing during the year relating to this report, a number of problems under different projects which could not be initiated in view of limitations of facilities and resources or which need confirmation, are also envisaged to be taken up in 1973. The details of such problems are given below.

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

- Problem : 1. 1 Composite culture of Indian and exotic species
(Old programme will continue)
- Problem : 1. 2 Evolving a balanced fish diet and to improve feeding techniques
(Old programme will continue)
- Problem : 1. 7 Culture of fish food organisms in the laboratory and field for feeding fish
(Old programme will continue)
- Problem : 1.12 Evaluation of indigenous plants as fish poisons
(Old programme will continue)
- Problem : 1.14 Qualitative segregation of fish seed
(Old programme will continue)
- Problem : 1.15 Selective capture of predators from carp culture ponds
(Old programme will continue)
- Problem : 1.17 Effect of irradiation on fish
(Old programme will continue)
- Problem : 1.18 Role of some trace elements in pond fertilisation
(Old programme will continue)
- Problem : 1.19 Conversion ratio of selected carp feed into fish flesh
(Old programme will continue)
- Problem : 1.20 Carp culture with periodic replenishment of fresh-water

Experiments are to be initiated to study the enhancement of per hectare production of fish in ponds by replenishment of water as compared to stagnant water fish culture.

- Problem : 1.21 Carp fry rearing for optimum survival and growth under high stocking density

Experiments will be taken up for obtaining optimum per hectare production of fry, fingerlings and fish in culture fishery operation under high stocking density.

- Problem : 1.22 Biology of fish food organisms — Cladocera
(Water fleas)

The growth, reproduction, food and life-history of water fleas for their proper propagation to serve as food of fishes in freshwater ponds will be studied.

- Problem : 1.23 Evolving efficient method for sampling of bottom dwelling fishes in ponds.

Experiments will be initiated for devising a suitable gear with high degree of efficiency for operation in small bodies of water for the maximum exploitation of bottom dwelling fish.

Problem : 1.24 Studies on the effects of chemical fertilisers; like, urea — formaldehyde, ammonia liquor, sodium nitrate and calcium cyanamide in relation to pond productivity

Experiments will be initiated to study whether the fast or slow acting fertilisers would be more efficient in enhancing the plankton production and growth of fry when applied alone or in combination with other inorganic and organic manures.

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. 5 Effect of inbreeding on the growth, maturity and viability of major carps
(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

Experiments are proposed to be initiated to make available ready made preparation of fish pituitary gonadotropin for induced breeding work.

Project 3 : Reservoir fisheries

Problem : 3. 6 Fisheries of paninsular tanks : Assessment of biological productive potentialities
(Old programme will continue)

Problem : 3. 8 Fisheries of peninsular tanks — introduction and propagation of cultivable species
(Old programme will continue)

Problem : 3. 9 Development of fisheries of the Loni reservoir

Investigations are proposed to be carried out to stock the reservoir with suitable food fishes to develop and conserve fish stock of the reservoir with a view to enhance the per hectare production, to study the nutritional resources of the reservoir and to eradicate the unwanted fishes to improve the environment for better growth and survival of desirable fish stock.

Problem : 3.10 Development of fisheries of the Tilaiya reservoir
Investigations will be carried out to enhance fish production from the reservoir through continuous stocking.

Problem : 3.11 Development of fisheries of the Konar reservoir
Investigations will be carried out to enhance production from the reservoir through stocking.

Project 4 : Riverine carp spawn prospecting and collection techniques

- Problem : 4.4 Comparative growth rate of spawn from different sources
(Old programme will continue)
- Problem : 4.5 Yearly variation in quality and quantity of spawn in the river Ganga
(Old programme will continue)

Project 5 : Brackish water fish farming

- Problem : 5.1 Productive potential of polyculture in the lower Sunderbans and behaviour of pond dykes
(Old programme will continue)
- Problem : 5.2 Detailed survey of islands in the lower Sunderbans for designing brackish water fish farm (400 ha)
(Old programme will continue)
- Problem : 5.3 Experimental trial of model brackish water fish farm in the lower Sunderbans
(Old programme will continue)
- Problem : 5.7 Culture of brackish water fish food organisms
(Old programme will continue)
- Problem : 5.8 Induced breeding of grey mullet, *Mugil cephalus*
(Old programme will continue)
- Problem : 5.9 Response of different fertilizers (both inorganic and organic) on fish productivity
(Old programme will continue)
- Problem : 5.10 Detailed survey of Mahisani Island for designing brackish water fish farms
(Old programme will continue)
- Problem : 5.11 Quantitative assessment of brackish water fish and prawn seed in Bakkhali region

Studies on the qualitative and quantitative assessment of the seed resources in the estuarine waters around Bakkhali in connection with 200 ha semi-commercial brackish water fish farm will be taken up.

Problem : 5.12 Method of silt control and experimental trials on sluices

Experiments are proposed to be initiated to evolve preventive and curative measures to overcome silt from entering the feeder channel and farm ponds along with the flood tide water and to strengthen the protective dykes on canal bank by silt collected from canal water, and also to undertake successful management of large brackish water fish farms with sluices made up of economical as well as durable materials.

Problem : 5.13 Selective culture of *Mugil parsia* and *Mugil tade*

Experiments are to be initiated to obtain the maximum production of fish per unit water area through intensive culture of mullets.

Problem : 5.14 Culture of *Penaeus monodon*

Experiments will be initiated to develop effective methods for the maximum per hectare per annum production of the prawn, *Penaeus monodon*.

Problem : 5.15 Culture of *Penaeus indicus*

Experiments will be taken up to evolve effective methods for the maximum per hectare per annum production of the prawn, *Penaeus indicus*.

Problem : 5.16 Culture of *Lates calcarifer*

Experiments will be initiated for obtaining the maximum production of carnivorous fish through the utilisation of forage fish and uneconomic prawns.

Problem : 5.17 Brackish water prawn culture in Madras region

Experiments are proposed to be initiated to evolve methods and practices for culturing the postlarvae and juveniles of commercially important penaeid prawns (*Penaeus indicus*, *P. monodon* and *P. semisulcatus*) to marketable size in brackish water ponds.

Problem : 5.18 Culture of the edible oysters in the lake Pulicat

Experiments will be carried out to evolve suitable methods for achieving the optimum yield of the edible oyster, *Crassostrea madrasensis* in the Pulicat lake

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 river

Assessment of the prawn resources in the middle stretch of the river Ganga between Allahabad and Ballia, biological investigations of the commercially important prawns including extent of exploitation in time and space, size composition and growth studies will be taken up.

Project 8 : Estuarine and brackish water lake fisheries

Problem : 8.1 Brackish water fish seed prospecting
(Old programme will continue)

Problem : 8.2 Prawn seed resources of the Hooghly-Matlah estuarine system
(Old programme will continue)

Problem : 8.3 Fisheries of the Pulicat lake
(Old programme will continue)

Project 9 : Selective breeding and hybridisation

Problem : 9.1 Biological and genetical features of some Indian carp hybrids
(Old programme will continue)

Problem : 9.3 Hybridisation between silver carp, grass carp and common carp
(Old programme will continue)

Project 10 : Fish farm designing

Problem : 10.1 Formulation of fish farm designs under the soil conditions of Orissa

Experiments are to be initiated to study the fish farms of Orissa with a view to investigating the farm with reference to soil type, water supply, size, shape, slopes, inlet and outlet facilities etc. for fish ponds at Dhauli ; and to formulate fish farm designs under the soil conditions at Dhauli, Orissa.

Project 11 : Economics of fishery investigations

Problem : 11.1 Economic evaluation of fish culture operations in West Bengal and Orissa
(Old programme will continue)

- Problem : 11. 2 Economic evaluation of various spawn production methods
(Old programme will continue)
- Problem : 11. 3 Economic evaluation of different weed control methods
(Old programme will continue)
- Problem : 11. 4 Assessment of marketable size for fish culture enterprises in West Bengal

Investigations will be initiated to find out the marketable size of fish in West Bengal, taking into consideration the consumer preference and economics of fish culture.

Project 12 : Exotic fish culture

- Problem : 12. 1 Standardisation of techniques of breeding of grass carp and silver carp
(Old programme will continue)
- Problem : 12. 2 Monoculture of silver carp
(Old programme will continue)
- Problem : 12. 4 Suitable supplementary feeds for grass carp fry and fingerlings

Experiments are to be initiated to evolve a suitable supplementary feed for *C. idella* (fry and fingerlings).

Project 13 : Cold water fish culture

- Problem : 13. 2 Studies on the food and feeding habits of trout
(Old programme will continue)
- Problem : 13. 8 Commercialisation of trout culture
(Old programme will continue)
- Problem : 13. 9 Estimation of mahseer and allied fisheries in deep waters of hill streams of Jammu province
(Old programme will continue)
- Problem : 13.10 Food of *Salmo trutta fario* in natural streams
(Old programme will continue)

Problem : 13.11 Biological studies of *Orienus plagiostomus*
Investigations will be taken up to determine the possibilities of culture of *Orienus plagiostomus* in confined waters of high altitudes.

Problem : 13.12 Biological studies of mahseer, *Tor putitora*
Investigations will be initiated to assess the possibilities of culture of mahseer, *Tor putitora* in confined waters in the hills of northern India.

Project 14 : Riverine and estuarine 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. 5 Fish catch statistics of the Pulicat lake
(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 Fisheries of the Brahmaputra river
(Old programme will continue)

Project 15 : Fish pathology

- Problem : 15. 1 Etiology and control of parasite diseases of cultured warm water fishes
(Old programme will continue)

Project 16 : Weed control

- Problem : 16. 1 Standardization of methods of control of emergent and floating weeds with hormone weedicides
(Old programme will continue)
- Problem : 16. 2 Control of algae in fish ponds
(Suspended for lack of facilities)
- Problem : 16. 3 Evolution and evaluation of weedicide formulations
(Old programme will continue)
- Problem : 16. 4 Standardization and evaluation of the use of ammonia as an aquatic weedicide/fertilizer
(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

Experiments are to be initiated for investigating the seasonal fluctuations of phytoplankton and primary productivity under different soil and water conditions, for culturing selected dominant algal forms in the labora-

tory with a view to ascertaining their nutritional requirements and their ability for nitrogen fixation and for the control of excess growth of algae by chemical means.

Problem : 16. 8 Investigations on the biodegradation, persistence and the effects of the 2,4-D and Simazine weedicides on the productivity and fish life in culturable waters

Investigations will be taken up to assess the nature of the effects of sub-weedicidal doses of the chemicals upon the fauna, flora and productivity of the aquatic ecosystem and also to assess the time lag for total elimination of the weedicides from the ecosystems.

Project 17 : Frog farming

Problem : 17. 1 Induced breeding of commercially important species of Indian frogs
(Old programme will continue)

Problem : 17. 2 Raising and rearing of tadpoles to early frogs of indigenous commercial species
(Old programme will continue)

Problem : 17. 3 Culture of frogs and study of productivity in frog farming
(Old programme will continue)

Problem : 17. 4 Fish-cum-frog culture
(Old programme will continue)

Problem : 17. 5 Stock building of *Rana catesbeiana*
(Research work suspended for nonavailability of frogs)

Problem : 17. 6 Culture of frog food organisms

Experiments will be taken up to develop methods for culture of selected tubificid worms and insect larvae on mass scale for feeding tadpoles and frog stages of commercial species.

Project 18 : Sewage-fed fisheries

Problem : 18. 1 Ecology of sewage-fed fisheries
(Old programme will continue)

Project 19 : Hilsa fisheries

Problem : 19. 2 Hilsa fisheries of the lower stretch of the Ganga river system
(Old programme will continue)

- Problem : 19. 3 Artificial propagation of the Godavari hilsa
(Old programme will continue)
- Problem : 19.4 Hilsa fisheries of the Hooghly-Matlah estuarine system
(Old programme will continue)
- Problem : 19. 5 Artificial propagation of *Hilsa ilisha* (Ham.)
(Old programme will continue)
- Problem : 19. 6 Hilsa fisheries of the Allahabad-Buxar stretch of the
Ganga river system

Investigations are to be initiated for quantitative assessment of spawning success of *Hilsa ilisha* in relation to time and space and ecological conditions, and to correlate the larval abundance with the breeding populations, with a view to understanding the cause of fluctuations in the fishery of *H. ilisha*.

Project 20 : Water pollution investigations

- Problem : 20.1 Pollution in the Hooghly-Matlah estuarine system
(Old programme will continue)
- Problem : 20. 2 Pollution study in different river systems of India
caused by various sources with reference to aquatic
bio-mass
(Old programme will continue)

Project 21 : Fisheries of river basin

- Problem : 21.1 Ecological studies of Mans and Chauris in the Gandak
basin

Investigations will be initiated for scientific appraisal of nutritional resources of the Mans and Chauris with reference to fish production and to suggest remedial measures towards their rapid development.

- Problem : 21.2 Ecological studies of Dhars and fishery development in
tanks and ponds in the Kosi basin

Investigations will be initiated for scientific appraisal of nutritional resources of Dhars, tanks and ponds in the Kosi basin.

Project 22 : Fish culture in running water

- Problem : 22. 1 Cage culture in running water in the river Yamuna
near Mahewa

Investigations will be initiated to determine the optimum production of fish from unit water area in running waters adopting artificial feeding.

3. PAPER PUBLISHED

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4. EXTENSION

The Fisheries Extension Unit of the Central Inland Fisheries Research Institute was established in April, 1972.

(a) *Result of immediate practical application*: In addition to the pamphlets finalised in 1971, two more pamphlets, during the year under report, were finalised. As such, action is being taken up to print the following pamphlets :—

1. Techniques of nursery management
2. Induced breeding of major carps
3. Breeding of common carp
4. Intensive fish farming
5. Techniques of carp pituitary gland removal and ampouling for setting up pituitary banks
6. Riverine carp spawn collection techniques

A pamphlet entitled "Kendriya Antardeshiya Matsya Gaveshana Sanstha O Matsya Chashider Upoyogi Ihar Katipaya Abadan" in Bengali which means "Central Inland Fisheries Research Institute and some of its achievements useful for pisciculturists" was published on the occasion of Silver Jubilee of India's Independence.

Supply of fingerlings of grass carp (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys molitrix*) was arranged to many private pisciculturists through the West Bengal State Fisheries Department.

A number of written and telephonic queries regarding various problems faced by the fish farmers were attended to and necessary assistance and advices rendered accordingly.

Thirty two ponds belonging to private fish farmers were inspected and suggestions for their improvement were given. Soil and water of several ponds were tested and suggestions for the improvement of the nutrient levels were given.

39 fish farmers, who called on this office with their problems, were advised as to the solutions of individual problems in fish culture.

(b) *Results likely to be useful to the farmers, but needing further trials*: One hundred and nine ponds were inspected in the districts of Burdwan, Nadia and Malda for selection of ponds for initiating the "Fish Production Scheme"—Operational Research and the National Demonstration Centre.

A short training for a fortnight on "Intensive Fish Farming" was arranged at Barrackpore during December 16 to 30, 1972 for the extension workers of the State Fisheries Departments.

In all, 21 trainees from the states of Gujarat, Meghalaya, Tripura, Pondicherry, Kashmir, Mezoram, Assam, Nagaland, Andhra Pradesh and Kerala attended the course.

Fish Farmers Days were observed on August 18 and November 19 when

talks by the scientists of the Institute, discussions, film shows and exhibition on fish and fisheries were arranged for the benefit of the common fish farmers.

Copies of draft extension pamphlet on "Technique of carp pituitary gland removal and ampouling for setting up pituitary banks" were circulated among State Fisheries Departments, Union Territories, Ministries and Indian Council of Agricultural Research for guidance and informations. Action has been taken to print the pamphlet.

(c) *Publicity activities* : An exhibition depicting the achievements of the Institute was arranged at Bidhan Nagar during December 26, 1972 to January 10, 1973 at the fisheries pavilion jointly sponsored by the Institute and the Directorate of Fisheries, Government of West Bengal. The whole pavilion had the shape of a fish. The exhibits displayed were live specimens of grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and the Indian major carps (*Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*) which with common carp (*Cyprinus carpio*) formed a high yielding, combination of fishes. The main themes of the exhibition were composite fish culture and induced fish breeding—two techniques which have the potentiality of revolutionizing fish culture in West Bengal. A model of carp hatchery, a new development in India, was also displayed. The inside of the pavilion depicted an array of posters detailing achievements of research and development. Among the exhibits, a model of modern brackish water fish farm and live fishes in aquaria including a number of hybrids, produced for the first time in India were also displayed.

The Institute participated in an exhibition arranged on the occasion of the conference of West Bengal Fishermen Association at Bangaon during December 31, 1972 and January 1, 1973. Posters about composite culture, nursery management and induced breeding were mainly displayed there.

An exhibition which was arranged at the lawns of the Institute at Barrackpore during the celebrations of the Institute's Silver Jubilee continued from November 24 till December 1, 1972. Fiftyfive posters depicting important research achievements of the Institute, working models of glass jar carp hatchery, bio-assay equipments, spawn collection net in operation and plankton culture apparatus were displayed. Clay models of various types of fishes and a model of Kakdwip Brackish Water Fish Farm along with publications of the Institute were also exhibited.

Besides various exhibitions, the poster exhibitions were also arranged at the headquarters of the Institute on 8 occasions with a view to apprising the visitors on the working and achievements of the Institute.

Demonstration of high fish production, achieved by the All India Co-ordinated Research Project on Composite Culture of Indian and Exotic Carps with exceptionally excellent growth of grass carp (*Ctenopharyngodon idella*), was arranged on September 8, 1972 at Kulia Fish Farm for Shri Santosh Roy (Hon'ble Minister of West Bengal), a few MLAs of West Bengal, Director and Deputy Director of Fisheries (West Bengal), press reporters, representatives of All India Radio and others. The news of the demonstration was flashed with a photograph in

Amrita Bazar Patrika of September 10, 1972. A similar demonstration was arranged on September 17, 1972 during the visit of the Director General of the ICAR, Vice-Chancellor of the Kalyani University, Principal of the Agricultural College at Kalyani and others to the Kulia Fish Farm at Kalyani. Poster exhibitions depicting the research activities of the Institute were also arranged during these two days of demonstrations.

August 17, 1972 was an open day for students and 81 students from Mahadevananda Vidyalaya, Barrackpore visited the Institute. The students were appraised of the successful research carried out by the Institute through posters and other exhibits. Film show was also arranged for them.

Eighteen photographs on induced fish breeding were sent to the Director of Exhibition, Directorate of Extension, Ministry of Food and Agriculture for displaying the same at the Third Asian International Trade Fair, 1972 held during November and December.

Seven posters on fisheries development were prepared and exhibited at the National Science Exhibition for Children at New Delhi during November 11 to 19, 1972.

A handout entitled "Glimpses of a break through in pond fish culture" was distributed among the press reporters and the representatives of the All India Radio to appraise them about the techniques developed at the Institute for composite fish culture and to keep them informed about the high fish yield at Kulia Fish Farm.

As many as five news flashes on composite culture by CIFRI came in different leading newspapers of West Bengal. The captions of the news items were : "Fivefold increase in fish production likely" by a staff correspondent in the Statesman dated September 8, 1972 ; "Fish for thought" in editorial column of the Hindusthan Standard of September 15, 1972 ; "CIFRI tests may boost fish out put" by special representative in the Amrita Bazar Patrika of October 11, 1972 ; "Record fish yield claimed" by a reporter in the Statesman of October 28, 1972 ; and "New method of pisciculture" by special representative in the Amrita Bazar Patrika of November 8, 1972.

A report on the CIFRI and Silver Jubilee celebration on the completion of the 25th year of the Institute was published by a reporter of northern suburb in the Ananda Bazar Patrika on December 10, 1972 under the caption "Kendriya Matsya Prajanan Goveshanar Rajat Jayanti Utsab" in Bengali which means "Silver Jubilee Festival of Central Fish Breeding Research". Likewise, reports about the inauguration of the symposium "Aquaculture as an Industry" organised by the Institute during its Silver Jubilee was published under the titles "Aquaculture solution to sustained fish production" by staff correspondent in the Statesman of November 11, 1972 and "Ahmed stress need to boost fish out put" by a staff reporter in the Amrita Bazar Patrika of December 2, 1972.

Two handouts ; viz., "The fisheries pavilion at Bidhan Nagar" and "Introductory remarks by Dr. M. S. Swaminathan delivered on December 1, 1972 at Barrackpore" were prepared and sent to Press Information Bureau on 27.12.1972 and 1.12.1972 respectively for country wide publicity.

A paper entitled "Estuarine pollution and fisheries" by V. Gopalakrishnan was presented at the seminar on "Estuarine Pollution" held under the auspices of the Central Public Health Engineering Research Institute and Calcutta Metropolitan Development Authority on March 9 and 10, 1972.

The under mentioned papers prepared by the Scientists of the Institute were sent to the "Fifteenth Session of the Indo-Pacific Fisheries Council" held at Wellington, New Zealand during 18-27 October, 1972.

Jhingran, V. G.

A critical appraisal of the water pollution problem in India in relation to aquaculture.

Gopalakrishnan, V.

Biological process involved in pollution of coastal aquaculture waters.

Jhingran, V. G. and V. Gopalakrishnan

Multiferious use of coastal areas for aquaculture development.

A paper entitled "Status of culture of brackish water and freshwater prawns in India" by V. Gopalakrishnan was presented at the seminar on "Different Aspects of Culture Fisheries" held at Freshwater Fisheries Research Station of the Directorate of Fisheries (West Bengal), Kulia on August 16, 1972.

The second workshop on All India Co-ordinated Research Project for "Studies on Ecology and Fisheries of Freshwater Reservoirs" was held on August 28 and 29, 1972 at the premises of Ranchi Agricultural College, Kanke, Ranchi to review the progress of work made at the various sub-centres, to finalise the programme for 1973 and to discuss the proposals for the Fifth Five Year Plan.

A paper entitled "The potential for intensive cultivation of estuarine prawns in India" by V. Gopalakrishnan was sent to the Directorate of Fisheries, Government of Tamil Nadu, Madras-6 for the seminar on "Mari culture and Mechanised Fishing" held in October, 1972.

On the occasion of the Silver Jubilee of the Central Inland Fisheries Research Institute, a symposium on "Aquaculture as an Industry" sponsored by the Indian Council of Agricultural Research was held at Barrackpore during November 24 to 28, 1972. A total of 129 delegates including several foreigners attended the symposium and 92 scientific papers on different aspects of aquaculture were reviewed and discussed.

The second workshop on All India Co-ordinated Research Project on "Composite Culture of Indian and Exotic Fishes" was held during November 29 to 30, 1972 at the Central Inland Fisheries Research Institute, Barrackpore. The workshop dealt with the progress of work made at various subcentres and finalised the technical programme for 1973, besides, discussing the proposals for the Fifth Five Year Plan.

Workshops on All India Co-ordinated Research Projects on "Propagation and Stocking of Seed of Air-breathing Fishes for Culture in Swamps" and

"Investigations on Riverine Carp Spawn Prospecting and Collection Techniques" were held during December 20-21 and 22-23, 1972 respectively at Patna.

The progress of work made at various subcenties, the finalisation of work programme for the year 1973 and the discussions on the proposals of the Fifth Five Year Plan were the highlights of the two workshops.

The paper entitled "Prospects for the development of brackishwater fish and shrimp culture in India" by V. G. Jhingran and V. Gopalakrishnan was sent for presentation at the Technical Conference on Fishery Management and Development to be held in Vancouver, British Columbia, Canada during February 13 to 23, 1973 under the auspices of FAO.

A paper entitled "Present status of pollution in the Hooghly estuary with special reference to the adverse effects observed on the fishery resources" by V. Gopalakrishnan, P. Ray and B. B. Ghosh was sent for presentation at the symposium on Environmental Pollution at the Central Public Health Engineering Research Institute, Nagpur to be held during the period January 17 to 19, 1973.

6. SUMMARY

During the year, progress was made in 18 out of 20 projects and action was taken to set up the project on "Fish Farm Designing". The work on the project on "Murrel and live fish culture" was kept in abeyance during the year as the studies were continued under a Co-ordinated project.

Project 1 :

1.1 : In composite culture to raise fingerlings from fry of catla, rohu, mrigal and grass carp stocked in 2 ponds in the ratio of 3.6 : 3.6 : 1.6 : 1.2 at 2.07 lakh/ha, aggregate survivals of 75.0 and 89.2% and net productions of 3,108 and 3,163 Kg/ha/3 months were obtained.

To raise large fish, fingerlings of catla, silver carp, rohu, mrigal, common carp and grass carp in the ratio of 1 : 2 : 3 : 1.5 : 1.5 : 1 along with miscellaneous fish were stocked at 5,000/ha. The survivals and net production in Kg/ha/yr were 79% and 4,874 for the pond harvested at the end of the year, 62.8% and 5,000 for the pond harvested intermittently but without replenishment and 76.4 and 56.4% and 5,440 and 3,770 for the two ponds harvested periodically but with replenishment.

In experiment with intensive feeding and fertilisation in two 0.25 ha ponds stocked with catla, rohu, mrigal, grass carp, silver carp, common carp, *N. chitala*, *Ompok* sp., *Mystus* sp. and *Pangasius* sp. at 10,500/ha, net productions of 2,660 and 2,553 Kg/ha in two months were estimated and the average growths of catla (500 gm) and grass carp (404 gm) were also observed.

Fingerlings of silver carp, grass carp and common carp were stocked at 1 lakh/ha in two 0.08 ha ponds and the species ratio was 4 : 3 : 3. The

average survival (%) and growth (mm/gm) in 6 months were 98.4 and 209.0/68.0, 88.6 and 166.9/44.0 and 79.9 and 181.0/35.4 for the three species respectively. Further trial with higher stocking rate (2.5 lakh/ha) is in progress.

An experiment of one year duration to raise large fish in two 0.12 ha ponds with catla, rohu, mrigal, silver carp, grass carp and common carp stocked in the ratio of 1 : 3 : 1.5 : 2 : 1 : 1.5 and at 5,000/ha is in progress.

To compare the production at the end of one year with two years', fingerlings of catla, rohu, mrigal, silver carp, grass carp, common carp, bata and reba were stocked at 4,250 major carp and 1,500 minor carp/ha in the ratio of 1 : 2.5 : 1.5 : 2 : 2 : 1.2 : 0.75 : 0.75 and were provided with artificial feeding as well as fertilisers for the ponds against controls. The productions (Kg/ha) in treated/control ponds were 2,418.54/450.21 in ponds harvested after 1 year and 5,176.81 (estimated)/628.40 (estimated) in ponds harvested after 2 years.

1.2 : Among the supplementary feeds (prawn powder, prawn powder with plant material, rice-bran, groundnut oilcake, and fish meal with plant material) tried, fish meal with plant material though proved better, was less effective than the mixture of rice-bran and groundnut oilcake while rice-bran proved superior for the growth and survival of the carp fry.

1.3 : Trials were made with growth promoting substances and cobalt chloride @ 0.01 mg/day/fish was found to be the best.

1.4 : Relative efficiency of three nitrogenous fertilisers were tested in different soils with varying pH. Calcium ammonium nitrate was found to be the best for acid soils, urea for slightly acid to neutral soils and ammonium sulphate for alkaline soils. High dose (80 Kg N/ha) of fertiliser was good for the soil with pH 5.0-6.8 and the medium dose (50 Kg N/ha) for alkaline (pH 8.0) soil.

1.5 : Research work completed in 1970

1.6 : Common zooplankters could be cultured with the help of fertilisers — mohua oilcake : cow-dung : poultry dropping (6 : 3 : 1) at 1,000 ppm.

1.7 : Mass culture of plankton was done in plastic cisterns. Laboratory cultures of *Chlorella* sp. and diatoms were maintained.

1.8 : Research work completed in 1971.

1.9 : Acid soils, though primarily unproductive due to poor availability of nutrients, responded satisfactorily to inorganic fertilisers and the manures preferably with nitrogen content were observed to be the best for fish culture in such waters.

1.10 : Since high nitrogen and phosphorus in soluble form indicated high productivity of fish ponds in acid soils, the chemical test of the water indicating their contents was observed to be the quickest method for assessing the productivity of the ponds in Tripura.

1.11 : Experiments with NaCl solution, NaOH solution, Bentonite clay etc. for treating the soil for prevention of seepage were conducted. But no remedial measure could be derived to stop the seepage up to a tolerable limit in fish culture ponds.

1.12 : To evolve fish poison, the unripe fruit powder of the plant "Khakada" (*Caesaria graveolens*) was found to kill *Channa marulius* within 6 to 8 hr at 10-25 ppm level.

1.13 : "Capture and recapture" method to estimate fish in ponds was applied for a number of times in Killa Farm. It was found that the difference between the estimated and actual population is 2-9% for surface feeders, 3-13% for column feeders and 5-23% for bottom feeders.

1.14 : Variations in light intensities and odour had no differential effect on the spawn of different species. The stress in DO concentrations also failed to segregate the spawn species-wise.

1.15 : Different types of trap were fabricated for selective capture of predatory fishes.

1.16 : To determine the age of rohu, the scale of fish were examined and growth checks appeared to be more in number than the years in the life of fish and as such they could not be considered as annuli. The checks were not clear on the otoliths of pond grown rohu. Transparent rings on the opercular bones did not correspond with the age of the fish in terms of years. Same was the case with concentric markings in the vertebrae.

1.17 : Exposure of rohu and catla eggs to ultraviolet irradiation for over 5 seconds resulted in slower absorption of yolk and abnormal development of embryos.

1.18 : Among the trace elements, B, Co, Mo and Zn at 0.05 ppm, the treatment with Mo improved the growth and survival of spawn in the laboratory and Zn and Co in the yard experiments for good growth of fry.

1.19 : Zooplankton, silk-worm pupae, soyabean, groundnut oilcake : wheat-bran (1 : 1), mycelium of *Penicillium* sp. were tried as feeds for spawn and fry. Spawn and fry of catla and rohu had better growth and survival with zooplankton and mrigal spawn and fry with soyabean/wheat-bran + groundnut oilcake/silkworm pupae. Mycelia did not appear to be useful. Feed with high carbohydrate content proved good for the common carp fry.

1.20-1.24 : Research work contemplated in 1973

Project 2 :

2.1 : Research work completed in 1970

2.2 : Pituitary gland extracts from catfishes were found effective in rohu

2.3 : 871 ampoules of pituitary extract were prepared during the course of 5 years and 424 of them were supplied to 56 centres in most of the cases induce breeding of carps was possible with preserved pituitary extract.

2.4 : With the newly installed hatchery complex better hatching and survival of spawn was achieved.

2.5 : Suspended for lack of facilities.

2.6 : Breeding for the second time through hypophysation of one rohu and one catla could be obtained during the same breeding season.

2.7 : Research work contemplated in 1973.

Project 3 :

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

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

3.6 : Assessment of primary productivity, biomass production, littoral and benthic organisms, fish production and physico-chemical features of soil and water were continued in Arsikere, Nidige, Milghatta, Hutcharyankere, Madaga and Anjanapur tanks. Fingerlings of *Cyprinus carpio* were stocked at Madaga and Hutcharyankere tanks.

3.7 : Research work completed in 1970

3.8 : Observations on the breeding of *P. pulchellus* and *T. khudree* were continued. Fingerling of these fishes were collected from rivers and released at Krishnarajasagar Fish Farm and Vinivilassagar Fish Farm for rearing and further observations. The farm grown *P. pulchellus* have been stocked in different water bodies of the peninsular India for biological studies.

3.9, 3.10 & 3.11 : Research work contemplated in 1973

Project 4 :

4.1, 4.2 & 4.3 : The work is being done under a Co-ordinated project.

4.4 : Comparative studies of the growth of spawn from the river Kosi and from different floods in the river Ganga were continued and no specific difference in the pattern of growth were observed. But for the survival and quality, the spawn from the third flood in the river Ganga, was found to be better.

4.5 : Studies on the qualitative and quantitative assessment of spawn were carried out in the river Ganga at Kishanpur, Buxar and Sahibganj. The amount of spawn collected and the percentage of desirable spawn were 460 ml and 26-80, 430 ml and 8-34 and 5,389 ml and 40-95 at Kishanpur, Buxar and Sahibganj respectively.

Project 5 :

5.1 : In a polyculture experiment in K pond, gross production was estimated to be 800 Kg/ha after 15 months. The pond was restocked in October. Observations on primary productivity and other hydrological conditions were continued. Growth rates of the stocked fish were determined.

The total subsidence of the dykes at Bakkhali Fish Farm was found to be 90 cm.

5.2 : Reconnaissance survey of Dhanchi island was completed and detailed contour survey of Mahisani island was taken up.

5.3 : The maximum ingress of brackish water seed through the secondary sluice with adjustable valve-shutter occurred at velocities of 1.22 to 1.26 Km/hr.

5.4 : Major carp fingerlings were found to thrive well up to 10.5‰ salinity. Growth pattern was high when salinity came down to 4.72‰ and was observed to be low at higher salinity ranges.

5.5 : Monoculture experiments on the culture of *Mugil parsia*, *Lates calcarifer* and *P. monodon* were conducted. Growth rates of *P. monodon* and *P. indicus* were determined under laboratory conditions. Mixed culture experiments with *Mugil parsia* and *P. monodon* were conducted.

5.6 : Brackish water fish seed collection techniques were developed at Brackish Water Fish Farm at Kakdwip. Primary productivity of the Brackish water farms were also determined.

5.7 : Mass culture of *Cymbella* sp., *Pleurosigma* sp. and *Chlorococcum* sp. was done in Miquel's solution. Culture of *Cymbella* sp. and *Amphora* sp. was also maintained in the laboratory in Miquel's solution and pond soil extract.

5.8 : Hatchlings of *M. cephalus* obtained through hypophysation survived for 23 days in laboratory rearing.

5.9 : The effect of various organic and inorganic fertilisers on fish growth was determined.

5.10 : Contour survey of Mahisani island was conducted during the year.

Project 6 :

6.1 : No progress.

6.2 : Young ones of *M. malcolmsonii* were stocked @ 5,000/pond in 4 ponds at Katheru Fish Farm. Rearing was done for 5½ months excepting in the fourth pond where experiment continued for 3½ months only. The total productions from the four ponds were 414, 195, 80 and 63 Kg respectively.

Mixed culture of prawn *M. malcolmsonii* and carps was taken up in four ponds at Kadium Fish Farm. The total productions (Kg/ha) in the first and second ponds were estimated to be 86.22 and 228.00 after 10½ months. Production from the third pond was only 43.0 Kg after 6½ months duration while there was total mortality in the fourth pond.

Juveniles of *M. malcolmsonii* were collected from the Gautami estuary in the months of October and early November. Seeds of *M. rude* were also collected. No intermixing of populations was observed when 4,000 prawns were tagged and released at the two centres.

Biological studies and catch statistics of prawn (*M. malcolmsonii*) were continued.

Project 7 :

7.1 & 7.2 : Investigations are being conducted under a Co-ordinated project.

Project 8 :

8.1 : Brackish water fish seed investigations were conducted at Diamond Harbour, Namkhana, Lot No. 8 and Port Canning.

Brackish water prawn seed investigations were conducted at Uluberia.

8.2 : The larvae of *M. rosenbergii* could be reared up to the IX stage.

P. indicus were available in considerable numbers during March and July while *P. monodon* were found common during March-June.

8.3 : The recruitment of postlarvae and juveniles of economically important fishes into the lake showed considerable decline (about 30%) from that of the last year. Contrary to this, recruitment of postlarvae of prawn was much higher (about 66%) than in the previous year.

Of the artificial pelleted food mixtures tried on mullet-fry, the mixture of ground-nut oilcake, prawn powder and sago gave the best growth and survival.

The phytoplankton population showed a peak (15,315 no./haul) during June at lake-mouth while zooplankton recorded a peak (68,345 no./haul) in May from Southern sector. Primary productivity ranged from 0.18 to 1.73 gm C/m²/day.

30 sets of mullets (*L. macrolepis* and *M. parsia*) were injected with pituitary extracts achieving partial success only.

Culture of edible oyster has been initiated on experimental rafts in the lake with different cultch materials. Spatfall has been observed from September onwards and growth was best on empty oyster shells.

The study of the hydrobiological conditions of four ponds in Adyar estuarine fish farm was continued. Culture of fish food organisms under yard conditions was initiated using various organic and inorganic fertilisers.

Project 9 :

9.1 : Hybrids of *L. calbasu* × *C. catla* showed better growth than *C. mrigala* × *C. catla* hybrids and coloured *catla* × *L. rohita* hybrids grew better than those of *L. rohita* × *C. catla* and *L. calbasu* × *C. catla*. *C. carpio* × *C. catla* hybrids produced for the first time were deformed and majority of them died within a week.

9.2 : Encouraging results were obtained in storing of sperms in coconut milk. The sperms survived for 24 hours under refrigeration.

9.3 : The specimens of *C. idella* and *H. molitrix* hybrids of 1970 progeny could be reared for about 17 months.

Project 11 :

11.1 : Economic aspects of fish culture operations were studied both in private and public sectors in West Bengal and Orissa.

11.2 : Data from seed farms in Orissa and West Bengal were collected for an economic evaluation and are being analysed.

11.3 : Studies on economics of weed control by chemical treatment were initiated. Expenditure involved in removal of weeds by copper sulphate treatment was found to vary between Rs. 1,278 and Rs. 4,158 per hectare of weed infestation.

Project 12 :

12.1 : Selection of female breeders, using a catheter, was done. Altogether 30 sets of *H. molitrix* and 46 sets of *C. idella* were injected with pituitary hormone of Indian major carps, *C. idella* and *H. molitrix* out of which 16 *H. molitrix* and 25 *C. idella* could be stripped. In all 2.62 lakh of *H. molitrix* and 4.855 lakh of *C. idella* spawn were produced.

12.2 : An experiment of one year duration on monoculture of *H. molitrix* was carried out in two 0.12 ha ponds stocked @ 3,000/ha which resulted in a production of 248 Kg and 320 Kg/ha.

12.3 : The use of *C. idella* for controlling the noxious vegetation has been encouraged by supplying fry and fingerlings of the fish and the technical help required.

Project 13 :

13.1 : Research completed in 1970

13.2 : Trout fry were fed with sheep liver + Aurofac at Laribal fish Farm for the first 11 months and then with artificial pelleted feed. Composition of different feeds has been given and nutritive values of these feeds were analysed.

13.3—13.5 : Research completed in 1971

13.6 : Two centres, Hazaratbal and Sadiakadal, were selected to assess the productive potential of the Dal lake. Studies on physico-chemical features, surface plankton, vegetation, bottom biota and catch/man/hr for the period of 1969—1972 were completed.

13.7 : Research completed in 1970

13.8 : Altogether 60,720 green eggs were stripped and the cumulative percentage of survival from green egg to fry stage was 80.9%.

13.9 : No progress

13.10 : Gut contents of *Salmo trutta fario* from the Lidder, Erin and Sind streams were examined. The percentage composition of insect samples in these streams was also recorded and correlated.

Project 14 :

14.1 : The total fish landings at Sadiapur and Daraganj (February-November, 1972) and Buxar (January-November, 1972) were estimated to be 99.02 and 49.75 and 2.90 t respectively. Net production in the Yamuna river, in the Ganga river above the confluence and in the Ganga river below the confluence ranged from 37.05-87.5, 100.0-125.0 and 37.5-87.5 mg C/m³/hr respectively. The maximum and minimum plankton values were observed in the months of January, 1972 (3,939 u/l) and March, 1972 (750 u/l).

14.2 : Lalgola centre contributed major portion (123.90 t) of the total catch (451.36 t) followed by Bhagalpur (97.54 t), Dhulian (77.10 t), Farakka (73.34 t), Rajmahal (43.20 t) and Sahibganj (36.28 t). *H. ilisha* was the prime contributor forming 46.07% of the total catch. Studies on the primary productivity, plankton and hydrology of the lower stretch of the Ganga river system were continued.

14.3 : Research completed in 1969.

14.4 : Research completed in 1971.

14.5 : The total fish landings from the Pulicat lake were 1,371.448 t, showing an increase of 17.0% over the previous year. *P. indicus* was the most dominant species (40.53%), mullet occupied the second place (27.95%) and perches were the third in order of abundance (9.87%).

14.6 : During November, 1971 to September, 1972, the total catch from the Hooghly-Matlah estuarine system was 15,692.1 t. *T. jella* (3,592.2 t), *H. nehereus* (2,927.6 t), prawns (1,607.0 t) and *H. ilisha* (1,367.4 t) were the dominant forms among catch. Bagnet contributed the major portion of the catch (7,934.7 t) followed by large seine (5,070.6 t).

14.7 : Fish catch statistics at Ujanbazar and Fancybazar landing Centres were recorded. A survey of the southern bank of the river Brahmaputra and its important tributaries including a stretch of about 600 Km was undertaken. Major carps were the predominant forms in the catches in the lower stretch of the Brahmaputra. Catfishes and minor carps like *L. gonius* were the main contributors in the catch in the upper stretch.

Project 15 :

15.1 : 0.5 to 1.0 ppm Gammaxene (BHC 10%) was found effective against the infection of *Argulus* sp., *Trichodina* sp. and *Dactylogyrus* sp. infection in *O. bimaculatus* could be checked by the treatment of 1 : 4,000 solution of formalin.

Project 16 :

16.1 : In yard and field experiments, increase in nutrient level and fish production were recorded after killing and disintegration of water-hyacinth by 2,4-D treatment.

Ipomoea carnea, *Typha latifolia* and *Jussiaea repens* were effectively controlled by 2,4-D treatment in field trials.

16.2 : Research suspended.

16.3 : Gramaxone was found to be very effective against *Salvinia* sp. and *Spirodela* sp. in field trials at economic doses. Tok E-25 and Stam F-34 were tried against *Hydrilla* sp., *Pistia* sp. and *Typha latifolia*.

16.4 : Aqueous ammonia was found to be effective against *Pistia* sp. in field trials. Increase in the nutrient level and fish production were observed in yard trials after the death and disintegration of *Hydrilla* sp. by the treatment with ammonia.

16.5 : Experiments on effectiveness of copper sulphate pellets on storage were carried out. *Eichhornia* sp. would be completely destroyed with the treatment of superphosphate solution (16%) @ 1,500 Kg/ha. Superphosphate @ 1,500 Kg/ha was found effective against *Hydrilla* sp. and *Vallisneria* sp. 50% *Vallisneria* sp. died and remaining plants were in decaying conditions when Fernoxone solution was applied @ 50 Kg/ha while @ 250 Kg/ha all plants decayed completely within 40 days after the treatment.

Pond infested with *Vallisneria* sp. (95%) and *Lagarosiphon* sp. (5%) could be cleared with the 4 intermittent doses of copper sulphate @ 2.5, 2.5, 1.5 and 1.5 ppm with a period of 26 days.

16.6 : Collections of water, soil and plant samples were made from different areas and they were separately analysed to correlate the elements present within the body tissues of each species of plant with those present in the soil and water of the area from where the respective plants were collected.

Project 17 :

17.1 : In the pre-breeding and breeding seasons, altogether 25 sets of *Rana tigrina*, *R. hexadactyla*, *R. crassa* and *R. limnocharis* were bred with a single sub-cutaneous injection of 2-3 mg of frog pituitary gland extract, within 3-7 hours, depending on the species. *Bufo* pituitary was also found effective in *R. tigrina*. Artificial fertilisation of eggs yielded cent per cent success. Fecundity varied according to size and species. Several hybrids were produced through induced hybridization between *R. tigrina*, *R. crassa* and *R. limnocharis*.

17.2 : 32,500 tadpoles of *R. tigrina*, *R. crassa* and *R. hexadactyla* and 1,000 hybrid ones resulting from crosses between the former two species and *R. limnocharis* were produced.

In mixed rearing of *R. hexadactyla* tadpoles and fish spawn, no adverse effect on either was noticed.

The cannibalism in the tadpoles of *R. crassa* and *R. tigrina* could be markedly reduced through hybridization between the two species and by provision of frog meat as their diet.

In field experiments with 3-day-old tadpoles of *R. tigrina* stocked at 3.0 lakh/ha, satisfactory survival and growth of advanced tadpoles were recorded.

17.3 : 689 and 214 Kg/ha/yr of *R. hexadactyla* and *R. tigrina* respectively were produced in the ponds at stocking densities of 6,500 and 4,000/ha.

17.4 : A production of 3,145 and 418 Kg/ha/yr respectively of fish and frog was obtained in a 0.08 ha pond where early fingerlings of major carps and small frogs of *R. hexadactyla* were stocked at 4,500 and 6,500/ha.

17.5 : No progress

Project 18 :

18.1 : Indian major carp fingerlings were stocked @ 52,414 and 74,000/ha in two ponds (0.8 and 0.6 ha) which were fed with 5.45 and 2.13 million litres of sewage water respectively. Among all, the growth of *C. catla* was better in the 1st pond.

Studies on plankton, bottom biota, primary productivity and hydrology of these ponds were also continued.

Project 19 :

19.1 : Winter breeding and migration of *H. ilisha* were very poor. Observations on post-monsoon and early winter spawning revealed that the breeding of *H. ilisha* was very poor all along the stretch in comparison to previous years.

Experiments on the bathymetric distribution and transport of the larvae of *H. ilisha* were continued.

19.2 : Total estimated landings from the lower stretch of the Ganga river system were estimated to be 207.94 t. Farakka and Dhulian contributed major part (93.54%) to the total catch. June to October was the peak period for catch from the entire stretch. Fishery in the entire stretch was supported by the three sub-populations; viz., 'Slender', 'Broad' and 'Broader'. Two separate spawning seasons, one during April and May and the other during July to October, were observed. The intensity of spawning was higher during the post-winter months at all the centres. Observations on distributional pattern of three sub-populations and number of *H. ilisha* larvae per 1,000 m³ water at all the centres were continued.

19.3 : Total landings of *H. ilisha* from the Godavari estuary and its branches were estimated. The size/age-composition showed the predominance of groups IV and III in the catches while group V was also recorded in good number. Fecundity, size of ova and sex ratio of the fish were also studied.

19.4 : Shooting and tow net operations revealed that the catch of *H. ilisha* larvae from Balagarh-Medgachi stretch was the highest in the month of October while the catch was very poor at Kalna-Datrigram stretch.

19.5 : Success in artificial fecundation of hilsa (*H. ilisha*) was again achieved through stripping and employing wet method of fertilisation.

Hatching of hilsa larvae was observed to be earlier in nylon *hapa* as compared to *markin 'hapa'* in riverine environment, the percentage of hatching varying between 10 and 70. Rearing of hilsa hatchlings produced through artificial fecundation is being continued in five ponds using different organic manures and trace elements.

Project 20 :

20.1 : Characterisation of individual waste effluents, discharged from the different industries to the Hooghly-Matlah estuary was studied to focus the source of the maximum pollution. The pollutional effects of different effluents on the plankton were also studied. Preliminary cage experiments performed in the outfall of India pulp paper using Indian major carps as test fish revealed that the effect of pollution was due to quick deoxygenation and sudden rise in temperature in water.

20.2 : Bio-assay experiments with Malathion EC-50, using *Colisa* sp. and *Notonecta* sp. as test animals were initiated. *Colisa* sp. were found to be better resistant to the water treated with DDT and BHC than *P. sophore*.

7. PERSONNEL

Retirement : Nil

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

Shri P. K. Sthanapati	:	From Accountant to Assistant
Shri K. C. Roy	:	From Senior Store Keeper to Assistant
Shri K. B. Rajani	:	From Head Clerk to Senior Store Keeper
Shri N. G. Chatterjee	:	From Cashier to Head Clerk
Shri B. C. Dutta	:	From Senior Clerk to Accountant
Shri R. C. P. Singh	:	From Junior Clerk to Cashier
Shri I. N. Kodandaraman	:	From Junior Clerk to Senior Clerk
Shri S. K. Pramanick	:	From Junior Clerk to Senior Clerk
Shri N. K. Mitra	:	From Junior Clerk to Senior Clerk
Shri S. K. Kar	:	From Junior Clerk to Senior Clerk

Transfers : The following transfers were made during the year under report :

		Senior Fishery Scientist
Shri A. V. Natarajan	:	From Nagarjunasagar to Hazaribagh

Junior Fishery Scientist

Shri K. N. Krishnamurthy	:	From Faridabad to Karnal
Dr. K. Algaraja	:	From Nagarjunasagar to Hazaribagh
Shri R. Chandra	:	From Allahabad to Gauhati
Shri M. R. Sinha	:	From Hazaribagh to Barrackpore

Assistant Fishery Scientist

Shri M. R. Sinha	:	From Allahabad to Hazaribagh
Shri A. K. Ghosh	:	From Gauhati to Cuttack
Shri C. Selvaraj	:	From Bhavanisagar to Cuttack

Senior Research Assistant

Shri J. B. Rao	:	From Faridabad to Karnal then to Kurnool
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Senior Clerk

Shri S. P. Sastry	:	From Nagarjunasagar to Rajahmundry
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Junior Clerk

Shri J. Rao	:	From Faridabad to Karnal
Shri I. N. Kodandaraman	:	From Bangalore to Bhadra
Shri I. G. C. Naidu	:	From Rajahmundry to Kurnool
Shri L. P. Misra	:	From Srinagar to Allahabad

Fieldman

Shri R. Raikwar	:	From Rewa to Kulgarhi
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Peon

Shri L. P. Dwivedi	:	From Rewa to Cuttack
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Fisherman

Shri P. Sayulu	:	From Bangalore to Nagarjunasagar
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Watchman

Shri D. Bahadur	:	From Panna to Allahabad
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Staff : The following staff rendered their services to the Institute during the year under report :

Director

DR. V. G. JHINGRAN

1 Freshwater Fish Culture Division (Cuttack)

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

Senior Fishery Scientist	:	Dr. H. Chaudhuri
Fishery Scientist	:	Dr. A. K. Mondal, Sarvashri V. Ramachandran, R. D. Chakraborty and S. B. Singh (on deputation to Tanzania)

Junior Fishery Scientist	:	Sarvashri M. A. V. Lakshmanan, R. M. Bhowmick, N. G. S. Rao, G. N. Saha, G. V. Kowtal, P. R. Sen, D. S. Murthy, S. Patnaik, N. K. Tripathi and Dr. C. R. Das
Junior Engineer	∴	Shri C. D. Saha
Assistant Fishery Scientist	:	Sarvashri A. K. Ghosh, R. K. Jana, D. K. Chatterjee, C. Selvaraj, T. Ramaprabhu, S. K. Mukhopadhyay and K. H. Ibrahim (on other duty under Tanzania Government)
Assistant Statistician	:	Shri M. D. Rout
Senior Research Assistant	:	Sarvashri A. K. Banerjee, S. Jana, S. N. Mohanty, R. K. Dey, K. J. Ram, D. R. Kanaujia, S. D. Gupta and P. L. N. Rao
Research Assistant	∴	Shri P. V. G. K. Reddy
Draftsman	∴	Shri Chakradhar Sahoo
Estimator	∴	Shri Muralidhar Mantri
Accountant	:	Shri P. C. Kanungo
Head Clerk	∴	Shri A. K. Das

and others

2 Riverine and Lacustrine Fisheries Division (Allahabad)

2.1 Central Inland Fisheries Research Substation, Allahabad (Uttar Pradesh)

Deputy Director	:	Dr. Y. R. Tripathi
Fishery Scientist	:	Shri J. G. Malhotra and Dr. A. G. Jhingran
Junior Fishery Scientist	:	Dr. R. S. Panwar, Sarvashri P. K. Mathur and D. V. Pahwa (Ad-hoc)
Assistant Fishery Scientist	:	Sarvashri S. P. Singh and S. C. Pathak
Senior Research Assistant	:	Sarvashri S. N. Mehrotra, R. K. Tyagi, P. N. Jaitly, D. Kapoor, Shree Prakash, Balbir Singh, R. N. Seth, H. C. Joshi and D. Nath
Research Assistant	:	Sarvashri A. C. Nandy, R. K. Saxena, S. K. Wishard, G. N. Srivastava, N. K. Srivastava, K. L. Shah, R. K. Dwivedi and S. K. Das, (up to 10.5.72)
Senior Store Keeper	:	Shri K. B. Rajani

and others

2.2 Central Inland Fisheries Research Unit, Bhagalpur (Bihar)

Junior Fishery Scientist	:	Dr. G. N. Mukherjee
Research Assistant	:	Sarvashri B. L. Pandey, S. N. Sar and R. C. Singh

and others

2.3 Small Reservoir Unit, Rewa (Madhya Pradesh)

Junior Fishery Scientist	:	Shri S. J. Karamchandani
Senior Research Assistant	:	Shri K. P. Srivastava
Research Assistant	:	Sarvashri D. N. Mishra and M. D. Pisolkar

and others

2.4 Krishna Godavari Unit, Rajahmundry (Andhra Pradesh)

Fishery Scientist : Shrimati T. Rajyalakshmi (Ad-hoc)
Assistant Fishery Scientist : Dr. Y. Rama Rao
Research Assistant : Shri T. S. Ramaraju

and others

2.5 Reservoir Fisheries Research Unit, Hazaribagh, (Bihar)

Senior Research Assistant : Shri M. Ramakrishnaiah
Research Assistant : Sarvashri S. K. Sarkar, B. Roy, B. K. Banerjee and
S. L. Kar

and others

2.6 Tank Fisheries Research Unit, Bangalore, (Mysore)

Fishery Scientist : Dr. A. David
Senior Research Assistant : Shri P. K. Sukumaran
Research Assistant : Shri S. Lakshmiraghavan

and others

2.7 Cold Water Fisheries Research Unit, Srinagar (Kashmir)

Junior Fishery Scientist : Dr. K. L. Sehgal
Senior Research Assistant : Sarvashri M. J. Bhagat, Kuldip Kumar, C. B.
Joshi and Shyam Sundar

and others

2.8 Brahmaputra Survey Unit, Gauhati (Assam)

Junior Fishery Scientist : Shri Ravish Chandra
Senior Research Assistant : Sarvashri H. P. Singh, M. Chowdhuri and S. N.
Upadhyaya

and others

3 Estuarine Fisheries Research Division (Barrackpore)

3.1 Estuarine Fisheries Research Substation, Barrackpore (West Bengal)

Senior Fishery Scientist : Dr. V. Gopalakrishnan
Junior Fishery Scientist : Dr. M. Subrahmanyam and Shri Apurba Ghosh
Fishery Economist : Shri M. Randhir
Assistant Fishery Scientist : Sarvashri K. K. Vass and B. B. Ghosh
Senior Research Assistant : Sarvashri S. B. Saha (on long leave), S. N. Dutta
(on long leave), D. D. Halder (Ad-hoc) (on long
leave), A. Chowdhury, K. K. Bhanot, G. C. Laha,
L. H. Rao, M. M. Bagchi and Srimati K. K.
Bhanot
Research Assistant : Sarvashri P. R. Das, B. K. Saha, R. N. De, A. R.
Chowdhury, R. K. Chakraborty, D. K. Dey, H. S.
Mazumdar and P. M. Mitra
Head Clerk : Shri M. L. Biswas

and others

3.2 Estuarine Fisheries Research Unit, Kakdwip (West Bengal)

Fishery Scientist	:	Shri A. N. Ghosh
Junior Fishery Scientist	:	Dr. P. U. Varghese
Assistant Fishery Scientist	:	Shri M. K. Bandhyopadhyay
Senior Research Assistant	:	Sarvashri G. N. Chattopadhyay, K. M. Das and H. C. Karmakar
Research Assistant	:	Sarvashri P. B. Das, P. K. Pandit and M. K. Mukhopadhyay

and others

3.3 Pulicat Lake Unit, Madras (Tamil Nadu)

Fishery Scientist	:	Shri K. Raman
Junior Fishery Scientist	:	Shri K. V. Ramakrishna
Assistant Fishery Scientist	:	Shri R. D. Prasadam
Senior Research Assistant	:	Sarvashri S. Radhakrishnan, R. Ganapathy, C. P. Rangaswamy, K. Gopinathan, M. Kaliyamurthy and G. R. M. Rao
Research Assistant	:	Sarvashri K. J. Rao, S. Srinivasagarm, K. S. Rao and D. R. Rao

and others

3.4 Sundarbans Survey Unit, Kakdwip (West Bengal)

Fishery Scientist	:	Shri B. B. Pakrashi
Junior Fishery Scientist	:	Shri A. V. P. Rao
Fisheries Farm Engineer	:	Shri A. Sengupta
Assistant Engineer	:	Shri A. B. Mukherjee
Senior Research Assistant	:	Shri N. C. Basu
Overseer	:	Shri P. N. Bhattacharjee

and others

4 Units under direct control of the Director

4.1 Soil Chemistry and Weed Control Unit, Calcutta (West Bengal)

Junior Fishery Scientist	:	Dr. (Miss) E. Mitra and Shri P. Ray
Senior Research Assistant	:	Sarvashri S. C. Banerjee, A. C. Banerjee, R. K. Banerjee and S. C. Thakurta

and others

4.2 Library & Documentation Unit, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri B. N. Saigal
Senior Research Assistant	:	Sarvashri A. K. Datta and Amitabha Ghosh
Research Assistant	:	Shri P. K. Chakrabarti
Senior Library Assistant (Gr. I)	:	Kumari Anjali Ghosh
Senior Artist	:	Shri J. Ghosh
Artist Photographer	:	Shri A. R. Mazumdar

and others

4.3 Fisheries Extension Unit, Barrackpore (West Bengal)

Senior Extension Officer	:	Shri P. Das
Extension Officer	:	Shri B. K. Sharma
Senior Research Assistant	:	Dr. K. G. Rao and Shri A. Mukherjee
Photographic Assistant	:	Shri P. K. Ghosh
Artist	:	Shri S. K. Das

and others

4.4 Administrative Section, Barrackpore (West Bengal)

Administrative Officer	:	Shri C. D. Kulkarni
Superintendent	:	Sarvashri H. N. Mukherjee and S. N. Chakraborty
P.A.-cum-Stenographer	:	Shri G. L. Lahiri
Head Clerk	:	Shri N. G. Chatterjee
Accountant	:	Sarvashri A. K. Sengupta and B. C. Datta

and others

4.5 Accounts and Audit Section, Barrackpore (West Bengal)

Accounts Officer	:	Shri B. N. Das
Assistant	:	Shri P. K. Sthanapati

and others

4.6 Stores Section, Barrackpore (West Bengal)

Superintendent	:	Shri S. K. Chatterjee
Assistant	:	Shri K. C. Roy

and others

5 Institute Based Co-ordinated Projects

5.1 Co-ordinated Project on Reservoir Fisheries

5.1.1 Main Centre, Hazaribagh (Bihar)

Senior Fishery Scientist	:	Shri A. V. Natarajan
Junior Statistician	:	Dr. K. Algaraja

and others

5.1.2 Sub-centre, Nagarjunasagar (Andhra Pradesh)

Junior Fishery Scientist	:	Shri G. K. Bhatnagar
Senior Research Assistant	:	Sarvashri V. V. Sugunan and S. R. Ghosh

and others

5.1.3 Sub-centre, Bhavanisagar (Tamil Nadu)

Junior Fishery Scientist	:	Shri Ch. Gopalakrishnayya
Senior Research Assistant	:	Sarvashri A. Mathew and B. P. Gupta

and others

5.1.4 Sub-centre, Rihand (Uttar Pradesh)

Junior Fishery Scientist	:	Shri V. R. Desai
Senior Research Assistant	:	Sarvashri M. A. Khan and R. K. Singh

and others

5.2 Co-ordinated Project on Composite Fish Culture

5.2.1 Main Centre, Barrackpore (West Bengal)

Senior Fishery Scientist : Dr. V. R. P. Sinha
Junior Fishery Scientist : Shri H. A. Khan
Senior Research Assistant : Shri D. P. Chakraborty
and others

5.2.2 Sub-centre, Barrackpore (West Bengal)

Junior Fishery Scientist : Shri M. V. Gupta
Senior Research Assistant : Shri Dharendra Kumar
and others

5.2.3 Sub-centre, Kurnool (Andhra Pradesh)

Junior Fishery Scientist : Shri R. M. Rao
Senior Research Assistant : Shri J. B. Rao
and others

5.2.4 Sub-centre, Bhavanisagar (Tamil Nadu)

Junior Fishery Scientist : Shri B. V. Govind
and others

5.2.5 Sub-centre, Jaunpur (Uttar Pradesh)

Junior Fishery Scientist : Shri K. K. Sukumaran
Senior Research Assistant : Shri P. M. Mathew
and others

5.2.6 Sub-centre, Karnal (Haryana)

Junior Fishery Scientist : Shri K. N. Krishnamurthy
Senior Research Assistant : Shri B. C. Tyagi
and others

5.2.7 Sub-centre, Poona (Maharashtra)

Junior Fishery Scientist : Dr. K. P. P. Nambiar
and others

5.3 Co-ordinated Project on Air Breathing Fish Culture

5.3.1 Main Centre, Darbhanga (Bihar)

Senior Fishery Scientist : Dr. P. V. Dehadrai
Junior Fishery Scientist : Shri N. K. Thakur
Senior Research Assistant : Shri N. K. Das
and others

5.3.2 Sub-centre, Bhadra (Mysore)

Junior Fishery Scientist : Shri S. P. Ayyar
Senior Research Assistant : Shri V. K. Murugusan
and others

5.3.3 Sub-centre, Gauhati (Assam)

Junior Fishery Scientist : Shri R. N. Pal
Senior Research Assistant : Shri D. N. Singh
and others

5.4 Co-ordinated Project on Spawn Prospecting

5.4.1 Main Centre, Allahabad (Uttar Pradesh)

Junior Fishery Scientist : Shri K. K. Ghosh
and others

5.4.2 Sub-centre, Barrackpore (West Bengal)

Junior Fishery Scientist : Shri M. R. Sinha
and others

5.4.3 Sub-centre, Gauhati (Assam)

Junior Fishery Scientist : Shri K. V. Rao
and others

5.4.4 Sub-centre, Patna (Bihar)

Junior Fishery Scientist : Shri M. Y. Kamal
and others