ANNUAL REPORT

1969

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

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

BARRACKPORE

ANNUAL REPORT

for the year

1969

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE, WEST BENGAL
INDIA

CONTENTS

ANNUAL REPORT FOR THE YEAR 1969

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

BARRACKPORE

1. DIRECTOR'S INTRODUCTION

The Central Inland Fisheries Research Institute, established in March, 1947 at Calcutta, under the Ministry of Food and Agriculture, Government of India, is since June, 1959, housed in its own buildings at Barrackpore, on the left bank of the Hooghly river, in an area covering about 5.2 ha. The Institute is under the control of the Indian Council of Agricultural Research.

The aims and objects of the Institute are to study and elucidate the scientific principles which could be applied to maximise fish production in the country from all available inland waters. Four Substations one each at Barrackpore, Cuttack, Allahabad and Hazaribagh have been established to deal with the problems of estuarine, pond culture, riverine and lacustrine fisheries respectively. For the study of the coldwater fisheries, a unit which was initially established at Kangra (Punjab) in November, 1963, was shifted to Srinagar in September, 1967.

The Estuarine Substation at Barrackpore, with its two constituent units at Kakdwip (West Bengal) and Madras (Tamil Nadu), is conducting investigations on problems of estuarine fisheries and survey of the fishery resources of the Hooghly-Matlah estuarine system. The Substation is also prospecting for brackish water fish and prawn seed in the estuaries of West Bengal. The problems of fish farming in brackish water ponds, besides the studies on the fisheries of the Pulicat lake, the Adyar estuary and the Ennore backwaters, are under investigation by this substation.

Development of suitable fish culture techniques, production of fish seed through hypophysation, efficacy and economics of the use of different types of fertilizers to increase the productivity of fish ponds, control of aquatic weeds in culture fishery waters, frog culture, etc. are the aspects which are dealt with by the Pond Culture Substation, located at Cuttack. A unit of the Pond Culture Substation at Calcutta is engaged with the work on soil and water analysis of fishery waters, pond productivity and weed control.

The Riverine Substation with its headquarters at Allahabad and three constituent units : one located on the river Godavari at Rajahmundry (Andhra Pradesh), the other on the Ganga at Bhagalpur (Bihar) and the third at Rewa (Madhya Pradesh), is concerned with carp spawn prospecting in the rivers of the country, with the problems of the development of riverine fisheries, with the investigations on riverine hilsa and the problems relating to the development of fisheries of medium sized reservoirs.

The Lacustrine Substation located at Hazaribagh is engaged in making comparative study of the fisheries of the Konar and Tilaiya reservoirs of the Damodar Valley Corporation.

The Coldwater Fisheries Research Unit at Srinagar is engaged in the investigations relating to the improvements in the techniques of trout culture.

The Sunderbans Survey Unit, with its headquarters at Kakdwip and its farms at Bakkhali, is dealing with the development of the techniques of brackish water fish farming in lower Sundarbans.

The Tank Fisheries Unit at Bangalore is engaged in the bioecological management and conservation techniques of the fisheries of the tanks in Peninsular India.

Work on fish pathology, experimental culture of fish food organisms, live fish culture and sewage fed fish culture is being conducted at Barrackpore.

The Documentation Unit at Barrackpore is concerned with supplying the scientific information as and when asked for by the fish farmers, with the editing, coordination and publication of the results of research conducted under different projects, besides maintaining the Institute's Library.

Library and Documentation : As the existing catalogue cabinet with a capacity of 20,000 cards was filled up completely, two more similar cabinets were provided during the year of report. 125 books, 313 reprints, 140 miscellaneous publications and 1,265 issues of periodicals were added to the library. The Institute subscribed 31 Indian and 42 foreign journals. It obtained, either as free gift or in exchange, 45 Indian and 136 foreign journals. The present library holdings, inclusive of the year's arrivals, comprise 2,233 books, 1,473 bound periodicals, 2,536 reprints and 1,116 miscellaneous publications excluding the stock of loose issues of journals, pamphlets, maps, departmental publications and reprints of the papers published by the staff of the Institute. Besides maintaining exchange relationship with about 160 institutions and organisations, new exchange relationship was established during the year with 30 others for exchange of publications. Quarterly accession lists for January-March and April-June and the third supplementary list of publications by the staff of the Institute were brought out and circulated.

A total of 64 technical and non-technical inquiries from India and abroad were attended to by the Documentation Unit. The institute supplied a number

of publications to Ukai Fish Farm (Gujarat), Directorate of Fisheries (Punjab), Nayagarh College at Nayagarh (Orissa), Commonwealth Institute of Biological Control (Bangalore), Indian Association of Special Libraries and Information Centres (Calcutta) and Directorate of Fisheries (Bihar) on inter-library loan basis.

During the year, 54 reports (including mimeographed reports) on progress of research were compiled and sent to Indian Council of Agricultural Research while some were also sent to the departments under mailing list. "Bibliography of Indian Fisheries" Vol. 7(4), 1968 and 8(1-3), 1969, Cumulative Index of the Bibliography for Vol. 6(1-4), 1967, Bulletins of the Central Inland Fisheries Research Institute, No. 12 and 13 entitled "Methodology on Reservoir Fisheries Investigations in India" and "Limnology and Fisheries of the Tungabhadra Reservoir" respectively and Survey Report of the Central Inland Fisheries Research Institute, No. 5 entitled "Preliminary Survey Report on the Hydrobiology and Fisheries of Nagarjunasagar, Andhra Pradesh" were compiled, edited and published. Besides the above, 156 sketches/diagrams, 73 charts/posters and 1,207 photo copies on research findings were prepared.

Distinguished visitors : The following scientists and distinguished persons visited the Institute and its various establishments :

Shri D. N. Sinha, Ex-Acting Governor of West Bengal ; Shri Provash Chandra Roy, Ex-Minister for Fisheries, West Bengal ; Shri B. Venkatappiah, Member of the Planning Commission, Government of India ; Shri M. L. Kohli, Deputy Animal Husbandry Commissioner, Indian Council of Agricultural Research ; Shri S. S. Ahmed, Secretary, Tungabhadra Board ; Dr. R. H. McConnell (nee Lowe), Representative of United Kingdom for IBP ; Dr. S. W. Ling, FAO/UNDP(TA) Regional Fish Culturist, Bangkok ; Dr. S. Jones, Ex-Director, Central Marine Fisheries Research Institute ; Dr. B. S. Bhimachar, (Ex-Director, C.I.F.R.I.), Emeritus Scientist, Central Institute of Fisheries Education, Bombay ; Dr. T. V. R. Pillay, Chief, Fish Culture Section, Inland Fishery Resources Branch, FAO, Rome ; Dr. E. Woynarovich, FAO expert (from Hungary) serving in Nepal ; Shri Y. A. Tang, FAO expert (from Taiwan) serving in Philippines ; Shri G. N. Mitra, Jt. Commissioner (Fisheries), Government of India ; Shri Alfred Sin Wai Ching, Assistant Research Officer, Hongkong ; Miss Siti Sudarmi Ruslan, Head, Sub-Division of Analyse & Evaluation, Office of the Director-General of Fisheries, Djakarta ; Shri Dedi Hidajat Jusuf, Head, Inland Fish Culture Section, Directorate of Inland Fisheries, Djakarta ; Shri Atmadja Hardjamulia, Head, Breeding Sub-Division, Inland Fisheries Research Institute, Bogor, Indonesia ; Shri Chyung Suck Cho, Fisheries Officer, Korea ; Shri Mah Seng Kun, Fisheries Officer, Kuala Lumpur ; Shri Baharin Bin Kassim, Fisheries Officer, Kuala Lampur ; Shri Tay Seng Hock, Tropical Fish Culture Research Institute, Batu Berendam, Malacca ; Shri Krishna Gopal Rajbanshi, Department of Fisheries, Nepal ; Mrs. Medina N. Delmendo, Acting Chief, Freshwater Fisheries Division, Philippines ; Shri Augusto O. Manga,

Acting Officer-in-Charge, Philippines Fisheries Commission, Manila ; Shri Apolinar A. Tolentino, Fishery Biologist, Philippines Fisheries Commission, Manila ; Shri Adolfo M. Aldana, Bureau of Vocational Education, Manila ; Shri Manu Potaros, Department of Fisheries, Bangkok ; Shri Wiang Chuapoehuk, Kasetsart University, Bangkok ; Shri Ly-Ke-Huy, Fisheries Officer, Agriculture Department, Saigon ; Dr. R. Raghu Prasad, Assistant Director-General (Fisheries), Indian Council of Agricultural Research ; Shri K. P. A. Menon, Secretary, Indian Council of Agricultural Research ; Shri Zahid Husain, Deputy Director of Fisheries, West Pakistan ; and Dr. R. V. Kilambi, Arkansas University, U.S.A.

Important events of the year : A training seminar on "Induced Breeding of Cultivated Fishes", organised by FAO/UNDP(TA), was held at Central Inland Fisheries Research Institute, Barrackpore, Central Inland Fisheries Research Substation, Cuttack, and Central Institute of Fisheries Education, Bombay, during July 15 to August 18, 1969. Twentyone participants from South East Asian countries attended the seminar and sixteen experts from India and abroad delivered lectures on different aspects of the subject matter of the seminar. Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute was nominated as the Director of the F.A.O. Seminar.

Another seminar on "The Ecology and Fisheries of Freshwater Reservoirs", sponsored by the Indian Council of Agricultural Research, New Delhi, was held at Central Inland Fisheries Research Institute, Barrackpore on the 27th, 28th and 29th November, 1969. Fiftyfour papers on various aspects of reservoir fisheries were presented and discussed in the seminar.

Of the 20 priority laid projects, work on 18 was continued. Necessary action to initiate the remaining two projects ; *viz.*, "Fish Farm Designing" (Project 10) and "Economics in Fishery Investigation" (Project 11), from 1970 onwards, was taken.

Research collaboration with Institutes, Universities, Colleges and other Institutions at national level : Seventyfive ampoules of carp pituitary extract prepared by the Institute were distributed to several State Governments and the Tungabhadra Board to carry out experiments on induced breeding of carps. An attempt to set up a pituitary bank will be made, if success is achieved in this endeavour.

Carp spawn prospecting investigations in the Banas, the Parbati (the Utangan), the Son, the Brahmaputra, the Coleroon and the Cauvery river, was carried out in collaboration with the Fisheries Departments of Rajasthan, Bihar, Assam, Tamil Nadu and Mysore states.

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

Fellowships and Studentships : During the year, Dr. V. G. Jhingran, Director of the Institute, was elected as "Fellow of National Academy of Sciences India, Allahabad" and Shri P. Ray, Assistant Fishery Scientist, as "Fellow of Institute of Chemist, Calcutta".

Research Associations : Research workers of the Institute took initiative and established "Inland Fisheries Society of India", with its Headquarters at Barrackpore.

Central Inland Fisheries Research Institute continued to have institutional membership during the year with the following Societies and Associations :—

Indian :

(1) The Asiatic Society, Calcutta.

(2) Marine Biological Association of India, Mandapam Camp, South India.

(3) Indian Association of water and water pollution control, C/o. Central Public Health Engineering Research Institute, Nagpur.

(4) Indian Science Congress Association, Calcutta.

(5) Inland Fisheries Society of India, Barrackpore.

Foreign :

(1) Societas Internationalis Limnologiae, Westmorland, England.

(2) The Fisheries Society of the British Isles, Humtingdon, England.

(3) Freshwater Biological Association, Westmorland, U.K.

Advisory services received and provided : Advice, on a wide variety of topics ; like, stocking rate and manurial doses for a fish culture pond, transportation of live fish, use of mammalian hormones in induced breeding of carps, introduction of exotic fishes in the country, collection of fish fry and fingerlings, pollution in jute retting ponds, weed control in fish cultivable waters, problems pertaining to culture fishery management and causes of failure of induced breeding experiment at Tungabhadra Dam fish farm and their remedial measures, were supplied to private individuals, private institutions or bodies and Government departments.

Information on various topics ; like, the occurrence of *gharial* and the Gangetic dolphins, availability of larvicidal fishes, list of institutes engaged in fish breeding in India, prospects of frog culture, culture of *Cyprinus carpio* on commercial scale, use of pentachlorephenol fertilizer mixture and the availability of fish seed, were provided to various individuals, private bodies and institutions.

Detailed information, incorporating data on inland water biology and hydrobiological work, data on primary productivity studies conducted at different centres by this Institute, and the reports on spawn prospecting

investigations conducted at Sosale on the Cauvery river, Mysore, North Gauhati on the river Brahmaputra, Assam, and at Dighwara, Bahiara and Tilautu on the rivers Ganga and Son, were provided to Dr. S. V. Ganapati, Department of Biochemistry, M. S. University, Baroda in connection with International Biological Programme and to the State Governments of Mysore, Assam and Bihar respectively.

Extension and any nation-building activity : Laboratory and field demonstrations and training in various aspects of fish and frog culture were given to (i) 21 participants of FAO/UNDP(TA) seminar on "Induced breeding of cultivated fishes" from 11 South East Asian countries, (ii) trainees of the Regional Training Centres for Inland Fishery Operatives, Agra and Hyderabad and those of the Central Institute of Fisheries Education, Bombay and Inland Fisheries Training Unit, Barrackpore and (iii) the students of final year M.Sc. from Ranchi University.

In order to promote composite culture and control of aquatic weeds in fish ponds by grass carp, fry of exotic carps have been supplied to various agencies as per details given below : —

To whom supplied	Quantity by number	
	Silver carp	Grass carp
1. Jute Research Institute, Barrackpore	100	100
2. C.F.O., Manipur	250	300
3. Government of Burma	2,000	2,000
4. Government of Uttar Pradesh	—	300
5. Krishna Nagar Fish Seed Farm, West Bengal	300	300

Finance : The provision of funds for the Institute for the financial year April, 1969 to March, 1970 was as under :

Non-Plan	Rs. 21,44,800
Plan	Rs. 6,83,200
Total	Rs. 28,28,000

Against the above provision the expenditure from 1.4.69 to 31.12.69 was as follows :

Non-Plan	Rs. 17,88,152
Plan	Rs. 4,03,745
Total	Rs. 21,91,897

2. Progress of Research

The Institute continued its research investigations as per programme prepared under 18 projects. Each project has several problems and sub-problems to be worked out on the basis of priority. Investigations on two problems were completed by the end of the year, while work on the remaining problems is being continued. Besides these, a few new problems are proposed to be taken up in the near future.

(a) *Research completed*

Researches on problems ; *viz.*, fisheries of the river Godavari and toxicity of four therapeutic compounds, were completed and the results obtained are as under.

Project 14 : Riverine and estuarine fish catch statistics

Problem : 14.3 Fisheries of the river Godavari

Duration : Seven years

Personnel : T. Rajyalakshmi (Mrs.), G. R. Rao, L. H. Rao, P. L. N. Rao, M. Ranadhir, T. S. Ramaraju and K. S. Rao

Investigations on the decline in fisheries of the river Godavari were concluded by the end of the year.

Studies based on catch : The total fish yield during 1969 was estimated to be 218.0 t, showing a decline of 15.4 t from that of the year 1968 and a gradual decline since 1963. Zone I between Dowleiswaram and Pattiseema yielded highest catches as in previous years followed by zones lying between Pattiseema and Jidiguppa, Jidiguppa and Dumagudem (Zones II and III) (Table 1). The small meshed gears were mostly concentrated in Zone I (Table 2). The Zone II catch, with large meshed gill nets comprised higher age/size composition.

Table 1. Species wise and zone wise landings

Species	1969								1968	
	Zone I		Zone II		Zone III		Total		Total	
	t	%	t	%	t	%	t	%	t	%
C. mrigala	3.3	2.0	8.2	29.6	0.3	1.0	11.8	5.4		
L. fimbriatus	3.1	1.9	2.7	9.7	5.0	22.2	11.7	5.4		
C. catla	1.6	1.0	1.1	3.8	0.4	1.4	3.1	1.4		
L. calbasu	0.8	0.5	3.2	11.7	1.5	5.6	5.5	2.5		
						Total	32.1	14.7	43.6	18.6

Table 1 (*Contd.*)

Species	1969								1968	
	Zone I		Zone II		Zone III		Total		Total	
	t	%	t	%	t	%	t	%	t	%
M. seenghala	3.3	2.0	2.0	7.3	1.1	4.6	6.4	2.9		
W. attu	3.6	2.2	0.3	1.0	0.3	1.0	4.2	1.9		
S. childrenii	1.0	0.6	0.4	1.5	0.2	0.6	1.6	0.7		
						Total	12.2	5.5	14.9	6.3
H. illisha	21.2	12.9	—	—	0.5	1.9	21.7	10.0	21.6	9.3
Prawns	73.3	44.8	2.5	9.0	5.2	19.7	81.0	37.1	82.6	35.3
Miscellaneous	52.4	32.0	7.4	26.6	11.2	42.1	71.0	32.6	70.7	30.3
Grand Total	163.6		27.8		26.6		218.0		233.4	

Table 2. Estimated catch (c) in t, effort (E) in thousands of man-hours and catch/man-hour (d) in kg during 1969

	Gill nets		Seine cum drag nets				Cast nets		miscellaneous gear	
	Set gill	Drift gill	*Benduvala*	*Alivivala*	*Jaruguvala*	Drag net	Big mesh	Small mesh	*Iragavala*	Miscellaneous
Zone I										
c	12.3	18.9	—	20.7	59.3	6.0	1.3	39.0	—	4.3
E	185.2	198.0	—	56.8	168.4	47.8	15.0	136.5	—	28.7
d	0.07	0.10	—	0.36	0.35	0.15	0.08	0.29	—	0.14
Zone II										
c	16.7	—	—	2.6	0.4	0.4	—	3.1	—	1.0
E	251.6	—	—	29.6	2.4	2.3	—	19.8	—	5.5
d	0.07	—	—	0.21	0.17	0.17	—	0.16	—	0.18
Zone III										
c	3.4	—	1.7	1.4	2.2	0.6	0.7	14.9	1.3	0.4
E	44.8	—	5.5	4.6	7.0	2.1	3.1	52.9	4.2	3.7
d	0.08	—	0.31	0.30	0.31	0.28	0.22	0.28	0.31	0.11

The gill net effort in Zones I and II showed further rise over that of 1968. The catch per man-hour fell from 0.19 to 0.07 kg in Zone II and from 0.08 to 0.07 kg in Zone I, indicating very low density of population. Both, effort and the catch per man-hour were less in Zone I for the *Jaruguvala*. *Alivivala* show-

ed no great variation while the *Kontevala* showed high reduction in yield and catch per man-hour despite increase in effort. In Zone III, the catches by *Benduvala* and cast nets were stable (Table 2).

The age group composition of selected species indicated further fall during 1969 as compared to earlier years in higher age groups, indicating near scarcity of these size groups in the stocks (Table 3).

Table 3. Age class distribution of catches (in t)

Species	Year								Total
	1	2	3	4	5	6	7	8	
C. mriyala	0.4	0.6	1.1	3.1	4.1	2.0	0.5	—	11.8
L. fimbriatus	1.2	2.6	4.9	2.8	0.2	—	—	—	11.7
M. seenghala	0.9	0.5	0.8	1.4	1.1	0.8	0.6	0.3	6.4
H. ilisha	0.1	0.1	1.4	18.5	1.6	—	—	—	21.7

General observations indicated the necessity of adopting drastic measures to curb the practice of removing small sized fish from the fishery. Prohibition in the use of all small meshed gill nets in the nursery areas of Zone I, restricted operation of *Alivivala* in Zone I from November to June and prohibition in the use of cast nets at both the anicuts in the same period, are indicated. The sharp fall in the catches of *L. fimbriatus* and *M. seenghala* calls for a total prohibition of *Benduvala* and *Iragavala* at Dummagudem. In order to save the spawners of hilsa, banning of *Kattuvala* is also recommended.

Rise in total set gill net effort should be arrested by imposing a suitable ceiling on the total nets and mesh size.

Biological studies : The study of food and feeding habits of major carps of the river, were conducted to find out whether any inter specific competition for food exists. The first three species mentioned below are bottom feeders while *C. catla* is a column feeder. Percentage composition of food in the guts is as shown under.

Species	Diatons	Algae	Mud & organic debris	Miscellaneous	Copepods
L. fimbriatus	29.1	17.5	49.6	3.8	—
C. mrigala	11.3	21.4	65.7	1.6	—
L. calbasu	31.4	13.5	50.9	4.2	—
C. catla	20.1	5.7	14.5	3.1	56.6

L. fimbriatus occurring in the river at Dummagudem has been found to be of two varieties as revealed by morphometric studies.

Studies on the recruitment of juveniles have revealed that the number of recruits each year, over a 8 year period in *M. seenghala* and a 6 year period in *S. childrenii,* varied round 14.5% above and 85.5% below the mean in *M. seenghala* and 3.2% above and 96.8% below the mean in *S. childrenii.* This pattern of recruitment, viewed in relation to the fecundity potential of each species, showed that the percentage survival to recruitment and from recruitment to the first maturity was very low. This low level of survival to recruitment and maturity is postulated as one of the main reasons for the fall in catfish population.

As the catfish get entangled in the fine meshes of nylon gill nets, two immediate measures have been suggested to arrest the decline. They are : (i) to put a legal size limit of capture at 20 cm and (ii) to impose a ceiling on the number of seine and drag nets and cast nets exploiting the nursery cum recruitment grounds at Rajahmundry and Dummagudem anicuts.

A total yield of 330 t in 1963 has shown a reduction to 233.4 t in 1968. The average production per hactare has thus shown a reduction from 9.36 kg (1963) to 6.60 kg (1968). The area supports an average effort of 1,038.5 thousands of man-hours by a variety of gear. A recovery in the fishery appears possible through systematic stocking of fingerlings and effective control of effort pattern. In this direction, an economic evaluation has been made of stockings at a rate of 10,000 fingerlings/year, up to 5 years in the first instance, taking into consideration such factors as cost of fingerlings, cost of transport, natural mortality, average growth/year, etc. These recommendations form a part of the report prepared on the studies conducted.

A loss in weight of the ovary of *Hilsa ilisha* was observed during the years 1968 and 1969. Comparative states of 1965 and 1969 are given below.

1965	Gonad	Wt/Body	Wt	:	Log	GW =	1.6713	+ 1.2195	log	W
1969	„	„		:		„ =	0.4419	+ 0.5484	log	W
1965	Gonad	Wt/Body	L	:	Log	GW =	−3.4713	+ 2.1076	log	L
1969	„	„		:		„ =	−2.1881	+ 1.6220	log	L

The mean weight in ovary was found to have gone down from 164 gm (1965) to 148 gm (1969).

Studies on M. malcolmsonii : Probably due to unusual rainfall and sudden fall in temperature in the months of May and June, early breeding occurred with 28.8% of females in berry in May and 53.8% in June. Early flood in June, although of small intensity, probably ensured the passage of the early larvae to estuarine region, resulting in good survival and recruitment of juveniles in November.

The prawn fishery at Dummagudem sub-area was poor during January to June.

During 10th to 13th of February, 1,020 prawns were tagged with numbered polythene tags and released at Rajahmundry. The weekly recoveries up to date were as follows.

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	16	19
Nos. recovered	17	25	16	29	21	19	34	10	7	8	3	3	3	1

The second tagging was undertaken from 8th to 9th June, when 602 prawns were tagged and released. The weekly recoveries were as under.

Weeks	1	2	3	4
Nos. recovered	54	42	13	10

The first tagging was at the commencement of the commercial fishing season, while the second tagging corresponded to the commencement of breeding season. In both instances, the recoveries occurred within 1 to 10 km of release spot.

In staining experiments by Trypan blue, 1,368 prawns were stained and released. The recoveries were as follows.

Weeks	1	2	3	4	5	6	7	8	9	10
Nos. recovered	1	3	—	2	1	—	—	1	1	1

This staining experiment also indicated localised movement of prawns. Recoveries, however, were poor as compared to 1968 studies.

In order to assess the abundance of juveniles migrating over the Dowleiswaram anicut, a sampling design was repeated since October in order to have a comparative assessment.

The relationship of this abundance to the total population biomass in the commercial fishing season in the river, from January to June and to the residual spawning population from July to September, would be assessed.

Project 15 : Fish pathology

Problem : 15.1 Etiology and control of parasitic diseases of cultured warmwater fishes

Duration : Four years

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

Associated problem : Toxicity of four therapeutic compounds

Toxicity of sodium chloride, potassium permanganate, potassium dichromate, and Acriflavin to fry of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* was tested. Bio-assays were conducted in 5 and 10 litre jars in the laboratory for the periods of 24 and 48 hours at temperatures of 26.0 and 32.0°C. LC_{50} values

of the chemicals were in the ranges of 5,500-7,500, 37.5-48.0, 92.5-125.0 and 47.5-80.0 ppm respectively. The results evolved cheap control methods against some common fish diseases. Sodium chloride and Acriflavin can be widely used for chemotherapy and potassium dichromate is preferable to potassium permanganate for prophylaxis.

(b) *Research in hand*

Research work on 18 projects was continued during the year under report. Preliminary arrangements to set up Fish Farm Designing (Project 10) and Economics in Fishery Investigations (Project 11) were made. A description of the progress made under each project during 1969 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

1.1.1 Composite culture of fry of indigenous and exotic fishes to obtain maximum production of fingerlings : Experiments on species composition and stocking rate

Duration : Six months

Personnel : M. T. Philipose, P. R. Sen, R. D. Chakrabarty, D. S. Murty, G. V. Kowtal, A. C. Nandy, D. P. Chakraborty, P. C. Chakraborti, S. B. Singh and M. M. Bagchi

Two experiments were initiated in 0.08 ha ponds. In one experiment, where the fry of Indian and exotic carps were stocked in ponds in the ratios : (i) catla 2 : rohu 4 : mrigal 4 ; (ii) silver carp 4 : grass carp 3 : common carp 3 ; and (iii) catla 3 : rohu 3 : mrigal 2.5 : grass carp 1.5, with two replications for each set, but with different stocking densities of 75,000 and 1,00,000/ha in the replications of each set, the percentage survival, final size attained and production per hectare at the end of six months ranged between 74.4-97.8, 134.7-172.0 mm/25.1-47.4 gm and 1,682-3,192.75 kg respectively. In the second experiment the fry were stocked in the ratio of (i) silver carp 4 : grass carp 3 : common carp 3 @ 1,00,000 and 2,25,000/ha and (ii) catla 2 : rohu 4 : mrigal 4 @ 1,00,000 and 2,13,000/ha (due to non-availability of catla). Owing to heavy rains and floods, two ponds were reset to raise large fish, using the stocking density of 3,000/ha and the species ratio of silver carp 1.5 : catla 1.5 : rohu 3 : grass carp 1 : mrigal 1.5 : common carp 1.5 : miscellaneous fish (*C. reba*) 0.5. The experiment is continuing.

1.1.2 Composite culture of fingerlings of indigenous and exotic species to obtain maximum production of large fish in a single harvest : Experiment on species composition

Duration : One year

Personnel : M.T. Philipose, R. D. Chakrabarty, D. S. Murty, G. V. Kowtal, A. C. Nandy, D. P. Chakraborty, S. B. Singh, P. C. Chakraborti, M. M. Bagchi and P. R. Sen

Composite culture of fingerlings to raise large fish, using catla 3 : rohu 3 : grass carp 1 : mrigal 3 @ 5,000/ha, was initiated in two 0.15 ha ponds in August, 1968 and wound up at the end of six months. The average gross and net productions of fish were 1,724 and 1,254 kg/ha/6 months respectively. In the second set of two 0.12 ha ponds, with silver carp 3 : rohu 3 : grass carp 1 : common carp 3 @ 5,000/ha, the average gross and net productions were 2,080 and 1,772 kg/ha/6 months respectively. In the third combination of silver carp 1.5 : catla 1.5 : rohu 3 : grass carp 1 : mrigal 1.5 : common carp 1.5 : miscellaneous fish 0.5 in two ponds (0.133 and 0.4 ha), both stocked @ 5,000/ha, the average gross and net productions were 1,690 and 1,270 kg/ha/6 months respectively. In the seventh pond of 0.6 ha with the species combination as the last one @ 4,300/ha, but with additional 100 small frogs (*Rana hexadactyla*), the gross and net productions were 1,157 and 857 kg fish/ha/6 months. No frogs could be recovered. An experiment of one year duration, using combinations : (i) catla 3 : rohu 3 : grass carp 1 : mrigal 3 ; (ii) silver carp 3 : rohu 3 : grass carp 1 : common carp 3 and (iii) silver carp 1.5 : catla 1.5 : rohu 3 : grass carp 1 : mrigal 1.5 : common carp 1.5 : miscellaneous fishes 0.5 ; each @ 5,000/ha and with two replications ; was started in six ponds in April, 1969. Six ponds, belonging to the Orissa University of Agriculture and Technology, were taken over in September, 1969, and fingerlings of nine species of Indian and exotic fish were stocked in different combinations with two replications for each at 5,000/ha. Harvesting at the end of one, two or more years will be done.

1.1.3 Composite culture of fingerlings of Indian and exotic species to raise large fish by continuous harvesting

Duration : Two years

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

Composite culture in a pond stocked with seven species ; *viz.*, catla, rohu, grass carp, mrigal, silver carp, common carp and miscellaneous fishes to be harvested at marketable size and simultaneously replenished by fingerlings, is in progress.

Problem : 1.2 Conversion ratio of selected carp feed into fish flesh

Duration : Two years

Personnel : M. T. Philipose, R. D. Chakrabarty, P. R. Sen, G. V. Kowtal, D. S. Murty and D. K. Chatterjee

To determine the conversion ratios of natural and artificial fish food, preliminary experiments (each of 15 days' duration) were initiated in glass jars with catla, rohu and mrigal spawn, and in plastic pools with rohu, common carp and mrigal fry ; the food used being zooplankters, finely powdered mustard oilcake plus rice bran and silkworm pupae. *Moina* sp., *Cyclops* sp. and nauplii were the main constituents of zooplankters. Quantity of feed left over and faecal matter in the containers were weighed to determine the amount of food utilized.

Mortality was 97-100% among catla and mrigal spawn with mustard oilcake + rice bran or silkworm pupae as food ; whereas, with zooplankters the average percentage survival was 100 in rohu, 75 in mrigal and 80 in catla. Rohu gave a percentage survival of 52 with mustard oilcake + rice bran and 80 with silkworm pupae.

With fry, the survival percentages were : 100, 98 and 94 in rohu, 60, 98 and 95 in mrigal and 77, 88 and 85 in common carp with mustard oilcake + rice bran, silkworm pupae and zooplankters respectively. Corresponding average percentage increases in weight were : 28.7, 67.5 and 50 in mrigal and 16.8, 30.7 and 13.6 in common carp. With rohu, the increase was : 9.4 and 14.5% with silkworm pupae and zooplankters respectively. Pools in which mahua oilcake + rice bran was used, developed a dense algal bloom which interfered with the observations.

Problem : 1.3 Use of growth promoting substances
Duration : Two years
Personnel : A. David and P. R. Sen

In continuation of previous experiments in which starch, yeast and cobalt chloride proved promising in enhancing the survival and growth of fry and fingerlings, three other substances ; namely, selenium, molybdenum and boron, were screened in the laboratory on rohu fry @ 0.05, 0.5 and 1.0 mg/day/fish along with the regular feed. Boron @ 1.0 mg/day/fish gave the best growth increment and survival percentage of 7.55 mm/0.026 gm and 73.3 respectively in 15 days, followed by molybdenum @ 0.05 mg/day/fish (6.93 mm/0.022 gm and 48) and boron @ 0.5 mg/day/fish (7.79 mm/0.028 gm and 44.7) as against 6.68 mm/0.017 gm and 32.7 in the control. Selenium did not prove satisfactory.

A field trial with yeast, starch and cobalt chloride proved inconclusive. In an experiment in four 0.04 ha ponds, each stocked with fingerlings of catla, rohu and mrigal in the ratio 1 : 1 : 1 and @ 6,000/ha up to the end of December, 1969, catla has shown the maximum increment of 71.15 mm/108 gm with starch ; but rohu, 72.71 mm/72.63 gm with boron and mrigal, 81.05 mm/56.42 gm also with boron as against 58.89 mm/74.50 gm, 60.39 mm/50.63 gm and 70.48 mm/52.85 gm in catla, rohu and mrigal respectively in the control.

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

1.4.1 To select the right type of inorganic nitrogenous fertilizers in the preparation of nursery ponds for higher production of fish food organisms so as to achieve higher survival percentage and growth of spawn

Duration : Two years

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

In statistically designed laboratory experiments, nitrogenous fertilizers ; *viz.*, urea, calcium ammonium nitrate and ammonium sulphate, each applied at three rates of 20, 50 and 80 kg N/ha on moderately acid soil (pH 4.8) rich in organic matter (3.8%), gave high primary productivity of 0.68-1.16 mg C/l/day as compared to 0.45 mg C/l/day in control.

The higher rate of the three fertilizers was tried on the above soil as on neutral soil (pH 6.8) in plastic pools. Among the treatments, urea gave maximum survival and growth of rohu hatchlings (66%, 13.57 mm/20.67 mg) in neutral soil, and ammonium sulphate (51%, 12.77 mm/16.87 mg) and calcium ammonium nitrate (48%, 15.0 mm/39.16 mg) gave almost identical survival in moderately acid soil as compared to (29%, 10.3 mm/8.13 mg) and (31% 13.55 mm/15.75 mg) respectively in control.

Problem : 1.5 Fixation of nitrogen by blue-green algae in pond soils

Duration : Two years

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

In laboratory, moderately acid soil (pH 5.0) rich in organic matter in both sterilised and partially sterilised conditions when inoculated with *Anabaena* sp., showed an increase of total nitrogen in conical flasks—unsterilised 12-80 mg N and sterilised 6-21 mg N/100 gm soil. The treatment with P + Ca + Mo gave maximum increase of nitrogen. Although the increase of nitrogen was not consistent with the treatments in 10 l jars inoculated with *Anabaena* sp. and stocked with rohu hatchlings (5/jar), the survival and growth of fry were much better with the treatment with sterilised soil + P + Ca + Mo + algae (90% and 10.45 mm) as against unsterilised soil + P + Ca + Mo + algae (40% and 9.35 mm).

Problem : 1.6 Crude culture of fish food organisms

Duration : Two years

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

Experiments conducted in cement cisterns confirmed earlier results of glass

jar experiments ; *i.e.,* fairly sustained growth of the diatoms : *Nitzschia* sp. and *Navicula* sp. could be obtained with ammonium sulphate—bone meal—potassium nitrate: 5-15-3 at 230 ppm. Further jar experiments with ammonium sulphate/urea—double superphosphate—potassium nitrate : 75-15-3 at 230 ppm indicated that *Chlamydomonas* sp. could be grown in large numbers.

In cistern experiments, mahua oilcake at 600 ppm plus urea at 300 ppm gave good growth of rotifers ; whereas poultry droppings plus urea, each at 300 ppm, encouraged the growth of cladocerans and copepods. In jar experiments, using mahua oilcake and cow-dung/calcium ammonium nitrate, bone meal and cow-dung/calcium ammonium nitrate, the growth of zooplankters ; mostly, Ostracoda, Cladocera and Copepoda, was obtained.

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

Duration : Three years

Personnel : C. S. Singh and K. K. Bhanot (Mrs.)

Preparatory cultures of *Chlorella* sp., *Nitzschia* sp., *Navicula* sp., *Gompho nema* sp., *Selenastrum* sp. and *Closterium* sp. were done on agar plates in Chu-10, Bristol's solution with 0.1% urea, Desmid agar and soil extract solutions under a controlled temperature of 25°C ± 1 and 100, 200 and 500 lux illumination.

Stock cultures of *Chlorella* sp., *Navicula* sp. and *Gomphonema* sp. were achieved in Bristol's solution with 0.1% urea and Chu-10 solution. Sub-cultures of the aforesaid plankters were regularly done to maintain their stock.

Effect of light on the growth of *Gomphonema parvulum* (Kütz) Grun in Chu-10 solution under constant temperature of 25°C ± 1, and 100, 200, 500 and 3,000 lux light intensities, was studied. Light was found to play a vital role in the mass culture of *Gomphonema parvulum,* as an increase in the light intensity from 500 to 3,000 lux resulted in a threefold increase in cell counts.

Six media ; *viz.,* glucose 0.5%, yeast 0.04%, hot and cold paddy straw extracts, cotton seed extract 0.1%, and Bristol's solution with *Chlorella* sp., were tried to culture zooplankters. Five fully mature *Cyclops* sp. were introduced in 100 cc of each medium, and kept at a temperature of 25°C ± 1 and under 250 lux illumination. After 21 days' experiment, the survival was : 0 in glucose, 4 in yeast, 2 each in hot and cold paddy straw extracts, 2 in cotton seed extract and 1 in Bristol's solution. The eggs did not survive in these media.

Problem : 1.8 Algae in relation to fish nutrition

Duration : Three years

Personnel : C. S. Singh and K. K. Bhanot (Mrs.)

Four types of feed were prepared with the basic ingredients : filamentous algae (*Zygnema sphaericum, Sirogonium sticticum* and *Mougeotia gotlandica*) and fish meal ; mixed with other items in the proportion : algae powder or fish meal 40 gm, potato starch 57 gm, Terramycin 1.5 gm, yeast 1 gm and salt 0.5 gm.

An experiment with replication was set up to feed fingerlings of *Cyprinus carpio* var. *communis* to test the nutritive value of the algal feed against the fish meal feed and plankton, serving as controls. Five fishes were kept in each jar. They were daily fed between 10.00 to 17.00 hours, after which they were transferred to excretory jars provided with nylon screens. Length and weight of each fish were taken initially and then, after every 10 days interval during the experimental period. Chemical analyses for protein, fat, ash and carbohydrate of algae powders, fish meal, feeds, resultant faeces and fishes in the initial and final stages of the experiment, gave the following results (Table 4).

It was found that mean body weight of fishes showed an increase of 0.123 gm when fed with *Zygnema* feed, 0.093 gm with *Sirogonium* feed, 0.246 gm with *Mougeotia* feed, 0.157 gm with fish meal feed and 0.25 gm with plankton as control feed during 40 days' experiment. Growth attained by fishes with *Mougeotia* feed (0.246 gm) is easily comparable to the growth achieved with plankton (0.25 gm) as food. So, thick growth of *Mougeotia* sp. in ponds can be utilised to feed the fish.

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

Soils from two highly unproductive fish ponds, one from Lingipur (Orissa) and the other from Lembuchara (Tripura), were selected for the study. Experiments were conducted in plastic cisterns with these soils as substratum and with 6 replicates for each soil. The ratio of soil and water in cisterns was 1 : 20. After the establishment of a measurable quantity of phytoplankton in these cisterns by repeated seeding, three cisterns from each set were fertilised with the inorganic fertiliser combination N_{80} P_{40}, using ammonium sulphate (20% N) and superphosphate (16% P_2O_5) as fertilising materials. The total dose, (80 kg N + 40 kg P_2O_5) per hectare, was applied in four divided doses at an interval of three months. Both the soil types showed a marked response to this fertiliser combination, as measured by primary production. Dissolved nitrogen and phosphorus both showed increase in treated cisterns, though gradually decreasing in concentration, but remained relatively higher than those in untreated ones. The NH_4 form of nitrogen underwent gradual oxidation to NO_3 form. The removal of nitrogen by denitrification from water

Table 4. Chemical Analyses (%).

Chemical constituents analysed	Fish						Feed and Resultant faeces								Basic Ingredients			
	Initial	Final					*Zygnema*		*Sirogonium*		*Mougeotia*		Fish Meal					
		With *Zygnema* feed	With *Sirogonium* feed	With *Mougeotia* feed	Fish meal feed	Plankton Controlfeed	Feed	Faeces	Feed	Faeces	Feed	Faeces	Feed	Faeces	*Zygnema*	*Sirogonium*	*Mougeotia*	Fish meal
Moisture	77.3	77.3	77.6	77.1	77.4	77.5	—	—	—	—	—	—	—	—	6.1	10.3	4.5	10.8
Protein	9.67	11.17	10.98	12.68	11.25	12.67	9.38	3.5	10.93	3.5	12.37	3.87	15.32	7.38	8.68	7.4	9.5	13.13
Fat	0.94	1.09	1.1	1.43	1.29	1.53	2.3	0.3	2.4	0.2	2.5	0.1	1.3	0.31	2.48	2.9	2.59	1.8
Carbohydrate	3.33	3.57	3.57	3.67	3.58	3.68	71.1	63.5	75.87	62.7	64.4	62.5	65.1	63.0	44.96	58.57	40.90	40.07
Ash	8.76	6.87	6.75	5.22	6.48	4.62	17.2	32.7	11.6	33.58	20.13	33.53	18.3	29.31	37.78	20.83	42.51	35.2

appeared to be more rapid than the removal of phosphorus by fixation to soil. The results of the experiment are given in table 5.

Table 5

Farms	Condition	Primary productivity ($mgC/m^3/hr$)	Dissolved nitrogen : ($NH_3 + NO_3$) (ppm)	Dissolved phosphorus : (PO_4) (ppm)
Lingipur (Orissa)	Fertilised	286.1	0.51	0.79
	Unfertilised	74.3	0.03	0.06
Lembuchara (Tripura)	Fertilised	311.8	0.49	0.84
	Unfertilised	84.1	0.04	0.05

Problem : 1.10 Factors responsible for low and high productivities of fish ponds in acid soils of Tripura (India)

Duration : Three years

Personnel : S. M. Banerjea, S. R. Ghosh, N. C. Ghosh* and M. Bhattacharja* (* Representative of Tripura Fisheries)

To elucidate the factors responsible for low and high productivities of fish ponds, a field experiment was taken up in two fish farms, one highly productive and one quite unproductive, in acid soil zones of Tripura. Three morphometrically identical ponds were selected from each farm and were completely dewatered. A 10 cm layer of bottom soil was removed and then the ponds were refilled with the water they had originally. After allowing sufficient time for the establishment of soil-water nutrient equilibrium, the ponds were stocked with advanced fingerlings of the same stock and breed, in the ratio of catla, rohu and mrigal as 1 : 1 : 1 and @ 5,000 fingerlings/ha. Periodic observations were continued for one complete year on chemical quality of water, soil condition, plankton, primary production and growth rate of fish.

Average production of fish, primary production, soluble organic content and different forms of soluble nutrients for twelve months ending December, '69 are given in table 6.

Table 6

Farms	Fish production (kg/ha/an)	Primary production (mg C/m³/hr)	Organic content (ppm)	NH_3—N (ppm)	NO_3—N (ppm)	Organic—N (ppm)	Inorganic—P (ppm)	Organic—P (ppm)
Rajdharnagar, Tripura (Productive)	2,895.0	232.7	12.0	0.171	0.068	0.791	0.19	0.35
College Tilla, Tripura (Unproductive)	384.0	77.8	3.7	0.031	0.310	0.136	0.03	0.03

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

Duration : Two years

Personnel : P. Ray and S. C. Banerjee

Experiments conducted with highly percolative pond soil, showed that leaching with sodium chloride solutions was quite effective in reducing the seepage rate. It has been observed that dilute common salt solution 0.1-1.0% is more effective than the concentrated solution 1.0-3.0%. Further experiments with salt solutions 0.4, 0.5 and 0.6% indicated that, after repeated leaching, the seepage rate was minimum with 0.6% salt solution.

Another experiment was done in 3 set-ups : (i) initial leaching with 0.01% NaOH solution and subsequent leaching with 0.6% NaCl solution, (ii) leaching with 0.6% NaCl solution alone and (iii) leaching with 0.01% NaOH solution containing varying concentrations 0.4 to 0.6% of NaCl. Summarised results are as shown in table 7.

Table 7. Percolation rate (cm/hr) after leaching with NaOH and NaCl solutions.

Control	0.01% NaOH sol. initially and 0.6% NaCl sol. subsequently	0.6% NaCl sol. alone	0.01% NaOH solution together with		
			0.6% NaCl sol.	0.4% NaCl sol.	0.2% NaCl sol.
16.00	0.64	0.62	0.40	0.62	0.59

Problem : 1.12 Evaluation of indigenous plants as fish poisons

Duration : Two years

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

In a field experiment (in a small nursery pond of 0.05 ha/0.65 m depth), the seed powder of *Barringtonia acutangula* at 20 ppm killed a wide variety of fishes, including murrel, catfish, tilapia and carp, within two hours, thereby confirming the results obtained in glass jars in which tilapia alone was used as the test fish. In another experiment using the bark powder of *Walsura piscidia* at 10 ppm, tilapia and murrel were killed in two hours. The study will be continued.

Problem : 1.13 Estimation of fish population in ponds by capture recapture method

Duration : Three years

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

To carry out an experiment, fishes marked by clipping the anal fins were released in Killa Farm Pond 1 (0.4 ha), having an unknown fish population. Recovery samples were taken after three days. The number of marked fishes were : rohu 17, mrigal 27 and tilapia 78. On the basis of recovery samples, the estimated population which was found to be within 10% error of the total enumeration was 340, 153 and 600 for rohu, mrigal and tilapia respectively. The percentage of marked fish in the total population was : 5, 15 and 13 for rohu, mrigal and tilapia respectively.

Problem : 1.14 Qualitative segregation of fish seed

Duration : Two years

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

Reactions of 2-15 days' old spawn/fry to colour and odour were studied in glass jars and plastic pools.

For reaction to colour, a special cylindrical electric device, when kept immersed in the middle of the pool, permitted simultaneous passage of red, blue, green and yellow shades of light through equidistant slits. Electric bulbs of different wattage ; *viz.*, 25, 40, 100 and 200, were used to change the intensity of colouration. The spawn did not show any marked response to these colours, but 12-15 days' old fry of all the three species appeared to be attracted by yellow colour.

In an experiment conducted to study the reaction of spawn and fry to odour, no marked responses could be detected. The items used were : powdered mustard seed, menthi and silkworm pupae.

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

(No progress during the period under report)

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

Duration : Two years

Personnel : R. D. Chakrabarty

To study the validity of some of the methods of age determination, the hard parts : otoliths, scales, opercular bones and vertebrae, were collected from five fish every month to assess their usefulness as age indicators.

Project 2 : Induced fish breeding

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

Duration : Three years

Personnel : G. C. Panicker, R. M. Bhowmick and M. M. Bagchi

In continuation to the previous experiments in which gonadial development was induced by weekly injections of pituitary extract and HCG, 20 immature rohu (average weight 730 gm) were given 13 weekly injection of pituitary and eleven injections of HCG at 6 and 0.5 mg/kg respectively from the 18th February. Injections were discontinued on the 10th May. The fishes were kept under observation. In the middle of June, the fishes were injected with pituitary extract at 12-15 mg/kg body weight. Although the treated ones spawned completely, the development of eggs was adversely affected due to unfavourable weather and water conditions. However, a few hatchlings survived and developed normally in the laboratory.

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

Duration : Two years

Personnel : H. Chaudhuri and R. M. Bhowmick

During September, two sets of rohu and one set of catla treated with pituitary extract + Synahorin gave negative results probably due to gonadial resorption of the recipients both in treated and control.

Incidental to the experiments and demonstrations to the participants of the FAO/UNDP (T.A.) seminar, a total of 31.35 lakhs of spawn was produced of which 23.82 lakhs was handed over to the Orissa Fisheries Department.

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

Duration : Three years

Personnel : K. H. Ibrahim and R. M. Bhowmick

Extract of 6,000 mg of carp pituitary was prepared in distilled water/glycerine and ampouled in 124 ampoules at the rate of 40 mg/ml. 4 ampoules were tested after one month and found effective. 75 ampoules were distributed to 10 State Governments and 4 other induced breeding centres, as a preliminary step towards the establishment of a pituitary bank. Successful results were reported by the Tungabhadra Board (Mysore) and the Department of Fisheries (Andhra Pradesh).

Carp pituitary glands, preserved in acetone for 24 hours, dried at room temperature and kept in the refrigerator for six months, were found effective in inducing spawning in rohu.

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

Duration : Two years

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

Experiments in hatching jars showed successful hatching of major carp eggs, but hatchlings died after two days in the cistern where they were transferred from the hatching jars.

Problem : 2.5 Effect of inbreeding on the growth, maturity and viability of major carps

Duration : Two years

Personnel : M. A. V. Lakshmanan and R. M. Bhowmick

To know the effect of inbreeding, the riverine fingerlings in one part and the induced bred fingerlings in another part of each of the two partitioned ponds, were stocked in November, '69. Observations on survival and growth are in progress.

Project 3: Reservoir fisheries

Problem : 3.1 Fisheries of the Tilaiya and Konar reservoirs—I. Physico-chemical characteristics of water, soil and primary productivity

Duration : 3 years and 8 months

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

In the Konar and Tilaiya reservoirs, hydrographical observations were taken up during the year. The pooled averages of various parameters are presented in table 8.

Table 8. Pooled averages of various hydrological observations for surface water in the Tilaiya and Konar reservoirs.

	pH	DO (ppm)	Free CO_2 (ppm)	Total alkalinity (ppm)	Phosphates (ppm)	Nitrates (ppm)	Silica (ppm)	Ferric iron (ppm)	Air temp. (°C)	Water temp. (°C)	Transparency (cm)
Konar reservoir	7.66	8.41	3.82	34.58	0.009	0.071	4.9	0.048	21.36	23.45	12.42
Tilaiya reservoir	8.06	8.40	2.80	53.20	0.019	0.063	5.5	0.029	23.70	23.65	42.85

Observations on the vertical series of sampling in the two reservoirs are being continued.

Mean primary productivity for the Konar reservoir was 333.2 mg C/m^3/day (April-December) and the range of primary productivity was 215.6-513.0 mg C/m^3/day (May-July).

Problem : 3.2 Fisheries of the Tilaiya and Konar reservoirs—II. Food resources—A. Plankton B. Bottom biota and C. Larger aquatic plants and associated fauna and flora

Duration : 3 years and 8 months

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

The Konar reservoir

A. Plankton : Plankton studies in the Konar reservoir showed that the dominance of phytoplankton over zooplankton during January to June, '69 was 2.1 : 1.0, while it was reverse in the later half of the year with a dominance of zooplankton (1.4 : 1.0). During the first half of the year, the dominant group of phytoplankton was Myxophyceae (*Microcystis* sp.) and of zooplankton was Copepoda (larval *Diaptomus* sp. and *Cyclops* sp.). In the later half, the dominant groups were Rotifera (*Keratella* sp., *Brachionus* sp., *Polyarthra* sp. and *Filinia* sp.) among zooplankton and Chlorophyceae (*Botryococcus* sp., *Oedogonium* sp. and *Spirogyra* sp. mainly) among phytoplankton.

At the Konar reservoir, plankton concentrations in the vertical distribution from surface to 6 m depth, were 30 times and 75 times richer than those at 21-27 m depth in summer and pre-monsoon months, monsoon and post-monsoon months, respectively.

The average number of plankters was 40,000/m^3, and 51,000/m^3, and the average volume of plankton was 5.4 cc/m^3 and 4.4 cc/m^3 in summer and pre-monsoon months, monsoon and post-monsoon months, respectively.

B. Bottom macrofauna : The bottom macrofauna mainly comprised *Chaoborus* sp. in all the zones, followed by chironomid larvae, dragonfly nymphs and aquatic Oligocheta, the average number and weight being 1,293/sq m and 4.3 gm/sq m respectively.

The Tilaiya reservoir

A. Plankton : The plankton studies in the Tilaiya reservoir showed a general dominance of zooplankton over phytoplankton (1.8: 1.0). The dominant zooplankters were copepods (larval *Diaptomus* and *Cyclops*) next to which were Protozoa (*Difflugia*) and Rotifera (*Keratella, Brachionus* and *Polyarthra*). The phytoplankters, in order of dominance were : Myxophyceae (*Microcystis*) ; Chlorophyceae (*Botryococcus, Oedogonium, Spirogyra* and *Mougeotia*) ; and Diatomaceae (*Synedra, Fragilaria* and *Navicula*).

Problem : 3.3 Fisheries of the Tilaiya and Konar reservoirs—III. Utilisation of available food resources by fishes based on studies of gut analyses of fishes
Duration : 3 years and 8 months
Personnel : A. V. Natarajan and M. Ramakrishnaiya

The dominant food items in the guts of major carps from the Konar reservoir were examined. Catla was found to feed on plankton (copepods, rotifers and *Microcystis* sp.) throughout the year and decayed organic matter during monsoon months. Throughout the year, algae (Myxophyceae, Chlorophyceae and Bacillariophyceae) for rohu and decayed organic matter and algae (Myxophyceae and Bacillariophyceae) for mrigal formed the food items.

Owing to their being in advanced stages of maturity, feeding intensity in these species was observed to be low during May and June. The feeding pattern of *Cirrhinus mrigala, Labeo calbasu* and *L. rohita* was found to be more or less similar in both the Tilaiya and Konar reservoirs.

Puntius sarana, Liza corsula, Labeo boggut and *Cirrhinus reba* were found to subsist mainly on decaying organic matter of plant origin, while *Wallago attu, Mystus seenghala, M. cavacious* and *Channa gachua* were piscivorous. *Notopterus* was observed to feed on weed fishes and aquatic insects. *Esomus danricus, Amblypharyngodon mola, Osteobrama cotio, Barilius barna Ambassis nama* and *Glossogobius giuris* fed on zoo- and phytoplankton, and organic detritus to the disadvantage of major carps.

Problem : 3.4 Fisheries of the Tilaiya and Konar reservoirs—IV. Effect of impoundment on reproduction and survival of fishes

Duration : 3 years and 8 months

Personnel : A. V. Natarajan and S. Parameswaran

Pre-recruitment studies were conducted during 1969 fish breeding season at Hurlung and Bindi in the seasonal rivers Konar and Kakiya respectively.

A total of 23,942 eggs were collected from Hurlung centre by operating shooting nets for 944 hours. The yield of eggs ranged from 0.4 to 252/net hour. The average number of eggs per net hour for the days of spawn occurrence and the whole season was 41 and 25 of which major carps comprised 1 and 0.34 respectively. The percentage composition of the various species was as follows : *Cirrhinus reba,* 85.29 ; *Labeo bata,* 7.53 ; *Oxygaster* sp., 5.82 ; and *Labeo calbasu,* 1.36.

At Bindi centre in the mountaneous catchement area, only short and sharp floods (water level fluctuating from 2 to 100 cm), extending for one to six hours, occur when there were heavy rains in the catchment basin. The current velocity was very high (3.6 to 7.2 km/hr). Soon after the floods, the water course shrank to less than 1 m in breadth and 10 cm in depth, making it impossible for fishes to migrate and spawn.

The river Konar is the only source of fish seed for the reservoir. Among major carps, only *L. calbasu* spawned to a limited extent besides the uneconomic species.

Khadijal collection revealed *Ambassis nama* to be the most dominant among the smaller fishes in the Konar reservoir. Carp fry and juveniles occasionally encountered, were mostly those of *C. reba* and *L. bata* and rarely of *L. boggut* and *L. calbasu.*

Problem : 3.5 Fisheries of the Tilaiya and Konar reservoirs—V. Fisheries biology and population dynamics of commercial fisheries

Duration : Three years and 8 months

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

The estimated fish productions in the Konar and Tilaiya reservoirs during the year, were 2.79 and 13.398 t of which *C. mirgala* formed 35.84 and 34.96, *L. calbasu* 26.75 and 6.82, *C. catla* 21.96 and 11.82, *L. rohita* 4.97 and 4.41, others 10.48 and 41.98% respectively. Size ranges and modal lengths of *C. mrigala, L. calbasu, C. catla* and *L. rohita* were 310-650 and 450, 232-502 and 382, 287-987 and 512/912, 349-669 mm and 449/569 mm in the Konar reservoir ; and 129-629 and 209/469, 112-532 and 217/352/472, 237-862 and 312/662, 169-

489 mm and 389 mm in the Tilaiya reservoir respectively. In the Konar reservoir, the average size and weight in respect of *C. mrigala, L. calbasu, C. catla* were 457 and 860, 624 and 3,230, 476 mm and 1,200 gm respectively.

Fish in the IV, V and VI stages of maturity were found mostly during April-June. The fecundity of fish in the Konar and Tilaiya reservoirs is presented in table 9.

Table 9

Species	Konar reservoir		Tilaiya reservoir	
	Size range (mm)	Fecundity (Ova in million)	Size range (mm)	Fecundity (Ova in million)
C. mrigala	487—587	0.13—0.14	457—731	0.10—0.17
L. calbasu	364—420	0.15—0.30	400—410	0.10—0.11
C. catla	956	2.30	700—723	1.02—1.09
L. rohita	—	—	576	0.28

4,751 fingerlings of catla were clipped and released in the Tilaiya reservoir in 1968. After a year, in 1969, recovery of clipped specimens indicated a rate of growth between 14.5-16.5 mm/month. 918 fingerlings of major carps have been tagged and released in the Tilaiya reservoir during the year.

Problem : 3.6 Fisheries of the Tilaiya and Konar reservoirs—VI. Fishery management and development in reservoirs

Duration : 3 years and 8 months

Personnel : A. V. Natarajan

Studies on the optimum size at the entry of fisheries into exploitable phase and the optimum rate of exploitation, are in progress. In the Konar reservoir, the average size of *C. mrigala* in the catch was 457 mm and this occurred dominantly in mesh bar 50 mm. The average size : 371 mm in mesh bar 50 mm in *L. calbasu,* 624 mm in the mesh bar 105 mm in *C. catla* and 476 mm in the mesh bar 50 mm in *L. rohita ;* was encountered. In the Tilaiya reservoir, the average size of mrigal in the catch was 464 mm occurring in mesh bar 60 mm. The average size: 375 mm in mesh bar 50 mm in *L. rohita,* 395 mm in the mesh bar 50 mm in *L. calbasu* and 619 mm in mesh bar 105 mm in *C. catla ;* was encountered.

Problem : 3.7 Fisheries of the Loni reservoir

Duration : Five years

Personnel : H. P. C. Shetty, D. V. Pahwa, S. Jena, S. N. Mehrotra, M. Sinha, S. D. Gupta, B. Singh, A. G. Jhingran, R. Chandra, A. G. Godbole, S. C. Pathak, K. P. Srivastava, V. R. Desai and R. K. Saxena

Experimental fishing : Gill nets with varying mesh sizes (4, 5.5, 6, 7.5, 9.5, 10 and 15 cm) and either with floats and sinkers or with floats only, were operated for 12 hours period every fortnight. 204.35 kg of fish was harvested (tables 10 & 11) from all zones covered by gill nets during the year under report as against 333.88 kg of fish harvested during the year 1968. The maximum catch of 27.28 kg was recorded during July followed by 24.90 kg in February and 22.05 kg in June. The minimum catch, being 2.68 kg, was recorded in November. Gill nets without sinkers but with floats only, were observed to be more effective, as a total of 19.66 kg in Zone I, 67.04 kg in Zone II, 70.73 kg in Zone III and 10.20 kg in Zone IV was caught by these nets against 15.55 kg in Zone II, 17.60 kg in Zone III and 3.57 kg in Zone IV with nets provided with both floats and sinkers. The night catches were invariably better than the day catches.

Table 10. Zone wise total gill net catch (in kg) from the Loni reservoir

Months	Zone I		Zone II		Zone III		Zone IV		Total
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	
January	—	—	4.455	—	—	14.918	—	0.579	19.952
February	—	—	4.620	1.012	—	19.267	—	—	24.899
March	—	—	—	4.396	1.272	8.519	—	—	14.187
April	—	—	1.551	13.876	—	10.472	—	—	25.899
May	—	—	3.387	18.455	3.230	1.873	—	—	26.945
June	—	—	1.539	5.176	4.480	10.856	—	—	22.051
July	—	7.879	—	8.610	3.811	—	2.630	4.367	27.297
August	—	2.382	—	8.733	3.460	1.549	0.940	—	17.064
September	—	2.337	—	—	—	3.247	—	—	5.611
October	—	2.205	—	2.490	—	—	—	—	4.695
November	—	—	—	2.675	—	—	—	—	2.675
December	—	4.856	—	1.615	1.345	—	—	5.255	13.071
Total	—	19.659	15.552	67.038	17.598	70.728	3.570	10.201	204.346

Table 11. Catch (in kg) with different gear

Months	Gill nets				Total	Hooks and lines
	Zone I	Zone II	Zone III	Zone IV		
January	—	4.455	14.918	0.579	19.952	0.227
February	—	5.632	19.267	—	24.899	—
March	—	4.396	9.791	—	14.187	—
April	—	15.427	10.472	—	25.899	—

Table 11—(*Continued*).

Months	Gill nets					Hooks and lines
	Zone I	Zone II	Zone III	Zone IV		
May	—	21.842	5.103	—	26.945	0.265
June	—	6.715	15.336	—	22.051	0.068
July	7.879	8.610	3.811	6.997	27.297	1.435
August	2.382	8.733	5.009	0.940	17.064	—
September	2.337	—	3.274	—	5.611	—
October	2.205	2.490	—	—	4.695	—
November	—	2.675	—	—	2.675	—
December	4.856	1.615	1.345	5.255	13.071	—
Total	19.659	82,590	88.326	13.771	204.346	1.995

During the year, the following species in order of abundance by weight were caught by gill nets as in table 12.

TABLE 12

Species	Weight	
	(kg)	(%)
M. seenghala	102.268	50.2
C. mrigala	45.490	22.2
P. sarana	16.006	7.9
L. calbasu	12.266	6.0
L. bata	10.273	5.0
L. rohita	7.105	3.4
L. gonius	5.614	2.8
N. notopterus	2.121	1.0
L. fimbriatus	1.425	0.7
W. attu	0.670	0.3
E. vacha	0.650	0.3
Miscellaneous	0.458	0.2

Charting of bottom contour : Charting of bottom contour of the reservoir was initiated during the year. The high bank area was surveyed with the help of a plane-table and alidade.

Hydrology : Studies on hydrology of the Loni reservoir were continued. Transparency of water (Secchi's disc readings) ranged between 64-87 cm except during monsoon when it was between 14-21 cm. pH varied between

7.4-7.6 till June, becoming low as 7.0 in July and thereafter, gradually increasing to 8.0 in December. Alkalinity was because of carbonate and bicarbonate ions, except during monsoon when only bicarbonate ions were present. Carbonate and bicarbonate ions ranged between 4-22 ppm respectively. Minimum (48 ppm) and maximum (118 ppm) total alkalinity was observed in August and December respectively. Free carbondioxide observed in July and August varied between 3.5-6.4 ppm.

Maximum hardness, 100 ppm, was observed in December. During monsoon, hardness varied between 34-60 ppm and during rest of the months, it was almost uniform, being 72 ppm. Of the nutrients both, nitrate and phosphate, showed increasing tendency till August. Nitrate concentration ranged between 0.08-0.20 ppm and phosphate varied between 0.06-0.18 ppm. Silicate ranged between 11.0-12.2 ppm (January to April), 7.0-8.0 ppm (May and June) and 5.0-6.0 ppm (monsoon). Chloride ions ranged between 9.5-10.0 ppm up to April and increased to 13.2 ppm during summer. During monsoon, chloride concentration declined to 4.0 ppm which in the subsequent months gradually rose up to 10 ppm by December. Calcium varied between 44-70 ppm during the period under report. The dissolved oxygen concentration remained between 5.2-9.6 ppm, minimum being in July and maximum in November.

Soil analysis : Analyses of soil samples up to April, '69 revealed the following range of characters : pH, 6.4-6.8 ; alkalinity, 0.235-0.623 m.e.% ; chlorides, 9.2-13.2 m.e.% ; calcium, 0.056-0.085 m.e.% ; nitrate, 0.11-0.16 ppm and phosphate 0.09-0.12 ppm. Organic matter was found to range from 1.84-3.0% in air dried samples.

Primary productivity : Results on primary productivity studies of the Loni reservoir revealed maximum productivity of 1,200 mg $C/m^3/6$ hr in zone I in the first fortnight of October and minimum of 150 mg $C/m^3/6$ hr in every zone during September. In the remaining months the values fluctuated between 150-1,050 mg $C/m^3/6$ hr. During the year, zone I showed the peak in October (1,200 mg $C/m^3/6$ hr), zone II and zone III in March (1,050 mg $C/m^3/6$ hr) and zone IV in November (750 mg $C/m^3/6$ hr) as against peak values of 750 mg $C/m^3/6$ hr in every zone during October, '68.

Plankton : Quantitatively average monthly plankton varied between 11—365 u/l during the year. Two peaks represented by 365 and 103 u/l were observed in July and December respectively, the minimum 11 u/l being observed in February. Phytoplankton dominated throughout the year except in February and July. Zooplankton had slight edge over phytoplankton in February, while in July, the zooplankton formed 80.3% of the total average plankton. Domination of zooplankton in July, was due to the blooms of *Difflugia* spp. of Protozoa, *Filinia* spp. of Rotifera and nauplii larvae of Copepoda. *Spirogyra* spp. and *Ulothrix* spp. representing Chlorophyceae dominated

the phytoplankton. *Fragilaria* spp., *Synedra* spp. and *Nitzschia* spp. constituted the Bacillariophyceae. Rotifers represented by *Filinia* (*Tetramastix*) spp., *Keratella valga, K. quadrata, Brachionus calyciflorus, Lecane* sp. and *Monostyla* sp. formed the bulk of the zooplankton population. Copepods were represented by *Cyclops* sp., nauplii larvae, *Bosmina* spp., *Ceriodaphnia* spp., *Moina* sp., and *Moinodaphnia* spp. *Daphnia pulex* formed the bulk of the cladoceran group.

Bottom fauna : The average concentration of organisms in all the four zones was found to be the highest in December (2,946 unit/m^2) and the lowest in April (502 unit/m^2). The bottom fauna comprised molluscs (78-1,128 unit/m^2), dipteran larvae (75-793 unit/m^2) and oligochaets (101-1,103 unit/m^2).

Macro-vegetation : 44 species of macro-vegetation, belonging to 20 different families, were collected. Prominent species among them were: *Potamogeton pectinatus, Hydrilla verticillata* and *Vallisneria spiralis* in the marginal regions. The submerged weed *Najas marina* was common during the period January to May. In damp mud adjacent to the edge of the water surface, some species of Gramineae ; mainly, *Biophytum sersitivum* and *Tridex procumbens,* could be found.

Biology of commercially important fishes—(a) *C. mrigala* : Gut content analysis of specimens in the size range of 324-655 mm showed that the fish subsisted on decayed organic matter (68%), phytoplankton (18%) and aquatic vegetation (11%). Plankters identified were: *Euglena* sp., *Phacus* sp., *Pediastrum* sp., *Navicula* sp., *Cymbella* sp., and *Melosira* sp. Mucous commonly encountered was found to range between 5-100%.

(b) *L. calbasu*: 22 specimens with 229-460 mm T.L. were examined. Fish appeared to have subsisted mainly on decayed organic matter (76.9%) and phytoplankton (7.2%). Plankters were mainly diatoms represented by *Cyclotella* sp., *Navicula* sp. and *Pinnularia* sp. followed by *Merismopedia* sp. among Myxophyceae and *Pediastrum* sp. among Chlorophyceae. Occasionally crustacean appendages were encountered. The ova-diameter together with modal values for ovaries of 43 specimens were found to be as in table 13 during different maturity stages of ovary.

Table 13

Maturity stage	Ova-diameter (mm)	Modal value for ovaries (mm)
I	0.051—0.238	0.102
II	0.051—0.340	0.187
IV	0.612—1.105	0.901
V	0.680—1.190	1.020
VI	0.697—1.360	1.190

(c) *L. bata* : 28 Specimens with 298-379 mm T.L. were examined during the year. 17 out of 43 guts examined were found to be empty. Important food items encountered in the gut were digested vegetative matter (40.7%) and plankters (10.8%). Other food items of minor importance were algal filaments and rotifer eggs. *Pinnularia* sp. *Cymbella* sp. and *Navicula* sp., among diatoms and *Spirogyra* sp., *Ulothrix* sp. and *Zygnema* sp. among Chlorophyceae were dominant forms. In gonads of the I and II stages of maturity, the eggs were found to have an average diameter of 0.085 and 0.136 mm respectively. The sex ratio of the specimens collected from experimental fishings was found to be 1 ♀ : 1.8 ♂.

(d) *P. sarana*: Gut content analyses of 98 samples of fish, ranging 77-338 mm in length, showed 21 guts in empty condition. 2, 9, 30, 22 and 14 guts were fully, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ and in traces filled with food respectively. Food items found in the gut in more than 50% cases were in digested condition, making it impossible to discern the food items. No difference in the food preference, during different months or in different size ranges, could be recorded. Plant parts, debris, molluscan shells, insect parts and phytoplankton (*Navicula* sp., *Protococcus* sp., *Pinnularia* sp., *Cosmarium* sp., *Spirogyra* sp. and *Chara* sp.) were different food items encountered in the gut of the fish, in their order of occurrence.

The sex ratio of fishes analysed during the year was 1 ♂ : 1.05 ♀ with the majority of males in smaller length ranges. Ova-diameter of 40 ovaries confirmed that the fish breeds only once in a year, as there was only one batch of eggs maturing in the ovary at a time. Fecundity rate of 8 specimens of fish, ranging in length from 256 mm to 320 mm, revealed that fecundity ranged between 60,770-1,39,984 ova.

(e) *N. notopterus* : Analyses of the gut contents of 20 specimens (250-304 mm in length) revealed that the species fed mainly on insect larvae (55.8%), semi-digested plant and insect matter (9.4%), algae (5.3%), molluscs (1.7%), diatoms (0.9%) and Protozoa (0.1%). Fish scales (26.8%) were also encountered in the gut.

Problem : 3.8 Fisheries of the Govindgarh reservoir

Duration : Five years

Personnel : S. J. Karamchandani, P. M. Mathew, S. Jena, S. N. Mehrotra and M. D. Pisolkar

Experimental fishing : Experimental fishing with multimeshed gill nets with floats and sinkers and with floats only was conducted in the 3 zones of Govindgarh reservoir, resulting in 188.04 kg of fish catch. The percentage composition by weight of the catch was : *C. catla,* 56.9 ; *Tor tor,* 19.5 ; *L. rohita,* 11.2 ; *C. mrigala,* 7.4 ; *L. gonius,* 0.5 and *W. attu,* 4.5. The catch/net/day and catch/unit area of net (100 sq m) per day ranged from 0.03 kg (January-October) to 0.61 kg (July), and 0.06 kg (October and November) to

0.82 kg (July) respectively, the averages being 0.2 and 0.27 kg. The nets with floats and master floats yielded better results. The night catches were always better than the day catches. The average length and weight of various species caught in the gill nets of different mesh bars are presented in table 14.

Table 14. Selectivity of gear in the Govindgarh and Kulgarhi reservoirs (January—December, 1969).

Mesh bar (mm)	No. of	Length (mm)		Weight (kg)	
		Range	average	Range	average
Tor tor					
40-50	22	305-545	377	0.25-1.90	0.62
55-75	24	330-543	490	0.25-1.80	1.31
80-100	1	504	—	1.40	—
Cirrhinus mrigala					
40-50	33	350-493	429	0.40-1.20	0.74
55-75	29	430-570	491	0.60-1.75	1.26
80-100	1	690	—	3.50	—
Labeo rohita					
40-50	109	287-350	319	0.22-0.44	0.33
55-75	4	435-480	465	1.00-1.10	1.03
80-100	2	725-740	737	3.50-6.00	4.75
Catla catla					
55-75	4	420-796	535	1.00-10.00	3.30
80-100	2	655-669	662	5.00- 7.50	6.25
105-130	16	692-835	767	6.00-10.00	8.17
135-155	20	727-1,052	879	6.50-29.00	15.05
160-190	12	732-1,045	866	7.00-28.00	12.98

Hydrology : Water temperature, transparency and pH ranged from 18.12°C (January) to 30.44°C (June), 66.37 cm (July) to 91.62 cm (October) and 8.0 (February to December) respectively. Total alkalinity increased from 39.21 ppm (January) to 53.9 ppm (June) and again declined from 45.32 ppm (July) to 30.77 ppm (September) with gradual rise thereafter. Dissolved oxygen ranged between 7.58 ppm (April) to 10.64 ppm (January). In other months, it varied between 8.02 ppm to 9.30 ppm. Free carbondioxide ranged from 1.95 ppm (February) to 4.56 ppm (December). Phosphates, nitrates and silicates varied from traces (May to October) to 0.033 ppm (January).

Primary productivity : The gross organic productivity was found to vary from 450 mg $C/m^3/6$ hr in December to 1,031.25 mg $C/m^3/6$ hr in October. The primary productivity was highest in zone I (1,192.5 mg $C/m^3/6$ hr), followed by zone II (807.3 mg $C/m^3/6$ hr), zone III (613.5 mg $C/m^3/6$ hr) and zone IV (515 mg $C/m^3/6$ hr).

Plankton : 592 samples of plankton were analysed. Total plankton varied from 566 u/l (March) to 1,632 u/l (September). The plankton content

in the 4 zones ranged from 23.2% (zone III and IV) to 26.8% (zone I and II). The surface plankton content was maximum at 06.00 hour (29.38%) and minimum at 24.00 hour (21.5%). Phytoplankton (59.2%) dominated over zooplankton (40.8%). The phytoplankton varied from 237 u/l (May) to 1,399 u/l (September) and the zooplankton from 95 u/l (August) to 1,034 u/l (May). The phytoplankton comprised Myxophyceae (71.5%), Chlorophyceae (18.0%) and Bacillariophyceae (10.5%). *Phormodium* sp. and *Microcystis* sp. among Myxophyceae, *Ophiocytium* sp. and *Pediastrum* sp. among Chlorophyceae and *Synedra* sp. among Bacillariophyceae were the most dominant forms. The zooplankton was made up of Protozoa (71.0%), Rotifera (16.5%) and Crustacea (12.5%). *Ceratium* sp. among Protozoa, *Brachionus* sp. among Rotifera, nauplius, *Cyclops* sp. and *Ceriodaphnia* sp. among Crustacea were the most dominant forms.

Bottom biota : 55 bottom biota samples from the 4 zones were examined during the year. The number of bottom organisms/m^2 ranged from 293 (July) to 1,263 (April) and the weight of the organisms/m^2 ranged from 813 mg to 5,849 mg. Zone wise dominance of bottom organisms by number and weight was : zone II (34.6% and 22.8%), zone IV (33.7% and 24.6%) zone III (22.9% and 18.1%) and zone I (9.8% and 34.5%). The composition of bottom biota by numbers and weight was : chironomid larvae (55.9% and 37.0%), oligochaetes (28.5% and 58.0%), insect larvae and pupae (15.6% and 5.0%).

Soil quality : The soil samples collected up to October, 1968, when analysed, revealed the following ranges of various characters : pH, 6.2-6.4 ; alkalinity, 0.058-0.175 m.e.% ; chlorides, 9.6-11.9 m.e.% ; calcium, 0.076-0.1 m.e.% ; nitrates, 0.12-0.16 ppm and phosphate, 0.17-0.42 ppm. Estimated from air-dried samples, organic matter in the soil was found to range from 1.6-2.3%.

Biology of fishes—(a) *T. tor* : 81 specimens (size range : 220-573 mm) were examined. The gut contents comprised digested matter including plant matter (73.5%), sand and mud (15.0%), grasses and twigs (7.1%), fish matter (2.1%), plant seeds (0.9%), insects (0.5%), algae (0.5%) and molluses (0.4%). The gastrosomatic index, indicating feeding intensity, was found to be 19.04, 11.36, 10.16 and 18.03 during the I to IV quarter. The Gonadosomatic index, showing maturity and breeding season, was 0.51, 8.43, 12.29 and 0.51 during the I to IV quarter. The fish has prolonged breeding season from June to September with the peak in August. The condition factor for combined sexes, calculated from the weight of whole fish and gutted fish, ranged from 0.85 and 0.77 (June) to 1.22 and 1.19 (March) respectively. The fecundity of 50 females in the size range 330-585 mm was found to range between 11,500-44,500.

(b) *C. mrigala* : Specimens (350-690 mm T.L.) were examined. The gut contents comprised sand and mud (63.56%), decayed organic matter (27.53%), diatoms (8.09%), Chlorophyceae (0.42%), Myxophyceae (0.29%), Protozoa (0.11%). The Gastrosomatic index varied from 12.14 (August) to 84.48 (January). The fecundity of 22 females (460-690 mm T.L.) ranged from 2.0-5.55 lac of ova.

(c) *L. rohita* : 21 specimens (300-740 mm) were examined. The gut content consisted of sand and mud (28.19%), decayed organic matter (43.96%), diatoms (15.07%), protozoans (0.42%), Chlorophyceae (11.55%) and Myxophyceae (0.8%). The gastrosomatic index ranged from 0.1 (September) to 13.92 (June).

Problem : 3.9 Fisheries of the Kulgarhi reservoir

Duration : Five years

Personnel : G. K. Bhatnagar, S. N. Mehrotra, D. N. Misra, S. Jena, R. K. Dwivedi and S. J. Karamchandani

Experimental fishing : Multimeshed gill nets with floats and sinkers and with floats only were employed for experimental fishing when 517.54 kg of fish was landed. The percentage composition (by weight) of the catches was : *C. catla,* 77.8 ; *L. rohita,* 8.7 ; *C. mrigala,* 9.7 and *P. sarana,* 0.2. Catch/net/day and catch/unit area of net (100 sq m)/day ranged from nil (October and November) to 1.0 kg (July) and nil (October and November) to 1.25 kg (July) respectively, the averages being 0.39 and 0.51 kg. The details of catch/unit effort of gill nets (mesh wise and zone wise) operated in the Govindgarh and Kulgarhi reservoirs are given in tables 15 and 16. Nets with floats and master floats yielded better results. The night catches always had an edge over the day catches. Average length and weight of various species caught in the gill nets of different mesh bars are presented in table 14.

Table 15. Mesh wise gear efficiency in the Govindgarh and Kulgarhi reservoirs (January—December, 1969).

Mesh bar (mm)	Thickness of twine (mm)	Nets operated (No.)	Nets with catch %	Observation days (No.)	Fish caught		Catch/net day		Catch/unit area (100 sq m) of net	
					(No.)	(kg)	Range (kg)	Average (kg)	Range (kg)	Average
Govindgarh Reservoir										
40-50	0.85—1.00	70	28.8	36	34	19.64	0.00—0.83	0.37	0.00—1.68	0.52
55-75	0.80—1.25	204	8.0	36	34	48.50	0.00—1.28	0.22	0.00—1.60	0.22
80-100	1.14—1.40	182	2.1	36	4	15.90	0.00—1.35	0.08	0.00—0.44	0.10
105-130	1.00	161	0.9	36	2	19.00	0.00—0.75	0.16	0.00—1.06	0.22
135-155	1.00—1.12	288	2.8	36	8	85.00	0.00—2.00	0.40	0.00—2.29	0.4
160-190	1.00—1.36	219	Nil	36	Nil	Nil	—	—	—	—
Kulgarhi Reservoir										
40-50	0.85—1.00	103	44.0	47	160	71.29	0.00—1.67	0.70	0.00—2.62	1.04
55-75	0.80—1.25	280	6.2	48	24	47.14	0.00—0.53	0.16	0.00—0.68	0.20
80-100	1.14—1.40	225	2.4	44	4	16.85	0.00—1.25	0.14	0.00—1.48	0.16
105-130	1.00	230	6.9	47	16	128.75	0.00—2.03	0.53	0.00—2.87	0.78
135-155	1.00—1.12	402	4.3	47	18	155.50	0.00—2.00	0.44	0.00—2.26	0.49
160-190	1.00—1.36	178	4.5	47	9	76.50	0.00—2.00	0.54	0.00—1.83	0.49

Table 16. Zone wise gear efficiency in the Govindgarh and Kulgarhi Reservoir (January—December, 1969).

Zone	Nets operated (No.)	Nets with catch (%)	Observation days (No.)	Fish caught		Catch/net/day		Catch/Unit area (100 sq m) of net	
				(No.)	(kg)	Range (kg)	Average (kg)	Range (kg)	Average (kg)
Govindgarh Reservoir									
II	712	5.1	29	71	128.47	0.00—1.54	0.09	0.00—1.87	0.14
III	126	4.9	14	7	16.75	0.00—1.71	0.13	0.00—1.84	0.15
IV	286	1.8	19	4	42.82	0.00—0.86	0.06	0.00—2.90	0.21
Kulgarhi Reservoir									
I	263	15.7	39	94	150.02	0.00—1.98	0.58	0.00—2.08	0.68
II	365	5.7	47	29	97.21	0.00—1.70	0.30	0.00—2.06	0.34
III	492	6.2	46	74	197.00	0.00—0.86	0.32	0.00—1.09	0.43
IV	298	7.3	45	34	51.80	0.00—0.96	0.20	0.00—1.30	0.24

Hydrology : The water temperature, water transparency and pH fluctuated between 15°C (January) to 28.8°C (July), 20.4 cm (July) to 90.9 cm (November) and 8.1 to 8.3 respectively. Total alkalinity ranged from 47.75 ppm (August) to 140.1 ppm (May). Dissolved oxygen ranged from 7.94 ppm (August) to 10.38 ppm (February). Free carbondioxide increased from 2.52 ppm (February) to 4.66 ppm (March to August) and abruptly increasing to 6.25 ppm in September followed by decline thereafter (3.31 ppm in November). Phosphates were in traces throughout the year, except for January to May (0.055 ppm). Nitrates declined from 0.152 ppm (July) to 0.031 ppm (September). Silicates ranged between 7.6 ppm (August) to 20.15 ppm (March). The hardness varied between 39.0 ppm (August) to 125.37 ppm (May) fluctuating irregularly in other months.

Primary .productivity : The gross organic productivity varied from 495.94 mg C/m^3/6 hr in February to 1,549.37 mg C/m^3/6 hr in May and 281.25 mg C/m^3/6 hr in October to 665.15 mg C/m^3/6 hr in July.

Plankton : The total plankton content decreased from 1,641 u/l (January) to 60 and 33 u/l in July and August respectively with revival thereafter, to 128 and 76 u/l in September and November respectively. The plankton content in zones I-IV was 20.59, 23.7, 28.31 and 27.4% respectively, being minimum at 12.00 hour (23.87%) and maximum at 24.00 hour (26.23%) in surface waters. Zooplankton (58.72%) was dominant over phytoplankton (41.28%). The former varied from 17 u/l (August) to 1,415 u/l (January and the latter from 3 u/l (July) to 477 u/l (May). The zooplankton comprised Protozoa (23.3%), Rotifera (20.27%), Copepoda (12.91%) and Cladocera (2.24%). *Peridinium* sp. and *Difflugia* sp. among Protozoa, *Keratella* sp. and *Brachionus* sp.

among Rotifera, *Cyclops* sp. among Copepoda, *Diaphanosoma* sp. among Cladocera were the most dominant forms. The phytoplankton was made up of Myxophyceae (28.67%), Bacillariophyceae (11.0%) and Chlorophyceae (1.61%). *Microcystis* sp. and *Phormidium* sp. among Myxophyceae, *Synedra* sp. and *Navicula* sp. among Bacillariophyceae, *Pediastrum* sp. among Chlorophyceae were the most dominant forms.

Bottom biota : 85 bottom biota samples were analysed. The number of bottom organisms/m^2 ranged from 32 in June to 203 in November and the weight of the organisms/m^2 ranged from 51 mg in July to 55,325 mg in April. The dominance of bottom organisms by number and weight in the 4 zones was: zone II (34.0% and 96.9%), zone I (32.6% and 0.9%), zone III (29.9% and 0.6%) and zone IV (3.5% and 1.6%). The composition of bottom biota by number and weight was: chironomid larvae (35.9% and 17.0%), nematodes (31.0% and 1.8%), insect larvae and pupae (32.9% and 3.5%) and molluscs (0.2% and 72.7%).

Soil quality : Soil samples collected up to October, 1968, when analysed, revealed the following range of characters: pH, 6.4 ; alkalinity, 0.056-0.185 m.e.% ; chlorides, 9.2-12.2 m.e.% ; calcium, 0.07-0.1 m.e.% ; nitrate, 0.14-0.18 ppm and phosphate, 0.11-0.16 ppm. Organic matter was found to range from 1.2-1.58% in air-dried samples.

Biology of fishes—(a) *C. mrigala* : 46 specimens (size range : 377-512 mm) were examined. The gut contents comprised sand and mud (23.24%), diatoms (3.78%), green algae (0.8%), blue-green algae (0.11%), Protozoa (0.16%) and Rotifera (0.15%). The gastrosomatic index varied from 20.86 (September) to 38.24 (February). The examination of scales from 114 specimens, have shown that the fish attains the length of 271 mm in the first year and 370 mm in the second year.

(b) *L. rohita*: 114 specimens (size range: 287-350 mm) were examined. The gut contents comprised sand and mud (60.0%), decayed organic matter (29.54%), diatoms (5.48%), Protozoa (2.67 %), green algae (0.52%), blue-green algae (0.48%), Rotifera (1.3%) and Copepoda (0.01%). The gastrosomatic index ranged from 32.22 (May) to 61.56 (August).

(c) *C. catla*: 45 specimens (size range: 303-836 mm) were examined. The gut content consisted of sand and mud (8.56%), digested matter (75.24%), decayed organic matter (3.15%), diatoms (4.45%), green algae (0.19%), blue-green algae (4.14%), protozoans (0.2%), rotifers (1.78%), copepods (2.09%) and cladocerans (0.2%). Gastrosomatic index varied from 3.85 (January) to 9.6 (September). Fecundity of 5 specimens (755-825 mm) ranged from 24.0 to 31.0 million ova.

(d) *O. bimaculatus*: The stomach contents of 418 fish examined comprised fish matter (88.5%), digested matter (6.2%), insects (2.9%), decayed organic matter (1.2%), prawns (1.1%), sand and mud (0.1%). Gastrosomatic index, was found to be 23.11, 17.33, 20.96 and 25.96 during the I to IV quarter. Gonadosomatic index increased progressively from 0.19 (February) to 8.01 (June) and thereafter declined from 0.03 (July) to 0.21 (January). The ova-diameters followed the same trend, the maximum size of ova being 0.99 mm in June indicated that the fish breeds from May to July. Fecundity of 20 females (240 320 mm) was found to range between 11,500-40,500.

Spawning potentialities of undesirable fishes: Studies on the spawning potentialities of some predatory and uneconomic species were continued. The details of fecundity and other relevant data are given in table 17.

Table 17

Species	No. of Specimens	Size range (mm)	Range	
			Fecunditv	Ova diam. (mm)
Labeo boga	50	121—226	1,752—14,434	0.99—1.24
Labeo boggut	41	86—174	917—16,164	0.9 —1.2
Rasbora daniconius	13	101—121	840— 7,339	0.73—0.95
Puntius ticto	41	61—132	470—15,186	0.62—0.86
Puntius sophore	27	65—101	610— 6,600	0.67—0.83
Garra mullya	12	95—115	730— 4,279	1.1 —1.26
Mystus cavasius	7	95—138	1,416— 5,825	0.66—0.72

Problem : 3.10 Fisheries of Peninsular tanks—I. Assessment of biological productivity

Duration : Three years

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

Primary Productivity: Primary productivity was assessed once a month in 4 tanks and 2 ponds by light and dark bottle method. Photosynthetically fixed carbon values indicating primary productivity ranged as follows: Hutchammankere tank, 175.0-499.9 mg C/m^3/day ; Sakalawara tank, 225.0-949.9 mg C/m^3/day ; Karpur tank, 275.0-999.9 mg C/m^3/day ; Bellandur tank, 716.1-4,799.0 mg C/m^3/day ; Kadagrahara pond, 175.0-429.9 mg C/m^3/day and Side-Hoskote pond, 307.0-1,794.0 mg C/m^3/day. Disintegration and consequent disappearance of *Microcystis* sp. bloom in Bellandur tank (August-September) resulted in the fall of primary productivity values. Reappearance of *Microcystis* sp. bloom (October onwards) increased the primary productivity values to the maximum in the year. Persisting turbidity was responsible for low productivity values in Hutchammankere tank.

Epiphytic biota : Epiphytic organisms on weed flora were constituted by diatoms, mainly desmids, representatives of Chlorophyceae and rhizopod protozoans. The maximum density 52,000-68,000 unit/sq cm of weed area during summer was observed in Jigani and Bidargupee tanks.

Particulate organic matter: Extent of settled particulate organic matter assessed by slide submersion experiment indicated carbon production range of 3.0-23.0 mg on 30 sq cm slide area (37.4-511.1 mg C/sq m/day) in Hutchammankere tank and 5.0-20.8 mg on 30 sq cm slide area (59.53-462.4 mg C/sq m/day) in Kadagrahara pond.

Plankton : Plankton density ranged from 18-2,060 u/l in tanks (0.6-54.0 ml/m^3 by volume). Sudden death and consequent disappearance of *Microcystis* sp. in Bellandur in August-September, '69 resulted in a sharp fall (from 80,000 to less than 1,000 u/l, phytoplankton). Chlorophyceae formed of Chlorococcales, *Spirogyra* sp. and *Cladophora* sp. In ponds, a decline in densities of plankton from 92-8,080 to 76-826 u/l with the rain water incursion, was observed. Dominance of zooplankton in the higher range (1.2-86.2 ml/m^3) was observed.

Littoral and benthic organisms : Density of invertebrate organisms, constituting littoral and benthic fauna, ranged from stray numbers to 1,840 u/sq m in tanks and from stray numbers to 1,550 u/sq m in ponds. Charred weights of these samples indicated carbon content of 34.0-2,437 mg/sq m in tanks and 55.68-731.6 mg/sq m in ponds.

Problem : 3.11 Fisheries of Peninsular tanks—II. Influence of environmental factors on biological productivity

Duration : Three years

Personnel : A. David and S. L. Raghavan

Various physico-chemical factors of water and soil phases during observations ranged as in table 18.

Table 18

	In Tanks	*In Ponds*
Water phase :		
Physical factors		
Temperature (°C)	20.30—30.75	21.00—31.80
Turbidity (mg/l)	100—800	100—1,000
Chemical factors		
pH	6.8—9.6	6.8—8.7
Dissolved oxygen (mg/l)	3.32—17.28	1.60—17.44
Alkalinity (mg/l)	41.0—400.0	92.0—700.0
Hardness (mg/l)	26.0—114.0	32.0—156.0
Specific conductivity (x10 mhos. at 25°C)	92.0—1,232.0	121.0—868.0

Table 18—(*Continued*).

	In Tanks	*In ponds*
Nutrient factors		
Nitrate (mg/l)	0.086—1.750	0.128—0.800
Silica (mg/l)	15.0—35.0	12.0—22.5
Phosphate (mg/l)	Trace—1.0	Trace—0.4
Iron (mg/l)	0.054—11.250	0.100—25.000
Soil phase :		
pH	1.19—1.56	1.34—1.56
Calcium (kg/ha)	367.12—1,101.37	183.56—1,101.37
Magnesium (kg/ha)	7.34—22.03	7.34—22.03
Phosphorus (kg/ha)	Trace—4.59	Trace—4.59
Ammonia (kg/ha)	2.75—18.36	2.75—18.36

Turbidity observed in Hutchammankere tank during the first half of the year was due to suspension of silt owing to disturbances by extraneous influences and shallowness, while in the later half it was due to the incursion of rain water. Turbidity in Bellandur tank was due to *Microcystis* sp. bloom. Turbidity was found to decrease from October onwards in all the tanks, except in Hutchammankere.

Concentration of nutrients, during April-May, was due to evaporation. Dilution of nutrient concentration in June-October was due to repeated rains. The subsoil leachings of the rain water brought in nutrient rich water into the tanks/ponds. Direct relationship between turbidity, silicate, and iron was observed.

Enhanced photosynthetic activity with the rise in temperature during April-May resulted in higher pH and dissolved oxygen values. Low pH of bottom soil of tanks may be due to organic decomposition.

Problem : 3.12 Fisheries of Peninsular tanks—III. Management of tank fish populations to obtain optimum catches

Duration : Three years

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

Stocking of tanks and ponds under study with major carp fingerlings, was done. 24,000 murrel fingerlings and 2,240 major carp fingerlings were stocked in seasonal Karpur tank in January for an experimental assessment of the results of mixed fish culture of murrels and carps. Murrels stocked in Karpur tank along with Gangetic major carp and common carp fingerlings, have grown

up to 340 mm as against carps up to 320 mm (*C. mrigala,* 320 mm ; *L. rohita,* 280 mm) in about 12 months.

The river Kumudvati above the Anjanapur reservoir was explored for possible breeding and availability of the spawn of *Puntius pulchellus.* No females in running or spent condition could be observed during July-August. Fingerlings in the shallower areas of the reservoir were available only in stray number.

Thirty eight fingerlings of *Pangasius pangasius* known for its molluscan feeding habit from the Hooghly river near Calcutta were released in the Anjanapur reservoir for preliminary observations.

Problem : 3.13 Fisheries of Peninsular tanks—IV. Conservation of Fishery in Bellandur and other selected tanks and small reservoirs

Duration : Three years

Personnel : A. David, S. L. Raghavan, H. N. Chandrasekhariah and N. G. S. Rao

Fishing, resumed after six months in Bellandur tank, yielded 30-60 kg of fish/day consisting of Gangetic major carp yearlings with *Catla catla* in abundance and followed by the common carp, *Cyprinus carpio,* scale and mirror carp varieties. The latter two carp varieties have bred in the tank and are established.

Decay and consequent disappearance of *Microcystis* sp. bloom in the tank with higher temperature appears to be the cause for mortality of economic fishes in the tank. With the disappearance of *Microcystis* sp., large scale breeding of forage fishes and carp varieties was observed. Eggs, collected in November in the tank, on rearing have proved to be mostly of *Rasbora daniconius.*

Young fish fauna, indicating viability of eggs and larvae, exhibitted a composition of *Gambusia* sp., *Puntius ticto, P. stigma, Rasbora daniconius* and *Cyprinus carpio.* These young fishes subsisted on zooplankters and insects. Their breeding potentialities are being studied.

Predatory fishes were available in stray numbers for detailed studies. Predatory fish fauna comprising *Heteropneustes fossilis, Channa striatus* and *C. gachua* were observed to feed on insects, forage fishes and zooplankters.

Project 4 : Riverine carp spawn prospecting and collection techniques

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

Duration : Two years

Personnel : H. P. C. Shetty, A. G. Jhingran, Ravish Chandra, G. N. Srivastava, T. V. Prem Swarup, D. V. Pahwa, A. G. Godbole, K. V. Rao and S. C. Pathak

Pre-monsoon survey of river stretches : To conduct spawn prospecting investigations during 1969, in the States of Rajasthan, Bihar, Assam, Tamil Nadu and Mysore, pre-monsoon surveys of selected stretches of six rivers ; *viz.*, the Banas, the Parbati (the Utangan), the Son, the Brahmaputra, the Coleroon and the Cauvery, were conducted.

In a 60 km stretch of the Banas river (Rajasthan) from Dubbi to Rameshwar, the only approachable sities at Billoi near Malarna Dungar Railway Station and Khandhar were surveyed. The former had a suitable place for operation of nets in contrast to the latter. Two sites, one at Rupbas and the other at Baretha on the Utangan river (Rajasthan), were selected. At Rupbas, the ground available for the operation of nets was small and covered by rocks. The sites at Baretha had good accessibility to collection grounds and promises of good availability of seed. In the stretch of the Son river (Bihar) along its west bank, from Ram Dihra to Koelwar (120 km) and along the east bank, from Koelwar to the confluence of the river with the Ganga (16 km), 16 sites (Koelwar, Dhandila, Farangpur, Bahiara, Khangaon, Bishanpur, Saripur, Tirkaulghat, Sandesh, Peur, Sehar, Amiaor, Dehri-on-Sone, Inderpur, Tilauthu and Ram Dihra) on the west bank were examined and Bahiara was selected. Both, the accessibility to the river bank and spawn harvested on the east, were very poor. In a 385 km stretch (210 km in Kamrup and 175 km in Goalpara) of the Brahmaputra river in Assam, the sites (Kurwa, North Gauhati, Asho-klanta Hill, Amingaon, Saulkusi, Bamundhi, and Hatimorah along the north bank and Chandrapur, Pandu, Sadilapur, Khanamukh, Dharapur, Bhatpara, Majargaon, Chimhab, Phaturi and Negarbera along the south bank in Kamrup and Jogighopa, Chandradengha, Dudh Nath, Bhasanichar and Kalapani along the north bank and Dolgoma, Goalpara, Poncharatna, Purorbhita, and Boraburi along the south bank in Goalpara) were surveyed. Of these sites, North Gauhati, Bhasanichar and Dolgoma were selected. In view of early floods in Assam, investigations were initiated on 21.5.69. During the receding phase of the first flood in May, 1-5 standard experimental nets collected 961 ml (*c.* 4.805 lakh) of spawn, in addition to 213 ml (*c.* 1.065 lakh) collected by 1 research net of $\frac{1}{8}''$ mesh. The second spawn spurt occurred in the rising phase of the second flood during the first fortnight of June. The collection of spawn by experimental nets and 1 research net was 505 ml (*c.* 2.525 lakh), taking the total to 1,579 ml (c. 7.895 lakh).

In the stretch of the river Coleroon from Grand anicut to Lower anicut, three sites (Vadukagudi, Nirathanallur and Kachhaperumalnathur) were examined and Nirathanallur was selected. A 175 km stretch of the river Cauvery from Krishnarajasagar to Hagainakal falls was surveyed. The sites (Bunnur, Sosale, T. Narsirpur, Talkad, Chikkaylur and Palar) were examined and Sosale was selected.

Spawn prospecting investigations : After a thorough pre-monsoon survey five sites ; *viz.*, Baretha on the river Parbati (the river Utangan), Bahiara on the river Son, North Gauhati on the river Brahmaputra, Nirathanallur on the river Coleroon and Sosale on the river Cauvery, were selected for detailed spawn prospecting investigations. At all these sites, observations were made as in previous years.

Baretha : Spawn prospecting investigations at Baretha Barrier on the river Utangan (the river Parbati) in Rajasthan were carried out from 1.7.69 to 27.8.69. The river had only scattered patches of shallow water pools, having absolutely no current in them, till 22.00 hour of 8.7.69. A temporary rise in water level was observed thereafter, attaining the peak of 0.46 m at 13.00 hour of 9.7.69. The first flood, which touched 2.49 m level at 22.00 hour on 19.7.69, yielded in its receding phase 135 ml of spawn and 500 ml of eggs. The spawn spurt was of short duration, from 02.00 hour of 19.7.69 to 12.00 hour of 20.7.69, and was of undesirable spawn quality. The eggs were found to be mostly unfertilized. Before the appearance of the second flood, a vacillatory phase was recorded, touching the peak level of 1.29 m at 10.00 hour on 29.7.69, yielding no spawn. The second flood was observed between 6.8.69 and 24.8.69, touching the peak level of 5.81 m at 10.00 hour on 14.8.69. This flood yielded only traces of spawn for about 20.00 hr. Thus, during the entire period of the investigations, only 135 ml spawn of minor carps could be obtained.

Rajakheda site, 79 km downstream and Bayana site, 125 km upstream on the major tributary Gombhir, were prospected. Both these sites did not yield any spawn. Hence, the sites were unsuitable for commercial exploitation.

Bahiara : Observations in 150 km stretch of the river Son in Bihar, during the monsoon of 1969, were made to ascertain the extent of migration of major carps from the river Ganga : up the river Son for breeding and the effect of Indrapuri anicut on fish migration and spawn flow, and to know the role of flood in the river Son on the availability of spawn in the river Ganga at Dighwara.

Three places ; i.e., Dighwara (downstream of both Indrapuri anicut and confluence of the Ganga), Bahiara (downsream of Indrapuri and above the confluence of the Ganga) and Tilauthu (upstream of Indrapuri) were surveyed. The work at Bahiara was conducted by the staff of this Institute in collaboration with the staff of Bihar Fisheries Department, whereas at Dighwara and Tilauthu the work was carried out by the research staff of Bihar Fisheries Department only.

The flat, gradually sloping sand bar, available at Bahiara, was ideal for large scale opertion of shooting nets. As such, 400 to 500 nets of private fishermen are commonly operated. Observations on spawn were recorded at Bahiara from 3.7.69 to 5.9.69. The river faced five floods. A total catch of 3,120 ml of spawn could be collected by 1 to 5 standard and state nets. The floods I and II yielded 275 and 2,845 ml of spawn. Duration of spawn availability was

longer and in traces during the flood III. During the floods IV and V, spawn was available in traces but for very short durations.

The spawn of flood I, on rearing in a nursery of State Fisheries Department, were found to consist of *C. mrigala* (53.6%), L. *rohita* (32.4%), *L. calbasu* (1.4%), *C. reba* (11.2%) and *L. bata* (1.4%). The flood wise spawn analyses are given in table 19.

Table 19

Flood No.	Flood level (m)	Seawn catch (ml)	Quality (Span analysis)		
			Major carp	Minor carp	Others
I	3.19	2,845	62.8	32.9	4.3
II	3.65	275	47.8	44.1	8.1
III	4.18	Traces	52.4	44.0	3.6
IV	4.53	,,	58.2	34.2	7.6
V	5.63	,,	53.0	44.0	3.0
		3,120			

Major carps which do not form any permanent fishery, but are commercially caught only during the post-monsoon months, yielded the major part of the spawn available in the river Son. So, the temporary availability of major carps in the Son river may be due to the breeding migration from the river Ganga.

In the rearing experiment of spawn collected during the flood II, *Catla catla* was found to be dominating, followed by *C. mrigala*. This observation, coupled with frequent occurrence of catla fry in the collection, indicates the breeding of *Catla catla* in shallow marginal areas of the river.

The water of the Ganga river which becomes red due to the water drainage from the river Son, yields spawn. As such, the Son flood plays a vital role in the availability of spawn in the river Ganga at Dighwara.

North Gauhati: The detailed investigations from 21.5.69 to 9.7.69 at North Gauhati and periodical spawn prospecting at Saulkusi and Barnaddi area were made. A total quantity of 1,233 ml of spawn was collected, while the first flood contributed 70.55% and the second 29.44%.

Percentage of *Labeo rohita* which was only representative of major carps, was ranging between nil and 9.58.

On 21.5.69, the river was in rising phase of the first flood which lasted till 5.6.69. The second flood, with its peak on 14.6.69, lasted from 6.6.69 to 21.6.69. The third flood lasted for 10 days only, attaining the peak on 26.6.69.

Spawn appeared for the first time from 18.00 hour of 22.5.69 to 04.00 hour of 23.5.69, and a total of 39 ml of spawn could be collected. At 21.00 hour on 23.5.69, it reappeared and the catch in five standard nets amounted to 515 ml. Another spurt of 2 hr on 25.5.69 yielded 52 ml of spawn in one standard net. After six days, a spurt, lasting between 22.00 hour on 31.5.69 and 02.00 hour on 1.6.69, yielded 4 ml of spawn in one standard net. All the above collections, except the first one, were made during the receding phase of the first flood. The availability was not continuous.

Another spurt for 7 hr in the rising phase of the second flood, from 21.00 hour on 9.6.69 to 04.00 hour on 10.6.69, brought in a quantity of 360 ml in five standard nets.

Nirathanallur: The first of the three floods was encountered in the river Coleroon from 14.7.69 to 19.7.69. The second and third floods commenced on 21.7.69 and 24.7.69 and the rising phase lasted for 32 and 28 hr respectively. The fourth flood commenced from 28.7.69 and the water continued to rise, with minor fluctuations, till the close.

The first of the two spawn spurts encountered at Nirathanallur lasted for 12 hr, yielding 1,387 ml of spawn ; and the second for 26 hr, yielding 127 ml of spawn. Besides this, 69 ml of spawn was also available outside the spurt period. Further, 661 ml of spawn were also collected by the research nets, raising the seasons' total to 2,239 ml. Major quantity of spawn was available during the period when water receded.

The percentages of desirable spawn during the first and second spurts were 16 and 26 respectively.

Sosale: In all 25 ml of spawn and 300 ml of eggs were collected during the course of the 14 major floods encountered in the river, from frequent release of water from the Krishnarajasagar reservoir.

No sizeable spawn spurt was observed. With the recession in the flood level, spawn appeared in traces, but the release of water at short intervals from the reservoir made it disappear. On 29.7.69 at 10.00 hour when the water receded after attaining a peak of 2.94 m, 0.5 ml of spawn could be collected till 18.00 hour. Similarly on 30.7.69 from 02.00 hour till 06.00 hour and on 1.8.69 from 10.00 hour to 14.00 hour spawn was available with the recession in flood level.

During spawn prospecting at Talkadu, 300 ml of eggs could be collected when the egg spurt was waning. For want of transport and rearing facilities, their species composition could not be determined. However, two advance fry of *C. catla* were also collected at Talkadu.

Microscopic examination of the spawn samples revealed a negligible percentage of the desirable species.

The failure of the centre to yield any spawn spurt may be attributed to the following: —

1. Absence of deep pools in the entire stretch surveyed.
2. The mass destruction of migratory and breeding fishes at Chunchukatta. Situated about 32 km upstream of Krishnarajasagar, the minor falls at Chunchukatta acts as a barrier for the carps ascending from Krishnarajasagar. The fishes, unable to circumvent the barrier, gather below the falls, providing a bountiful harvest to the local populace.
3. Fishes, ascending from the Mettur reservoir, can only reach up to the Hogainakal falls and congregate in pools. They are unable to ascend further on account of the falls acting as barrier. A 21.35-24.40 m rise in the water level can only allow them to ascend further, while bringing the water level at per with that of the falls.
4. Very frequent release of water from the Krishnarajasagar reservoir disperses the spawn flowing in the water.

Problem : 4.2 :	Standardisation of spawn collection techniques
Duration:	Three years
Personnel:	K. K. Ghosh, H. P. C. Shetty, A. G. Jhingran, M. Sinha, Ravish Chandra, G. N. Srivastava, T. V. Prem Swarup, D. V. Pahwa, A. G. Godbole, K. V. Rao and S. C. Pathak

Filtration rate: Experiments were intiated to assess filtration rate for the 1/8″ and 1/16″ meshed Midnapore type nets. At the net mouth, the velocity of the water flowing into the net almost became zero in 8 hr of operation of a 1/16″ meshed 10 m net, when the turbidity was about 1,200 ppm and current velocity in the river at the area of operation, about 1.5 km/hr. The choking of the meshes resulted in net vomiting. Owing to high hydro-pressure, the net mouth got enlarged by 50%, the lower wing being completely pushed to the river bed. In the case of 1/8″ meshed net under similar conditions, the average inflow of water into the net fell by 30-35% in even time.

Net size effect: Catching efficiencies of Midnapore type nets, 1/8″ meshed and of 6, 10, 14 and 18 m material, were found to be in the proportion of 1:2.7:4.4:1.5 respectively for the four sizes. When tested under a randomised latin square design of experiment with 5 replicates, the 18 m net was found to be poor in performance at all positions.

Mesh size effect: Nets, made of 1/8″, 1/12″ and 1/16″ meshed material but identical in other respects, were tested in a latin square design with six replicates, under turbidity values of 750 ppm and current velocity values between 0.45 and 1.2 km/hr. The 1/16″ meshed net was invariably found

to be the best for the first 4 hr of operation ; but, thereafter, this net became less efficient than 1/12″ or 1/8″ meshed nets. The extremely high net-to-net variability (estimated coefficient of variation being 80%) rendered the experimental precision of the inferences low. The over-all efficiency ratios were found to be 108% for 1/12″ meshed net and 159% for the 1/16″ meshed net when compared to the net of 1/8″ mesh. These very coefficients were 130% for 1/12″ and 176% for 1/16″ when the data for 4 hr alone were considered, as against 102% for 1/12″ and 61% for 1/16″ when the catch data made after 4 hr of operation were considered.

Spawn availability at Mahewapatti : Four floods, touching 75.48, 79.17, 82.44 and 83.11 m above MSL and the summer low level of 72.20 m, were experienced by the river Yamuna at Mahewapatti. The first three, during their receding phases, yielded spawn spurts. A low intensity spawn availability for 32 hr was also observed during the rising phase of flood II. The first spawn spurt, commencing 12 hr after the first flood had touched its peak, yielded mostly minor carps (80% by spawn analysis) at the average rate of 125 ml/hr/standard net for 16 hr and thereafter, yielded only prawn spawn for another 40 hr. The latter two major spawn spurts commenced 28 and 24 hr after the second and third floods had respectively turned to recession. These spurts yielded desirable spawn at the rate of 10 and 5.4 ml/standard net/hr for 44 and 60 hr respectively. The second spurt also yielded undesirable spawn at the rate of 10 ml/hr/standard net for 28 hr following the desirable spawn availability. The peak collection rates in all spurts corresponded to a rate of change of flood level of 1-2 cm/hr.

Indices of spawn quantity and quality were found to be 1,098 ml and 56% major carps (based on nursery rearings of the latter two spurts).

Problem : 4.3 Commercial spawn catch in the lower sector of the Ganga river system

Duration : Four years

Personnel : B. N. Saigal, S. N. Sar and R. K. Bhattacharya

Spawn export booking figures from selected railway stations along the lower sector of the Ganga river system, from Koelwar on the river Son in Bihar to Lalgola on the river Padma in West Bengal, were collected. The data are being processed.

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

Duration : Three years

Personnel : H. P. C. Shetty, B. N. Saigal and S. D. Gupta

Early spawn obtained from (i) the river Son at Bahiara in Bihar, (ii) the

river Yamuna at Mahewapatti near Allahabad and (iii) the Nain Talaiya dry *bundh* at Nowgong in Madhya Pradesh were reared under nearly identical conditions up to fry stage in plastic pools and from fry to fingerling stage in a fish farm. Owing to inadequate facilities, only one replicate could be had for every experimental rearing. The rate of stocking was 200 spawn/pool. The larvae were fed on plankton and also on artificial feed, consisting of rice bran and mustard oilcake in 50:50 proportion, at the following rates : during the first five days, 280 mg/pool (equal to the initial weight of stocked spawn) ; the next five days, 560 mg/pool (double the initial weight of stocked spawn) ; and the last eight days, 840 mg/pool (3 times the initial weight of stocked spawn). The number of spawn that survived up to fry stage and their size range on the 19th day in the various pools was as in table 20.

Table 20

Pool No.	Spawn source	No. surviving	Size (mm)	
			Range	Average
1	The Son river	53	16-36	23.5
2	The Son river	96	10-40	14.0
3	Nowgong *bundh*	126	10-25	16.6
4	Nowgong *bundh*	62	10-27	16.8
5	The Yamuna river	145	9-29	15.6
6	The Yamuna river	53	12-33	23.7

It is evident that one lot of spawn from the river Son exhibited a distinctly better rate of growth to fry stage than the spawn from other sources, except one lot of Yamuna-spawn which consisted of minor carps. Two sets, each with 3 equal sized nurseries, were selected to rear the fry to fingerling stage. The smaller nursery measured 18.3 m × 12.2 m and the larger 24.4 m × 15.25 m. 53 fry were stocked in each smaller nursery and 96 in each larger nursery. One small and one big nurseries were utilised for stocking the fry from each source. 50 and 100 gm of artificial feed were put daily in the small and big nurseries respectively for the first ten days. After 92 days' of nursery rearing, measurements were taken of all the surviving fingerlings in the various ponds. While the survival in the 3 small nurseries was fairly satisfactory, all the fry appeared to have perished in the larger 3 nurseries, probably due to low level of water in those ponds. 35 of Son-fry and 43 of *bundh*-fry could be collected in the nets from the smaller nurseries after 92 days of rearing. Their length range was duly recorded. Artificial feed approximately equivalent to their weight was given in both the nurseries for the next six days. In the pond stocked with Yamuna-spawn, only *Labeo bata* were encountered. So, further observations on this pond were stopped.

The growth of the surviving Son- and *bundh*-fingerlings was again finally recorded after 147 days of pond rearing. The size ranges of the various species are given in table 21.

Table 21

	C. catla		*L. rohita*		*C. mrigala*	
	Size range (mm)	Average size (mm)	Size range (mm)	Average size (mm)	Size range (mm)	Average size (mm)
In 92 days :						
Son-fingerling	90-170	143.1	150-175	159.8	175-190	181.5
Bundh-fingerling	53-126	99.1	76-132	104.3	—	—
In 147 days :						
Son-fingerling	107-172	149.7	166-198	175.0	165-206	184.7
Bundh-fingerling	77-130	113.0	79-159	124.1	—	—

Project 5 : Brackish water fish farming

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

Duration: One year

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

A fish farm with 11 ponds, having water of low salinity, was constructed at Bakkhali (Sunderbans). The study on seepage was completed in 1968. After manuring in 1968 with a basal dose of 25 t cow-dung/ha and monthly inorganic fertilisation with N-P-K: 18-8-4 @ 60 kg/ha in the central pond, nitrogen content of the water increased considerably, while phosphorus, after initial increase, decreased to 0.1 ppm resulting in an increase in plankton population and primary productivity (803 mg $C/m^3/hr$). The salinity of the pond water decreased to 6.0‰ in rainy season and remained steady at 6.7‰ during December, '69. The central pond retained sufficient water during summer months and had maximum depth of water of 295 cm only during the year. The central pond was stocked with fry of mullet and prawn along with 650 carp fry (25-40 mm). The increase in length of *M. parsia* was 140-150 mm as against 85-95 mm of *P. styliferus* and 150-160 mm of *P. indicus* in 6 months. The growth studies of other fishes are in progress. The primary productivity was 250 mg $C/m^3/hr$ in December. Acclimatisation of carps has been successful. The carp fry released were 35-45 mm in size and the water salinity was 12‰ at the time of stocking.

Problem: 5.2 Contour survey of Henry's Island No. 1 for designing a 500 acre brackish water fish farm at Bakkhali

Duration: One year

Personnel: B. B. Pakrasi

The contour survey of about 900 acres of forest land in Henry's Island of Bakkhali was completed. The areas suitable for construction of fish farm were demarcated. Two designs of layout for 500 acres brackish water fish farm were prepared for further action. To prepare a design of layout for the construction of brackish water fish farm, Dia and Prentice Islands are being surveyed.

Problem: 5.3 Experimental trial of model brackish water fish farm in the lower Sunderbans

Duration: Two years

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

The construction of an experimental brackish water fish farm was also completed at Bakkhali for carrying out investigations on different aspects of brackish water fish farming. Observations on different methods of stocking with fish seed of cultivable species, were initiated. The pond soil became further deficient in nitrogen (5.0-5.6 mg/100 gm) and organic carbon (0.36-0.64%) as compared to high phosphate content (22-24.8 mg/100 gm). In water phase, however, phosphate was low (<0.1 ppm) while nitrate-nitrogen was 1.1-1.3 ppm, because the water was taken into pond from the adjacent creek during high tide. Plankton production in these ponds, was appreciably high, being dominated by zooplankton. *M. brevicornis, M. monoceros, P. indicus, P. monodon, M. tade* and *M. cunnesius* were found to grow in the farm to a length of 20, 30, 30, 65 and 25 mm respectively in 4 months. The soil salinity ranged between 2.14-0.38% during June to December.

Problem: 5.4 Salinity tolerance of major carp fingerlings

Duration: Two years

Personnel: A. N. Ghosh, S. R. Ghosh and P. R. Das

The work under this problem could not be undertaken during the year due to non-availability of major carp fingerlings of the required size.

Problem: 5.5 Nursery management in brackish water ponds

Duration: Three years

Personnel: A. N. Ghosh, S. R. Ghosh, P. R. Das, H. S. Mazumder and A. R. Paul

5.5.1 Pilot investigations on different stocking rates and ratios of fish and prawn, their survival and growth, effect of arti-

ficial fertilizers and removal of uneconomic species for better production

M. parsia fry (average size: 17 mm) was stocked at 25,000/ha and both, *L. calcarifer* (average size: 17 mm) and *E. tetradactylum* (average size: 50 mm) were stocked at 1,375/ha in nursery pond. The growth achieved by them was 151, 178 and 186 mm respectively in 170 days.

P. indicus (average size: 84 mm), *P. monodon* (average size: 30 mm), *M. monoceros* (average size: 48 mm), *M. brevicornis* (average size: 53 mm), cultured separately at a total stocking density of 2,00,000/ha, attained size of 144, 83, 84 and 89 mm respectively in 90 days with the percentage mortality of 48.2, 50, 48 and 48 respectively. When reared further, up to 150 days, the mortality rates increased in *P. indicus* (96.8%), *P. monodon* (66.6%) and *M. monoceros* (100%) except in *M. brevicornis* (17.4%), the respective size attained by the survivors being 159, 178 and 114 mm respectively.

M. parsia fry (average size: 17 mm) were stocked at the rate of 2,00,000/ha in two unmanured nursery ponds of equal size. Supplementary feed (mustard oilcake: rice bran: : 2: 1) was resorted to in one pond at the rate of 50 mg/fish. Average growth of fish was 100 mm in 110 days as against 90 mm in control. Similar experiment at a stocking density of 12,500/ha showed a growth of 151 and 116.2 mm respectively in 120 days.

In wild culture, *M. parsia* when stocked at 30,000/ha and with or without unwanted fishes; *viz., Gerres setifer,* anchovies, etc. as against even growth of carnivorous fishes: *E. tetradactylum* (323 mm) and *L. calcarifer* (310 mm) in both types of culture, attained 97 and 126.7 mm respectively in 240 days.

5.5.2 Pilot investigations to breed *M. parsia, M. tade, L. calcarifer, E. tetradactylum* through hormone injection and/or stripping

M. parsia responded to homoplastic hormone injection, but the fertilized eggs did not survive after the embryonic streak formation stage.

5.5.3 Investigation for evolving suitable manuring and stocking rates

Pond soil, before water logging, had 0.43% organic carbon, 5.8 mg/100 gm available N and 2.45 mg/100 gm available P_2O_5. On water logging, pH, available N and P_2O_5 increased while organic carbon decreased. Pond bottoms without any silt deposition contained 20.06-37.37 mg/100 gm available nitrogen and 6.0-10.0 mg/100 gm available phosphorus while in the ponds having silt load, they varied from 14.07-19.89 mg/100 gm and 1.6-4.0 mg/100 gm respectively according to the silt load.

Various fertilisers; i.e., urea, superphosphate, muriate of potash, were used individually and in combination with each other. N-P-K: 6-8-4 and mustard

ficial fertilizers and removal of uneconomic species for better production

M. parsia fry (average size: 17 mm) was stocked at 25,000/ha and both, *L. calcarifer* (average size: 17 mm) and *E. tetradactylum* (average size: 50 mm) were stocked at 1,375/ha in nursery pond. The growth achieved by them was 151, 178 and 186 mm respectively in 170 days.

P. indicus (average size: 84 mm), *P. monodon* (average size: 30 mm), *M. monoceros* (average size: 48 mm), *M. brevicornis* (average size: 53 mm), cultured separately at a total stocking density of 2,00,000/ha, attained size of 144, 83, 84 and 89 mm respectively in 90 days with the percentage mortality of 48.2, 50, 48 and 48 respectively. When reared further, up to 150 days, the mortality rates increased in *P. indicus* (96.8%), *P. monodon* (66.6%) and *M. monoceros* (100%) except in *M. brevicornis* (17.4%), the respective size attained by the survivors being 159, 178 and 114 mm respectively.

M. parsia fry (average size: 17 mm) were stocked at the rate of 2,00,000/ha in two unmanured nursery ponds of equal size. Supplementary feed (mustard oilcake: rice bran: : 2: 1) was resorted to in one pond at the rate of 50 mg/fish. Average growth of fish was 100 mm in 110 days as against 90 mm in control. Similar experiment at a stocking density of 12,500/ha showed a growth of 151 and 116.2 mm respectively in 120 days.

In wild culture, *M. parsia* when stocked at 30,000/ha and with or without unwanted fishes; *viz., Gerres setifer,* anchovies, etc. as against even growth of carnivorous fishes: *E. tetradactylum* (323 mm) and *L. calcarifer* (310 mm) in both types of culture, attained 97 and 126.7 mm respectively in 240 days.

5.5.2 Pilot investigations to breed *M. parsia, M. tade, L. calcarifer, E. tetradactylum* through hormone injection and/or stripping

M. parsia responded to homoplastic hormone injection, but the fertilized eggs did not survive after the embryonic streak formation stage.

5.5.3 Investigation for evolving suitable manuring and stocking rates

Pond soil, before water logging, had 0.43% organic carbon, 5.8 mg/100 gm available N and 2.45 mg/100 gm available P_2O_5. On water logging, pH, available N and P_2O_5 increased while organic carbon decreased. Pond bottoms without any silt deposition contained 20.06-37.37 mg/100 gm available nitrogen and 6.0-10.0 mg/100 gm available phosphorus while in the ponds having silt load, they varied from 14.07-19.89 mg/100 gm and 1.6-4.0 mg/100 gm respectively according to the silt load.

Various fertilisers; i.e., urea, superphosphate, muriate of potash, were used individually and in combination with each other. N-P-K: 6-8-4 and mustard

oilcake individually and in combination at the rate of 50.0 kg N, 67.0 kg P and 33.34 kg K/ha were applied in thirty ponds. Within fifteen days in almost all cases, the nutrients were released to water phase. The response was quick in case of urea in the water phase and the effect lasted for a period of 45 days, but in case of superphosphate the effect lasted longer. The primary productivity also followed the same trend. Fish growth was observed in the set, treated with mustard oilcake and NPK where the *M. parsia* (average size: 51 mm) attained average lengths of 102 mm in wild culture (8,000/ha), 89 and 93 mm respectively at two levels of selective stocking at the rate of 8,000 and 16,000/ha in a period of 112 days.

Problem: 5.6 Brackish water fish farm management techniques

Duration: Three years

Personnel: A. N. Ghosh, S. R. Ghosh, P. R. Das, P. K. Pandit, H. S. Mazumder and A. R. Paul

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

A direct correlation was found between tidal amplitude and extent of flooding in Kakdwip Fish Farm. A minimum of 2.21 m tidal amplitude was required for 1.52 m optimal water depth in the farm where inlet was situated 1.17 m above the lowest low water mark of the estuary.

The water level of the farm could be maintained at the optimal level throughout the year by allowing two tides in a month during the full moon and new moon periods.

The seasonal availability of quality fish and prawn in the shooting net collection, covering all phases of the tidal conditions in a month, is presented in table 22.

Table 22

Months of 1969	Average Collection (No. of fish/day/net)	Quality fish seed (%)	Average Collection (No. of prawn/day/net)	Quality prawn seed (%)
Jan.	357	12.00	3,570	76.67
Feb.	73	15.07	2,636	44.76
Mar.	271	1.11	3,635	64.89
Apr.	323	3.10	2,006	68.69
May	739	8.93	5,776	6.72
Jun.	253	10.28	4,488	17.16
Jul.	16,103	6.28	2,12,868	59.80
Aug.	—	—	—	—
Sept.	576	56.70	678	97.00
Oct.	254	35.80	610	21.90
Nov.	1,139	3.13	4,803	76.40
Dec.	532	1.31	20,502	99.62

Mugil parsia was the dominant component of the fish seed during January and February. During the rest of the year, fry of *E. tetradactylum* formed the major component of the catch. In the prawn groups, *Penaeus indicus* formed the most dominant group throughout the year, excepting July, November and December, being maximum in July (1,20,843/net/day). *M. brevicornis* and *P. styliferus* were next in importance.

5.6.2 Control of the pond siltation

Erosion due to rain was controlled by providing bamboo piling on the eastern face and brick lining on the edges of the dykes. The internal piping within the dykes, gully formation and rill erosion of the surface of the dyke slopes could be controlled through these measures. Erosion due to wind action and rain drops on the dyke crest could be controlled by providing a *morum* carpet on the dyke.

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

Prawn culture in mixed farming with *Mugil parsia* did not give encouraging results. When stocked with fish and prawn of identical size (average size: 56 mm) heavy mortality (75.9%) of prawn was observed, though fish growth was good (125 mm in 155 days) from the date of stocking on 18.6.69. Mixed farming of prawn, *P. monodon*, with *M. tade* is being continued in a 0.02 ha nursery pond at the stocking density of 6,000/ha for *P. monodon* and 10,000/ha for *M. tade*.

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

In mixed farming of *M. parsia* (average size : 56 mm) and *L. calcarifer* (average size : 152 mm) at the stocking density of 15,000 and 1,275/ha, *M. parsia* attained an average size of 75 mm and *L. calcarifer* an average size of 186 mm in 80 days. The stock of *L. calcarifer* was reduced by 18.5% by removing those within the size range of 138-275 mm. Thus the average size was reduced to 103 mm. In another 53 days, *M. parsia* grew to an average size of 89 mm while *L. calcarifer* attained an average size of 147 mm. Similar experiment was conducted with *M. parsia* (average size : 56 mm) at 15,000/ha stocking density and *L. calcarifer* (average size : 343 mm) at the stocking density of 650/ha. In a period of 133 days, *M. parsia* achieved an average length of 91 mm and *L. calcarifer* 352 mm. With *E. tetradactylum* (average size : 135 mm) at the stocking density of 850/ha and *M. parsia* (average size : 56 mm) at 15,000/ha, the average length achieved were 155 and 111 mm respectively in a period of 133 days.

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

In order to find out a suitable medium for the growth of plankton and benthic algae, different types of soil with 100, 75, 50, 25 and 0% of silt was experimented in the laboratory. Best growth of benthic algae was observed in the soil having 75% of silt. The pH, organic C, total dissolved solid, available P_2O_5 (mg/100 gm), salinity (ppt), exchangeable Ca (mg/100 gm) and exchangeable Mg (mg/100 gm) were found to be 8.4, 0.30, trace, 7.0, 20.21, 8.35 and 5.40 respectively.

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

To isolate and achieve stock cultures of the preferred fish food organisms, different types of artificial media ; such as, brackish water and pond soil extract, Knop's solution, artificial sea water and natural sea water, are under trial for preparatory cultures of selected brackish water plankters at a temperature of 25°C ± 1 and illuminations of 100, 200 and 500 Lux. *Cymbella* sp. and *Nitzschia* sp. are growing well in the preparatory cultures made in artificial sea water. Experiments on primary productivity in pond No. 1 were continued to study the seasonal periodicity. To get sufficient inoculum and periodicity of the periphytic organisms, experiments have been set up. Quantitative and qualitative estimations of the periphytic organisms were done at intervals of 15/30 days every month.

Associated problem : Induced breeding of *Mugil cephalus*
Duration : Three years
Personnel : R. M. Bhowmick, K. H. Ibrahim, G. C. Panicker and M. M. Bagchi

Brood fishes were obtained from commercial catches of the inshore region near the mouth of the Chilka lake during their migration to spawning ground. The females ranged from 0.75-1.50 kg and the males from 0.3-0.6 kg. The former was in the 4th to 5th stage of maturity and the latter in the oozing condition. A few spent specimens also occurred in the catches. Since no *hapa* could be fixed in the sea coast, the breeders were transported to a creek, about 3 kilometers away from the fishing ground, and released in *hapas* after recording their lengths and weights. Pituitary extract was prepared in 0.6% saline. A minimum of two and maximum of four injections were given, using homoplastic or heteroplastic glands in combination with synahorin.

15 sets of fish were injected and positive results were obtained in 6 sets (40%). One set released eggs in the *hapa* fixed in the creek, but there was no fertilization. Out of four sets, taken to the sea and stripped inside plastic pools, fertilization took place in two ; but the eggs died in the process of cell division probably due to low salinity of the experimental waters.

Project 6 : Freshwater prawn culture

Problem : 6.1 Freshwater prawn culture techniques
Duration : Four years
Personnel : K. Raman

The rearing of *Macrobrachium malcolmsonii* in two 0.012 ha nursery ponds (one planted with *Ottelia* and the other with a bamboo platform fixed near the surface) and in the third as a control pond, was wound up after $11\frac{1}{2}$ months in September, 1969 due to near flooding condition and sudden mortality of prawns for oxygen depletion. The pond with bamboo platform showed a survival of 32.8% and an average length of 61.4 mm while the other with *Ottelia* showed a survival of 29.3% and an average length of 63.0 mm. In control, 43% survival and an average length of 51.7 mm was obtained after 8 months.

Physico-chemical and biological conditions of the ponds and prawn fry resources of Mahanadi at Jobra (Cuttack) were studied during the prawn fishing season.

Project 7 : Murrel and live fish culture

Problem : 7.1 Induced breeding of murrels
Duration : Three years
Personnel : R. M. Bhowmick, K. H. Ibrahim, G. C. Panicker and M. M. Bagchi

To produce fry of commercially important species of murrels by hypophysation, about 500 fingerlings (*Channa striatus* and *C. marulius*) were collected from natural sources and stocked in a small channel pond, pending the partition of a section of the Killa moat to have stocking ponds for their rearing.

Problem : 7.2 Breeding of *Anabas, Clarias* and *Heteropneustes*
Duration : Three years
Personnel : H. A. Khan and M. K. Mukhopadhyay

Success was achieved in induced breeding of *Anabas testudineus* and one year old induced bred *Heteropneustes fossilis* by injection of pituitary extracts.

One set of one year old *Heteropneustes* sp. was spawned 4 times at an interval of 15 days by hypophysation.

Out of 15 sets of *Anabas* sp., 46,500 hatchlings were produced, but only 500 of them could attain the fingerling stage due to their cannibalistic nature. *Anabas* sp. fry, reared in nurseries, attained an average of 65.5 mm in length and 5.54 gm in weight in 7 months. Out of 5 sets of one year old *Heteropneustes* sp. which bred partially, 800 hatchlings were produced, but only 200 of them could attain the fingerling stage.

Project 8 : Estuarine and brackish water lake fisheries

Problem : 8.1 Brackish water fish seed prospecting
Duration : Three years
Personnel : V. Gopalakrishnan, Apurba Ghosh, N. K. Thakur, M. V. Gupta and K. K. Bhanot

Investigations on the brackish water fish seed resources at Port Canning, Nurpur and Bakkhali stretches of the Hooghly-Matlah estuarine system, were made during the year under report. The salient features are summerised below :

Matlah Estuary : Observations on the brackish water fish seed resources of the Matlah estuary were made at five centres ; *viz.*, Taldi, Port Canning, Bhangankhali, Basanti and Haide, using standard Midnapur type spawn collection nets. The collections made during December, '68—March, '69 show that the region of the estuary is moderately rich in seeds of brakish water fish and prawn. The prawns were : *P. indicus* (10-20 mm), *M. brevicornis* (20-70 mm), *P. stylifera* (30 mm), *P. sculptilis* (30 mm) and *P. monodon*. The fish seed obtained during the period were : *Mugil parsia* (20-45 mm) in February, postlarval stages of *Polynemus indicus* and *P. paradiseus* (5-8 mm) and *E. tetradactylum* in March and the juvenile sciaenids.

Hooghly Estaury : This stretch appears to be a promising one for the collection of brackish water fish seed, including prawns. The species encountered at Nurpur were : *M. parsia* (15-55 mm), *M. corsula* (20-26 mm), *M. cunnesius* (45-60 mm), *M. tade* (17-54 mm), *L. calcarifer* (40-50 mm) and *Mystus gulio* (12-65 mm). Catch/net/hour was the highest (100) in the month of January and 96% of the catch consisted of *M. parsia* and *P. styliferus*. *P monodon* (12-15 mm) was available in good numbers in March-April. At Diamond Harbour, the highest catch/net/hour was recorded in the month of March(153.21) and mainly contributed two commercially important species, *P. monodon* (12-15) and *P. indicus* (10-45 mm). The other species encountered were : *M. brevicornis, P. sculptilis, P. stylifera* and *P. styliferus.*

Collections of fish seed at Bakkhali during monsoon and winter months were generally poor. The commercially important species encountered in the samples were: *P. indicus, P. monodon, P. styliferus, M. brevicornis, M. monoceros, P. tenuipes* and *P. stylifera* among prawns and *Mugil parsia, E. tetradactylum, L. argentimaculatus* and *I. elongata* amnog fishes. Maximum quantity of *P. indicus* (9.22/net/hour) and *P. monodon* (15.43/net/hour) was available during the full-moon period in March.

Problem : 8.2 Prawn fishery of the Hooghly-Matlah estuarine system

Duration : Four years

Personnel: M. Subrahmanyam, V. Gopalakrishnan and R. M. Rao

8.2.1 Breeding and rearing of prawns under laboratory conditions

The zoeal stages of *Macrobrachium rosenbergii* could be reared up to stage IV only. The salinity and temperature of the water were 8.67-10‰ and 24-33.5°C respectively. After the liberation of zoeae, the same female could be bred again in freshwater in the presence of a male. The zoeae hatched out in freshwater, but no further development took place although they were acclimatized to low salinity medium (4.54‰).

8.2.2 Identification of stages between postlarval and adult stages of prawns occurring in the Hooghly estuary

The postlarvae and juvenile stages of *Penaeus monodon, P. indicus, Metapenaeus monoceros, M. brevicornis* and *Macrobrachium rude* were identified from the material collected from the Roopnarayan river at Kolaghat.

8.2.3. Location of seed collection centres

Investigations on the prawn seed resources from the Roopnarayan river at Kolaghat were completed. The postlarvae were available during full-moon and new-moon quarter both at high and low tides. *P. monodon* and *P. indicus* were the dominant forms as presented in table 23.

Table 23

Species	Tide	Locality	Period of collection	Catch/net/hr	Peak
P. monodon	High	Kolaghat *Khal*	Jan–June	1.79— 372.33	April
	Low	—do—	Jan—May	1.75— 496.88	March
	High	River Roopnarayan	Jan–July	0.71—1,030.35	March
	Low	—do—	Jan—June	1.26—1,077.25	April
P. indicus	High	Kolaghat *Khal*	Feb—May	3.13— 146.00	April
	Low	—do—	Jan—May	0.05— 95.63	February
	High	River Roopnarayan	Jan—July	0.08— 597.25	March
	Low	—do—	Jan—June	0.57— 147.50	April

The peak periods of abundance of both the species were March and April, being the periods of high salinity (10.65-15.89‰) with the water temperature range of 28.2-28.9°C. The postlarvae and juveniles of *M. monoceros* and *M. brevicornis* were recorded from April through October with a peak in July in the Kolaghat *Khal* at high tide (383/net/hour). Palaemonid postlarvae were recorded throughout with a peak in October (1,726/net/hour). The hydrological conditions during the year at the above place were : pH, 7.9-8.4 ; DO, 4.0-8.4 ppm ; salinity, 0.29-15.89‰ ; turbidity, 150-650 ppm ; and water temperature, 19.8-36.0°C.

Problem : 8.3 Fisheries of the Pulicat lake

Duration : Three years

8.3.1 Studies on larvae and juveniles of fish and prawn

Personnel: Ch. Gopalakrishnayya, A. V. Prabhakara Rao and K. Janardhana Rao

Postlarvae and juveniles of almost all species were represented in the catches throughout the year with their maxima in April and August-September. The species represented in the shooting nets were as follows: *Anchoviella baganensis*—eggs and larvae during February-May, August, September and November at Northern Sector around Irakkan and near Pulinjeri; *Anchoviella* spp.—eggs and larvae available round the year with peaks in June (26.4/net/hr), October (1,025.8/net/hr) and December (59.3/net/hr at the Lake-mouth) ; *Thrissocles* spp.—eggs and larvae caught round the year at the Lake-mouth with peaks in April (1,746.7/net/hr), August (1,463.5/net/hr) and October (128/net/hr) and caught during January-May and August-December at Northern Sector ; *Elops saurus—Leptocephalus* larvae available round the year, except in February and March, with peaks in April (12.4/net/hr) and July (38.3/net/hr) at the Lake-mouth ; *Megalops cyprinoides*—larvae during April-July and October-November with peak in April (30.43/net/hr) at the Lake-mouth ; *Chanos chanos*—larvae (11-15 mm) during January and March-October with peaks in April (87.14/net/hr) and September (12/net/hr) at the Lake-mouth ; *Mugil* spp.—fry available round the year with peaks in April (233.4/net/hr), October (20/net/hr) and December (4/net/hr) at the Lake-mouth; *Mugil vaigiensis*—juveniles (45-90 mm) during July-September at the Lake-mouth ; *Gerres* spp.—juveniles (10-25mm) caught round the year with peaks in March (71.9/net/hr) and June (51.1/net/hr) at the Lake-mouth ; and *Sillago sihama*—juveniles available round the year with peak in March (82.43/net/hr), June (30/net/hr) and October (15.8/net/hr).

Penaeus indicus—postlarvae were available throughout the year with maximum number during March (4,684.75/hr/shooting net), while tow nets caught maximum (277/hr/nets) in April. In March, *Penaeus monodon* yielded maximum catch (127.75/hr/net) by shooting nets, while tow nets showed maximum catches in January (12/hr/net) and April (12/hr/net). *Peneaus semisulcatus*

yield was maximum during March (66.25/hr/net) by shooting nets and during April by two nets. The incursion of *Metapenaeus* spp. was observed round the year with peak in July (1,031.33/hr/net) by shooting nets and in April (1,108/hr/net) by tow net. Compared to those of 1968, the incursion of larvae decreased in 1969. The respective average number/hr/net for the species in 1968 and 1969 by shooting nets were : *Penaeus indicus*—1,138.63 and 975.89, *P. monodon*—47.48 and 31.37 and *P. semisulcatus*—213.69 and 13.75.

8.3.2 Studies on mullets

Personnel: Ch. Gopalakrishnayya, R. D. Prasadan and C. P. Rangaswamy

The condition of feeding in *Mugil cephalus* did not reveal any change and the fish from the Adyar estuary and the Ennore backwater showed similar feeding habits. The modal lengths of 240, 300 and 435 mm from the size frequency distributions could be attributed to I, II and III year groups respectively. The sex ratio remained at 2:1::males:females. Mature males and females, during October-December, ranged from 372 to 425 and 490 to 554 mm respectively.

8.3.3 Bottom biota studies

(No progress during the period under report)

8.3.4 Studies on hydrography, plankton and productivity

Personnel: Ch. Gopalakrishnayya and M. Kaliyamurthy

Primary productivity ranged from 0.18 gm C/m^2/day in November to 1.8 gm C/m^2/day in April. Physico-chemical features were as in table 24.

Settled volume of plankton ranged from 0.12 ml in July to 34.6 ml in April. Among phytoplankton, Bacillariophyceae was dominant over Dinophyceae and Myxophyceae and it comprised *Rhizosolenia* spp. followed by *Coscinodiscus* spp. and *Chaetoceros* sp. Swarms of *Noctiluca* sp. were observed in August. The zooplankton was constituted by decapod zoeae, copepod nauplii and cladocerans.

8.3.5 Experimental fishing in the Pulicat lake

(No progress during the period under report)

8.3.6 Food habits of *Penaeus indicus*

(No progress during the period under report)

8.3.7 Marking experiments on *Penaeus indicus*

(No progress during the period under report)

8.3.8 Development of *Neptunus pelagicus* and *Scylla serrata*

(No progress during the period under report)

Table 24

Features	Lake-mouth		Southern Sector		Northern Sector	
	Min.	Max.	Min.	Max.	Min.	Max.
Air tcmperature (°C)	25.62 (Jan.)	30.28 (May)	25.20 (Jan.)	32.35 (Jun.)	27.42 (Dec.)	36.55 (May)
Water temp. (°C)	25.47 (Nov.)	30.12 (May)	25.10 (Dec.)	31.04 (Apr.)	25.41 (Dec.)	32.88 (May)
Depth (cm)	105 (Feb.)	174 (Dec.)	100 (Nov.)	297 (Dec.)	68.8 (Mar.)	137 (Jul.)
Secchi disc (cm)	38.8 (Nov.)	97.25 (Mar.)	53.00 (Dec.)	109.3 (Feb.)	22.0 (Apr.)	69.0 (Jan.)
pH	8.3 (Jan. & Nov.)	8.6 (Mar. & Apr.)	8.1 (Dec.)	8.7 (Apr.)	7.4 (Dec.)	8.7 (Apr., Jul., Sep. & Oct)
D. oxygen (ppm)	4.03 (May)	6.97 (Nov.)	3.8 (Jul.)	7.06 (Jan.)	4.1 (Jan. & Jul.)	7.57 (Feb.)
Salinity (ppt)	10.00 (Nov.)	39.65 (Jun.)	13.83 (Dec.)	39.5 (Jun.)	1.9 (Dec.)	52.0 (Jun.)
Total alkalinity (ppm)	43.4 (Nov.)	103.0 (Feb.)	55.67 (Dec.)	96.0 (Nov.)	49.28 (Nov.)	87.0 (Feb.)
Phosphate (mg/l)	0.17 (Feb.)	0.51 (Jun.)	0.169 (Jan.)	0.66 (Oct.)	0.75 (May)	0.410 (Dec.)
Silicate (ppm)	2.10 (Jun.)	21.25 (Dec.)	1.75 (Apr. & Jun.)	21.67 (Dec.)	0.67 (Apr.)	25.0 (Dec.)

Project 9 : Selective breeding and hybridization

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

Duration: Three years

Personnel: K. H. Ibrahim

Study on the carp hybrids, produced in 1967, showed that catla x mrigal hybrids commenced feeding at 7-8 mm stage, their gut contents showing mainly diatoms, desmids and rotifers. As the larvae grew further, their gut contents revealed mainly cladocerans, copepods, nauplii and rotifers. At 20 mm stage, the length of the alimentary canal was equal to the total length of the fry and at 60 mm it was $3\frac{1}{2}$ times the total length.

Histological examination of the alimentary canal indicated the presence of the following layers at its anterior part, the outer serosa followed by the longitudinal muscles, the circular muscles, the submucosa and finally the elongated columnar epithelial cells. Under nursery conditions, its growth was very slow and unsatisfactory, attaining only about 150-160 mm in two years. Detailed study of its morphometric, meristic and biological characters, has finally indicated that in this hybrid, the feeding spectrum is considerably reduced, which could probably be the cause for unsatisfactory growth.

Studies on similar lines were also carried out with mrigal x catla and rohu x mrigal hybrids. Growth was satisfactory in both. Striking differences in the pharyngeal complex could be observed in these hybrids, and in mrigal x catla the feeding spectrum was evidently increased.

Problem : 9.2 Storage of fish sperms

Duration: Two years

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

Preliminary experiments on the preservation of fish sperms indicated that GPC-5 solution was a more effective preservative than Frog Ringer's solution. Sperms of *Cyprinus carpio* survived only for 3 days in the latter, while in GPC-5 containing 1% glycerine, they were viable for 10 days at 1-10°C, showing very feeble movement. While sperms of *Mugil cephalus* were motile for about 5 minutes in sea water of 26.3‰ salinity, they died immediately in creek water having lower salinity.

Problem : 9.3 Hybridization between silver, grass and common carp

Duration: Three years

Personnel: S. B. Singh and P. C. Chakraborty

Observations on growth, feeding habit and maturity of the hybrid between female silver carp and male grass carp, produced during 1968, were made.

The progeny survived in ponds for 14 months and one week. At the end of 13½ months, the fish had attained an average size of 367.5 mm/450 gm, but were emaciated. Utilization of zooplankters, duckweeds, cut bits of *Hydrilla* sp. and *Najas* sp. by the hybrids appeared inadequate. The gill structure was intermediate between those of silver and grass carp. Pharyngeal teeth were present, as in grass carp. The testes of a dead specimen (388 mm/350 gm) were found to be in the I stage of maturity.

In addition to above three problems under Project 9, hybridization between the mullets, *Liza troschelii* and *Mugil cephalus* was attempted for the first time. The successful crossing of a female *L. troschelii* with male *M. cephalus* demonstrated the possibility of intergeneric hybridization among mullets. The fertilized eggs, however, died after the formation of embryonic streak.

Project 12: Exotic fish culture

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

Duration : Three years

Personnel: S. B. Singh and P. C. Chakraborty

Out of 28 sets of grass and 14 sets of silver carp injected with fish pituitary hormones, 8 and 7 sets yielded 1.63 and 1.72 lakhs of healthy spawn respectively. Natural spawning (without stripping) inside *hapas* in 6 sets of grass carp, was recorded, the spawning being completed in 5 sets. The dose of hormone administered varied between 10-16 mg/kg body weight of females and 2-3 mg/kg body weight of males. Observations on the role of ecological conditions in induced breeding of Chinese carps were made.

Problem : 12.2 Mono-culture of silver carp

Duration : Three years

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

In an experiment initiated in 1968 in two 0.12 ha ponds at stocking density of 5,000/ha and concluded in 1969 after 6 months, gross productions of 2,010 and 1,550 kg/ha/6 months were obtained. The average size of silver carp attained in the two ponds, were 422.5 gm/357 mm and 317 gm/318 mm, the rate of growth being slow. In a fresh experiment in the above ponds at 4,000/ha stocking density, the fingerlings which initially weighed 46 gm, have attained an average weight of 583 and 416 gm respectively within 8 months. Regular fertilization of the ponds with organic and inorganic manures is being done.

Problem : 12.3 Food preferences of grass carp.

Duration : Three years

Personnel : S. B. Singh, P. C. Chakraborty and M. Rout

12.3.1 Control of aquatic weeds by grass carp
(No progress during the period under report)

12.3.2 Suitable feeds for grass carp

Experiments on the feeding of fingerlings of grass carp inside plastic pools, were repeated. It was observed that cut leaves of potato, radish, cauliflower and cabbage were consumed in the order given. The grass carp fingerlings registered an average increase of 3.1, 2.5, 2.5 and 2.2 gm with leaves of radish, cauliflower, *Hydrilla* sp. and *Spirodela* sp. respectively in one month.

Project 13 : Coldwater fish culture

Problem : 13.1 Control of "whirling disease" in adult trout
Duration : Two years
Personnel : K. L. Sehgal and C. B. Joshi

Artificial feeding of trout on raw flesh of different fish species, partially boiled fish and partially boiled fish + liver + wheat middlings were continued for the second year. Brown and rainbow trout, fed with raw Schizothoracinae species and *C. carpio* after deviscerating and cleaning, have shown two and three cases of whirling during July-September respectively against eight in the control (fed with raw minnows). In the second set of experiments, using raw and partially boiled Schizothoracinae species and partially boiled Schizothoracinae spp. + wheat middling + liver, only two cases of whirling have been recorded in the control against nil in the experimental ponds. Thus, by using Schizothoracinae spp. as artificial feed for trout, the incidence of Vitamin B deficiency is reduced to the minimum. High range of temperature (13.4-17.3°C) in July—September, also added to the intensity of the disease.

Intramuscular administration of thiamine chloride (Berin B_1, Glaxo) at 1.5-2.0 cc did not help in checking whirling, probably due to the fact that the disease becomes noticiable at a very late stage when the fish does not respond to the treatment given. In early stages the symptoms of disease are not visible.

Problem : 13.2 Studies on the food and feeding habits of trout
Duration : Two years
Personnel : K. L. Sehgal and K. V. Ramakrishna
(No work has been done due to lack of facilities)

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

Experiments on the use of Malachite green (1:20,000) for one minute's dipping and Acriflavin (1:2,500) for 25 minutes, have shown that at the alevin stage, the survival was better in Malachite green treated as compared to Acriflavin. There was a sudden mortality of brown fry at Laribal and Harwan in April due to 'blackening' of the body and 'pin-head' condition. The mortality of fry was 23.08% at Harwan and 46.62% at Laribal in the total number hatched. Further loss of fry at both the farms occurred on account of natural calamities ; like, sudden rush of water in the troughs and hail storm. In all 500 fingerlings (45-115 mm) survived in both the farms and were handed over to the State Fisheries Department.

At Laribal and Harwan the feeding of brown trout with silkworm pupae powder + Aurofac A2 and only silkworm pupae powder respectively was continued till September. In October, breeders of brown trout (215 at Harwan and 194 at Laribal) were selected and segregated. The breeders were fed at 2% body weight with partially boiled fish. At Laribal and Harwan, breeders ranged between 297-372 mm ♂ /285-375 mm ♀ and 233-346 mm ♂ /205-340 mm ♀ respectively. In the third week of November, stripping operation commenced in both the farms and was completed by the end of the month. 22,379 eggs were stripped at Laribal and 32,747 at Harwan. The average number of eggs/kg of body weight was 1,373 at Laribal and 1,390 at Harwan. The average percentage of fertilisation was 94.06 at Laribal and 87.61 at Harwan. In both the farms, green eggs have been stocked in hatching trays at the rate of 3,000, 2,000 and 1,000 each in replicates of 3, 5 and 4 at Laribal and 3, 6 and 5 at Harwan.

The selection and segregation of rainbow trout breeders were completed in February. The breeders were fed with pellet feed at 2% body weight. Stripping was completed in the second week of March. A total of 28,128 green eggs were stripped and stocked in hatching trays at 3,000, 2,000 and 1,000/tray. The breeders ranged between 285-417 mm in total length and 300-700 gm in weight. The average number of egg/kg body weight was 2,619. Percentage survival of these eggs up to eyed-ova in the trays stocked at 3,000, 2,000 and 1,000 eggs/tray, was 89.14, 79.05 and 41.07 in control and 82.79, 87.54 and 73.01 in treated respectively.

Problem : 13.4 Propagation of mirror carp in hilly areas
Duration : Three years
Personnel : K. L. Shah and P. M. Abdul Quadir

During the year, 3,86,275 spawn of mirror carp, produced through artificial breeding of 17 sets of breeders, were stocked in nurseries, manured with cow-dung at the rate of 7,500 kg/ha. The rates of survival were 36.31% during May-June, 25.0% during July-August and 75.0% during August-September.

Two experiments on artificial feeding and growth rate were concluded in December. The average size and weight of fry at the time of stocking were

19.00 mm and 0.211 gm respectively. The increase in length/weight from May-December in the ponds with 2% and 4% feeding dose was 41.4 mm/1.793 gm and 40.9 mm/2.125 gm respectively against 36.8 mm/1.438 gm in control ponds. The size range of fingerlings in artificially fed ponds was 22.0-192.0 mm in total length against 20.0-200.0 mm in control ponds. Percentage survival of fry, was 43.4 at 4% feeding, 32.5 in 2% feeding and 30.3 in control. The physico-chemical factors in eight ponds ranged as: water temperatures, 10.0-35.0°C; pH>7.6; dissolved oxygen, 6.0-12.6 ppm and total alkalinity, 114.0-270.0 ppm.

Problem : 13.5 Survey of mahseer seed resources in Jammu
Duration : One year
Personnel : C. B. Joshi, K. L. Sehgal and Shyam Sundar

From July to September, spawning grounds and seed collection centres of mahseer were located and pin-pointed in the two selected streams Jhajjharkotli and Anji in the Tawi and Chenab systems respectively of Jammu Province. In Jhajjharkotli, it was not possible to make collection of eggs, as the stream was subjected to frequent floods and with every flood, the substratum was subjected to a change. Suitable centres for exploitation of mahseer hatchlings and fry were marked and pin-pointed in Jhajjharkotli. The average number of hatchlings and fry was 110/sq m of stream area. In Anji stream both, fertilised eggs and fry, were collected, the fertilised eggs ranging from 4-75/sq m of stream area and the hatchlings as well as early fry occurring in the range of 43-73/sq m area. The average physico-chemical factors of the breeding grounds in Anji stream were : turbidity, 0.4 cm ; water temperature, 27.4°C ; pH, 6.9 ; dissolved oxygen, 7.2 ppm ; free carbondioxide, 0.6 ppm ; total alkalinity, 78.8 ppm ; and silicates, 1.16 ppm. The eggs were collected from rapidly flowing water among the gravels and stones at an average depth of 47 cm.

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

Studies on physico-chemical factors, plankton, vegetation, bottom biota in relation to catch statistics were initiated in the Dal lake of Kashmir. The physico-chemical factors were in the ranges : depth, 2.16-4.66 m ; turbidity, 55.5-172.2 cm ; water temperature, 6.9-25.4°C ; pH, 7.5-8.5 ; dissolved oxygen, 9.2-11.4 ppm ; free carbondioxide, 0.2-6.0 ppm ; total alkalinity, 75.0-125.0 ppm and silicates, 0.34-0.90 ppm.

The plankton mainly consisted of Bacillariophyceae, Myxophyceae, Chlorophyceae and Desmidiaceae among phytoplankton and Protozoa, Rotifera, Cladocera and Copepoda among zooplankton. The common genera recorded

were : *Amphora, Asterionella, Cymbella, Gomphonema, Navicula, Synedra, Controphysis, Polyarthra, Alonella* and *Bosmina.* The vegetation in the lake consisted mainly *Myriophyllum, Potamogeton, Nymphea* and *Salvinia* while the biota inhabiting the vegetation comprised periphytic forms ; like, diatoms, green algae, protozoans and rotifers growing over the weeds and free living Diptera, Cladocera, Copepoda, Ostracoda and Amphipoda. Bottom mud samples analysed for bottom biota contained Oligochaeta (Naididae and Tubificidae) and Diptera (Chironomidae and Simuliidae) as the dominant groups.

Respective catch/man hour at Hazaratbal and Saidakadal was in the ranges of 152-588 and 241-700 gm. The catch/man hour along with catch composition from April to December is given in table 25. The main species of fish recorded at the two stations were : *S. esocinus, S. niger, S. curvifrons, C. carpio, C. latius, Labeo dero* and *Botia birdi.*

Table 25. Percentage composition of species and catch/man hour at Hazaratbal and Saidakadal area of the Dal lake.

Month	Hazaratbal					Saidakadal				
	Catch/man-hour (gm)	*Schizothorax* spp. (%)	*Cyprinus carpio* (%)	*Crossochei-lus latius* (%)	Miscellaneous (%)	Catch/man-hour (gm)	*Schizothorax* spp. (%)	*Cyprinus carpio* (%)	*Crossochei-lus latius* (%)	Miscellaneous (%)
April	386.0	39.30	57.10	2.50	1.10	415.5	33.40	60.80	5.10	0.70
May	510.3	10.36	88.82	0.34	0.48	308.3	2.06	93.06	3.76	0.12
June	435.0	6.90	86.00	5.00	2.10	483.0	0.60	98.26	0.84	0.30
July	408.5	17.14	61.51	20.87	0.48	479.0	26.45	51.75	19.65	2.15
August	588.7	14.59	64.57	17.08	3.76	700.2	12.23	55.45	27.45	8.87
September	301.2	4.66	61.14	27.33	6.87	287.9	1.66	90.43	4.57	3.34
October	152.9	1.80	40.10	57.50	0.60	241.6	4.02	60.25	26.08	9.65
November	341.8	3.92	68.12	27.46	0.50	302.6	16.76	78.60	1.63	3.01
December	207.9	40.08	46.69	11.22	2.01	362.9	18.73	71.22	6.93	3.92
Mean	370.2	15.41	63.79	18.81	1.99	397.9	12.99	73.31	10.58	3.12

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

Duration : Two years

Personnel : M. J. Bhagat and Kuldip Kumar

Creel census in two beats each of the Lidder and Sind trout streams in Kashmir, was made for the full angling season (from April to September). In

both the streams, fly and spoon fishing was done. The angling pressure in the two beats combined was 273 kg by 136 rods in the Sind stream and 681 kg by 343 rods in the Lidder stream ; i.e., about 2 kg/rod in both the streams. The physico-chemical factors were in the following ranges : turbidity, 9.2-16.0 cm ; water temperature, 4.4-14.1°C ; pH, 7.3-8.3 ; dissolved oxygen, 9.8-10.0 ppm ; total alkalinity, 35.0-96.0 ppm ; and silicates, 0.37-1.03 ppm. Plankton population which had gone down to 11 u/l in the Sind stream during August, showed an upward trend in October, reaching to the maximum in December (397 u/l, In the Lidder stream, the minimum was in August (50 u/l), but there was no marked fluctuation in plankton population. The main groups constituting the plankton were : Bacillariophyceae and Chlorophyceae, while zooplankters occurred as stray specimens. The insect and other aquatic life in two streams consisted mainly of Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Coleoptera and Diptera in percentages of 42.46, 5.93, 40.80, 0.63, 4.37 and 4.75 in the Sind stream and 41.93, 13.73, 25.37, 3.90, 3.76 and 6.43 in the stream respectively. The other aquatic life consisted mainly of *Gammarus pulex* and planarians. Their aggregate percentage were 1.06 in the Sind stream and 4.88 in the Lidder stream. The important forms of insects whose nymphs or larvae recorded, were : *Epeorus* sp., *Heptagenia* sp., *Ephemerella* sp. among Ephemeroptera ; Perlidae and Nemouridae among Plecoptera ; Rhyacophilidae, Hydropsychidae and Philopotamidae among Trichoptera ; and Chironomidae, Blepheroceridae, Simuliidae and Leptidae among Diptera.

Project 14 : Riverine and estuarine fish catch statistics

Problem	: 14.1	Fish catch statistics of the middle stretch of the Ganga river system.
Duration	:	Four years
Personnel	:	K. K. Ghosh, S. P. Singh, M. J. Bhagat, S. Jena, R. K. Sexena, G. N. Srivastava and S. N. Mehrotra

An attempt to completely list the *araths* where riverine fish catches are brought from the selected stretches of the Ganga river from Kalakankar tc Mirzapur and of the Yamuna river from Rajapur to Allahabad, showed a total of 44 *araths* in the area, 16 being regular annual *araths* and 28 seasonal. The variability pattern was analysed to find the magnitude of variation of the mean monthly landings between *araths*. Preliminary analysis within selected months at some *araths* showed that within *arath,* coefficients of variation ranged from 17 to 47% with an average of 30%, while between *araths,* variability study gave the coefficients of variation as 88%. The same coefficient dropped to 30% for regular *araths* and shot up to 90% for seasonal *araths*. The possibility of estimating the mean daily landings, using *araths* as first stage units, properly stratified into less variable groups, appeared feasible. The landing centre method did not meet with much success, because of innumberable fishing grounds being exploited irregularly at odd hours. The *arath* wise estimation

method would certainly have been of value to yield data on effort and biology also. The requirement of very heavy man power to procure a representative sample of catch appears to be the main difficulty.

Earlier, the survey centres maintained at Agra, Kanpur, Varanasi, Ballia and Patna for collection of statistics, were closed. A new survey centre was opened at Buxar in Bihar with a view to assessing the changes in the fishing effort and catches from the Ganga river since the closure of observations at Buxar earlier.

Primary productivity : Studies on primary organic productivity of the Ganga river system in the vicinity of Allahabad were continued. The observations were made at three centres : one on the Yamuna river and two on the Ganga river (one above and the other below the confluence). Primary organic productivity at the Yamuna centre ranged as 225-1,350 mg $C/m^3/6$ hr, at the Ganga centres above the confluence as 262.5-1,725 mg $C/m^3/6$ hr and below the confluence as 187.5-1,725 mg $C/m^3/6$ hr during 1969. Minimum carbon fixation was noticed in August at every centre, while maximum values were recorded in April in the Ganga river above the confluence, and in November in both, the Ganga river below the confluence and the Yamuna river.

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

Duration : Four years

Personnel : B. N. Saigal, S. N. Sar and R. K. Bhattacharya

The total annual fish landing for the lower stretch of the Ganga river system from Sultanganj to Lalgola was estimated to be 400.08 t. At Bhagalpur, the production registered a decline by 24.42% and at Lalgola an increase by 72.90% as compared to those of the previous year. Miscellaneous species were the prime contributors to the total production at Bhagalpur (53.59%) and Rajmahal (66.03%), while for Dhulian and Lalgola, it is the hilsa fishery which contributed maximum to the total, being 57.79 and 90.11% respectively. At Bhagalpur, the production for January, September, October and November was of 12.16, 11.54, 36.29 and 12.18 t respectively, while during the remaining part of the year, it varied between 2.92 t (August) to 8.20 t (December). At Rajmahal, the maximum production of 16.90 t was recorded in May, followed by 12.70 t in December and 10.95 t in October. Since Dhulian and Lalgola assembly centres are mainly dependent on hilsa fishery, the production was high during July to October when hilsa formed the main landing. At Dhulian, the maximum production was recorded in July and at Lalgola, in September. The centre wise landing of the individual species for the year is presented in the table 26.

The rate of net organic carbon assimilation in the lower stretch of the Ganga at Bhagalpur varied during the year from 150 mg $C/m^3/day$ (August)

to 1,410 mg C/m³/day (May). Higher productivity values (1,090-1,410 mg C/m³/12 hr) were recorded during January-June, followed by an abrupt decline during the monsoon months. A partial recovery was noticed through the post-monsoon months. No relationship could be deduced between pH, water temperature and rate of organic carbon assimilation.

Table 26. Centre wise fish landings (in t) in the lower stretch of the Ganga river

Assembly centres	*C. mrigala*	*C. catla*	*L. rohita*	*L. calbasu*	*M. aor*	*M. seenghala*	*W. attu*	*H. ilisha*	Miscellaneous	Total
Bhagalpur	4.41	9.96	5.23	0.74	4.04	4.22	18.45	7.56	63.07	117.68
Rajmahal	0.60	1.30	0.10	0.04	1.76	0.55	0.90	22.48	53.95	81.68
Dhulian	0.64	1,28	0.41	0.15	1.75	1.23	1.85	66.82	34.20	98.33
Lalgola	0.05	0.01	0.08	0.01	—	0.03	0.03	92.27	9.91	102.39
Total	5.70	12.55	5.82	0.94	7.45	6.03	21.23	179.13	161.13	400.08

Maximum density of phytoplankton was found to coincide with the highest values of organic carbon assimilation in May. Likewise, the lowest values of carbon assimilation during the monsoon months coincided with low density of phytoplankton. The ratio of zooplankters and phytoplankters varied between 1:2.8 (August) to 1:22.6 (November) during the year.

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

Problem : 14.4 Fish catch statistics of the Hooghly-Matlah estuarine system
Duration : Four years (initially)
Personnel: P. Dutta, G. C. Laha, P. Mitra, 2 Sr. Survey Assistants, 4 Survey Assistants and 4 Jr. Survey Assistants

14.4.1 Reorganised survey programme for the Hooghly estuary

The table 27 shows the zone wise catches of the Hooghly-Matlah estuary.

Table 27. Zone wise half-yearly catches (in t) in the Hooghly-Matlah estuary for the year ending November, 1969

Zone	December, '68 to May, '69	June, '69 to November, '69	Total	%		Difference *
I. Nabadwip—Calcutta	515.0	426 4	941.4	11.3	+	103.3
	(511.7)	(326.4)	(838.1)	(10.4)		
II. Calcutta—Diamond Harbour	110.9	215.0	325.9	3.9	+	9.1
	(141.2)	(175.6)	(316.8)	(3.9)		
III. Lower Sunderbans	3,962.6	2,193.3	6,155.9	73.8	+	332.5
	(3,493.0)	(2,330.4)	(5,823.4)	(72.3)		
IV. Rupnarayan	351.0	449.8	800.8	9.6	–	156.6
	(636.6)	(320.8)	(957.4)	(11.9)		
V. Port Canning	57.6	61.5	119.1	1.4	+	0.8
	(61.7)	(56.6)	(118.3)	(1.5)		
Total	4,997.1	3,346.0	8,343.1	100.0	+	289.1
	(4,844.2)	(3,209.8)	(8,054.0)	(100.0)		
%	59.9	40.1	100.0			
	(60.2)	(39.9)	(100.1)			

N.B.—Figures within brackets relate to the corresponding period of the previous year i.e., 1968.

* These figures relate to the differences between the totals of current year and the previous year i.e., 1968.
Due to rounding off, the difference in total catch has become 289.1 t although the actual figure is 289.0 t.

The catch during the twelve months ending November, '69 was 8,343.1 t against 8,054.0 t of the last year, showing an increase of 289.1 t (Table 28). Contribution of Zone III to the total catch is 73.8% against 72.3% of the last year. Zone I and Zone IV commanded approximately 11 and 10% of total catch respectively. Species wise landings are shown in table 28.

Table 28. Species wise catches for the year ending November, 1969

Species	1969		1968	
	Kg	%	Kg	%
M. tade	13,101	0.2	12,017	0.1
M. parsia	56,291	0.7	58,160	0.7
L. calcarifer	25,342	0.3	21,729	0.3
S. panijus	45,098	0.5	57,603	0.7
P. paradiseus	63,724	0.8	38,906	0.5
P. indicus	2,11,591	2.5	2,43,757	3.0
E. tetradactylum	27,063	0.3	28,111	0.3

Table 28 (*Contd.*)

Species	1969		1968	
	Kg	%	Kg	%
S. biauritus	2,57,826	3.1	97,095	1.2
S. miles	31,878	0.4	21,881	0.3
P. pama	3,91,619	4.7	1,91,949	2.4
H. ilisha	11,31,866	13.6	5,89,390	7.3
H. toli	17,317	0.2	22,985	0.3
I. elongata	1,15,844	1.4	75,927	0.9
C. ramcarati	89,035	1.1	68,840	0.9
C. borneensis	7,331	0.1	2,495	*
S. phasa and *S. taty*	6,11,425	7.3	5,21,877	6.5
P. pangasius	1,20,252	1.4	1,06,806	1.3
T. jella	4,19,537	5.0	1,12,601	1.4
O. militaris	21,384	0.3	10,069	0.1
P. canius	16,359	0.2	7,103	0.1
T. savala and *T. haumela*	3,09,673	3.7	4,26,200	5.3
H. nehereus	15,46,776	18.5	22,30,976	27.7
S. cinereus	64,440	0.8	1,34,937	1.7
Prawns	11,10,789	13.3	11,93,854	14.8
Miscellaneous	16,37,491	19.6	17,78,771	22.1
Total	83,43,052	100.0	80,54,039	99.9

* Indicates less than 0.05%.

The species which predominated in catches, were: *H. nehereus* (18.5%), *H. ilisha* (13.6%), prawns (13.3%), *S. phasa* & *S. taty* (7.3%), *T. jella* (5.0%) and *P. pama* (4.7%). The species for which catches had gone up appreciably were: *H. ilisha* (by 542.5 t), *T. jella* (by 306.9 t), *P. pama* (by 199.7 t), *S. biauritus* (by 160.7 t) and *S. phasa* & *S. taty* (by 89.5 t). The species which registered decline in the catches were: *H. neherus* (by 684.2 t), *T. savala* & *T. haumela* (by 116.5 t) and prawns (by 83.1 t).

The position of the gears in order of their contribution is shown in table 29. Bag nets, as usual, have led with 53.8%. Drift nets (15.2%), large seine (10.1%), small seine (9.9%) and hooks & lines (3.3%) came next in order. The migratory bag net fishery usually starts a little earlier to November and continues till about the end of February. The total number of bag nets, operating around Fraserganj towards the close of the year, is 271 as against 334 of the last year. The total catch from the migratory bag net fishery, was 2,374.7 t

against 3,040.4 t of the last year. The main species caught were : *H. nehereus* (43.9%), *S. phasa* and *S. taty* (15.9%), *T. savala* and *T. haumela* (11.2%), *S. biauritus* (4.9%) and prawns (4.6%).

Table 29. Gear wise catches for the year ending November, 1969 at the Hooghly-Matlah estuary

Gears	1969		1968	
	Kg	%	Kg	%
Trawl	1,79,445	2.2	1,40,611	1.7
Large seine	8,42,450	10.1	4,31,912	5.4
Small seine	8,23,825	9.9	6,24,340	7.8
Purse	15,853	0.2	10,796	0.1
Drift	12,67,745	15.2	7,05,141	8.8
Lift	1,00,793	1.2	95,522	1.2
Cast	27,934	0.3	26,957	0.3
Bag	44,91,026	53.8	52,85,789	65.6
Set gill	79,511	1.0	2,81,912	3.5
Set barrier	1,36,540	1.6	1,41,894	1.8
Traps	50,724	0.6	26,358	0.3
Hooks and lines	2,72,459	3.3	2,20,375	2.7
Unknown and unclassified	54,747	0.7	62,432	0.8
Total	83,43,052	100.1	80,54,039	100.0

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

The work, based on the data relating to Raidighi was completed. Simple random sampling was found to be uniformly superior to systematic sampling of the same size, estimated variances of the estimates being all uniformly lower for simple random sampling in respect of all the selected species. For confirmation, the data of Namkhana were subjected to the same mode of analysis. Estimation of means and variances on the basis of simple random sampling were completed. Estimation of means and variances of the same selected species and also of total landings by systematic sampling were also done.

Problem : 14.5 Fish catch statistics of the Pulicat lake

Duration : Three years

Personnel: Ch. Gopalakrishnayya, H. Srikant, K. Janardhan Rao, S. Srinivasagam and S. Ganesan

The total estimated landing of the lake was 1,140.7 t, showing a rise of 23.06% over that of the previous year. Prawns contributed 564.1 t. *P. indicus*, *M. dobsonii* and *M. monoceros* yielded 61.93, 15.52 and 10.73% of the total prawn catch. Mullets contributed 215.65 t. *Mugil cephalus* (57.18%), *M. tade* (15.8%) and *M. cunnesius* (14.55%) were the main contributors. Clupeids yielded 105.0 t. The important species were *Nematolosa nasus* (57.27%), *Chanos chanos* (19.39%) and *Trissocles* spp. (15.51%). The perches were next in order of abundance (96.7 t) and comprised *Sillago sihama*, *Lates calcarifer* and other species, being 34.24, 18.27 and 17.74% respectively of the landings.

Stake nets (413.9 t), drag nets (254.7 t), shore seine (150.5 t) and hooks & lines (87.7 t) caught the major portion of the total catch. *Badivalai* recorded the highest catch/net/hr with 59.9 kg. The catch/net/hr for *Oivalai* was 11.1 kg and for *Panthavalai*, 8.8 kg. The catch/net/day for *Kondavalai* and *Sillappuvalai* were 3.0 and 1.6 kg respectively.

Project 15 : Fish Pathology

Problem : 15.1 Etiology and control of parasitic diseases of cultured warmwater fishes

Duration : Four years

Personnel : R. N. Pal, A. K. Ghosh and V. Gopalakrishanan

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

1,130 spawn of Indian major carps were examined during the period under report. None of them was found to harbour any parasite.

1,357 fry and 362 fingerlings of Indian major carps were also examined during the period under report and the data collected are furnished in table 30.

Table 30

Species	Size range (mm)	Fish examined (No.)	Percentage of infection with			
			Trichodina	*Myxobolus*	*Thelohanellus*	Monogenetic Trematode
C. catla	12-50	157	5.75	—	—	—
	51-235	70	64.29	25.71	—	14.29
L. rohita	11-50	572	—	—	—	—
	51-160	130	67.69	—	58.46	3.08
C. mrigala	9-40	628	15.29	—	—	—
	41-270	162	62.35	83.95	—	37.04

15.1.2 Studies on epidemical diseases

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

15.1.3 Studies on parasites of freshwater prawns

2,230 prawns were examined during the period under report. Data collected are furnished in table 31.

Table 31

Species	Size range (mm)	Prawns examined (No.)	Prawns infected (No.)	Percentage of infection
M. rude	14-83	245	0	—
M. villosimanus	26-95	438	2	0.05
M. mirabile	32-55	363	4	1.1
M. malcomsonii	19-110	798	42	0.5
M. lamerrei	30-54	685	158	23.0
P. sculptilis	40-71	19	1	5.26
P. monodon	91	1	0	—
M. scabriculum	31-58	29	0	—
M. dayanum	41-73	14	0	—
Caridina sp.	36	1	0	—

Project 16 : Weed Control

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

Duration : Three years

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

16.1.1 Control of water hyacinth

A tentative categorization of field infestations of water hyacinth in and around Cuttack, was made, basing on the density, size and leaf area into three categories as in table 32.

Table 32

Category		Individual plant height (cm)	Individual plant weight (gm)	Average density of plants (sq m)		Average leaf area of plants/sq m (sq m)	Average surface area/leaf (sq cm)	Average weight of stem (gm)
				(No.)	(gm)			
I	Small	20.1-25.9	100	145-176	6.5-16.2	2.90-4.00	21.60-33.0	2.0-13.0
II	Medium	42.3-75.1	100-500	45-82	12.9-25.7	2.25-5.34	30.96-122.7	14.5-54.2
III	Large	84.3-89.7	7,500	24-77	16.4-36.0	2.40-5.82	69.20-116.4	87.6-183.6

The response of the above three categories of plants to 2, 4-D in yard trials, indicated that a dose of about 5 mg of 2, 4-D/kg plant weight was required to achieve 100% kill in the first category and of 10-15 mg in the other two categories. Under field conditions a dose of 30 mg was necessary to bring about complete kill of the higher weight groups. The cost of clearance by chemical method worked out to be Rs. 122.35 as compared to Rs. 450-800/ha by manual method.

16.1.2 Control of other floating and rooted emergent weeds and grasses

Yard trials indicated that though 2-3 mg of 2,4-D/plant of *Cyperus* sp. in the 51-100 cm group could kill the plant, prolonged control of regeneration was not possible. 2, 4-D amine salt (Herbazol) was found very effective against *Nymphoides cristatum* at the rate of 5 kg a.i./ha in yard trials.

A field infestation of *Nelumbo nucifera* in Central Rice Research Institute Tank (3 ha) was cleared by spraying with 80% sodium salt (Hexamer) @ 10 kg a.i./ha using 0.25% of 'Surf' as a wetting agent.

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

The density of algae in four ponds studied season wise, showed a variation between 1,03,000-4,89,000/l. The same observations are being repeated during this year along with culture of bloom forming algae in the yard.

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

Phenoxylene (a.i. 25% MCPA @ 5 litres/ha in a field trial against *Ipomoea aquatica* and Simazine @ 5 kg/ha in a yard trial against *Salvinia* sp. gave satisfactory kill. A field infestation of *Pistia* sp. could be controlled with Gramoxone (a.i. 20% paraquat) @ 0.2 kg/ha at a cost of Rs. 75/- compared to Rs. 185/ha by manual clearance. The 12 hr TLm (tolerance level medium) was found to be 250 ppm against *Cyprinus carpio* fingerlings. Tafapon (85% sodium salt of 2,2-dichloropropionic acid) adversely affected *Panicum* sp. @ 10 kg/ha in small scale field trial.

The effect of laboratory prepared 2,4-D and Simazine granules kept regeneration of *Ottelia* sp. and *Hydrilla* sp. under check in the ponds treated in 1968.

Pithophora sp. was adversely affected by laboratory prepared Simazine granules @ 1 kg a.i./ha in a field infestation.

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

Duration : Four years

Personnel : V. Ramachandran

In a field trial to control water hyacinth, aqueous ammonia sprayed @ 14 kg N/ha with kerosene as an additive failed to kill the plants though there was visible foliar damage.

Yard experiments indicated that ammonia applied in the water near the roots adversely affected water hyacinth.

Problem : 16.5 Eradication of weeds by treatment of bottom soil with copper sulphate or superphosphate in mud pellets

Duration : Two years

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

Scripus articulatus is a strongly rooted grass, growing from the margins of the ponds to deeper layers of water. The plant has been successfully controlled by 4 intermittent doses (@ 35 kg/ha each) of copper sulphate mud pellets. For tne last 10 months, the regrowth of *Scripus* in the treated area is nil. In the control region, the plants are occassionally taken out by manual labour ; but they are constantly showing healthy growth. In the treated region, the maximum rise of copper ion in waer was 0.4-0.5 ppm.

In a pond, thickly, infested with the plants (*Vallisneria spiralis, Hydrilla verticillata, Potamogeton pectinatus, Ottelia alismoides* and *Nymphoides cristatum*) submerged floating plant (*Ceratophyllum demersum*) and having the green algae (*Cladophora glomerata*) as 10-15 cm thick layer on the bottom soil, four intermittent doses of copper sulphate (@ 35 kg/ha) were applied. After treatment, the rooted plants and the algae, *Cladophora* sp., floated up and were taken out by manual labour. The pond is remaining free of all types of weeds from July 1969. In another big lake (30,717 sq m), four intermittent doses (35, 10, 15 and 15 kg/ha) of copper sulphate were applied to the bottom soil in mud pellets during 28 days (end of November to middle of December). The treated area was thickly infested with *Vallisneria spiralis, Potamogeton pectinatus, Hydrilla verticillata, Ceratophyllum demersum, Nymphoides cristatum,* and scattered *Nymphea rubra. Hydrilla* plants showed 80% decay after the second dose. The 3rd dose was applied on the tenth day and the 4th dose was applied on the 23rd day from the second dose. Still the plants are getting uprooted and floating in a decayed condition and the manual cleaning of the area is continuing.

Associated problem : To make use of eradicated weeds in the form of compost for manuring fish ponds, *Eichhornia crassipes* and *Spirodela polyrrhiza* were separately made into compost. The jars with compost as substratum gave maximum production of phyto- and zooplankton than the jars with only soil as substratum or jars without any substratum. The plankton and the water analyses have been completed. The soil analyses is in progress.

Problem : 16.6 Autecology of *Vallisneria spiralis*

Duration : Two years

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

With the treatment of bottom soil, *Vallisneria* sp. showed almost 90% decay of underground parts and floated up. When kept in aquaria in floating state, they remained healthy for some time with the roots much reduced and vegetative propagation retarded. No sexual reproduction was observed. Floating plants on coming in contact with the soil, started rooting in.

Mature fruits of *Ceratophyllum demersum* were collected from ponds and observations were made on the germination of the seeds under different laboratory conditions. The seeds showed epigean germination, initially remaining on the soil and later floating up. The germinating plants showed formation of roots during primary stages of germination and later survived as rootless plants.

Project 17 : Frog Farming

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

Duration : Three to four years

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

36 out of 37 sets of *R. tigrina* and 2 sets of *R. hexadactyla* were bred with injections of homo- and heteroplastic pituitary gland extracts. The dose of extract for successful breeding of *R. tigrina* has been standardised. The time lapse between injection and final stripping has been reduced from 18 to 5/6 hr. Artificial fertilisation of eggs by dry method with sperm suspension yielded cent percent success. Incidental to induced breeding experiments, nearly one lakh tadpoles of the above species were produced. 4 out of 5 sets of *R. tigrina* could also be made to breed with progesterone alone and in combination with homoplastic pituitary gland extracts.

Fecundity study in *R. tigrina* revealed that the number of ova varied from 4,000 to 11,000 within a size range of 90-140 mm.

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

Duration : Three to five years

Personnel : A. K. Mondal, R. K. Jana, P. Gopalakrishna, One Survey Assistant and V. Panigrahi

Culture of fertilised eggs of *R. tigrina* and *R. hexadactyla,* obtained through induced breeding experiments, was done in pond water. Observations were made on the preferred food items of tadpoles. Tadpoles of *R. tigrina* prefer zooplankton, tubifex and earthworms to other food items. Tadpoles of *R. hexadactyla* could be reared with cent percent survival in cement cisterns by provisions of *Spirogyra* sp., *Oedogonium* sp., *Lemna* sp. and *Hydrilla* sp. While metamorphosis of tadpoles of *R. hexadactyla* was completed normally in 5 weeks, that of *R. tigrina* took 20 days to 1 month.

One yard experiment was conducted in 6 cement cisterns with a stocking rate of 500 early tadpoles of *R. tigrina*/250 litres of water. The final survival was slightly above 80% for *R. tigrina,* as compared to cent per cent survival of *R. hexadactyla* tadpoles in another experiment, conducted in 3 cement cisterns with a stocking rate of 1,00 tadpoles/250 litres of water. In laboratory and field experiments, powder of *Barringtonia acutangula* was found to be of use for assessing survival of tadpoles in field nurseries.

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

Duration : Five years

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

Early frogs of *R. hexadactyla* were stocked @ 6,000/ha in a fenced 0.08/ha rearing pond, provided with adequate quantity of suitable aquatic weeds. After a ten month rearing period, the frogs were found to grow to a size of 103.7 mm/145.1 gm resulting in production of 664.9 kg/ha. The final survival was 76.3%. Early frogs of *R. tigrina* were stocked at the same rate in a fenced 0.04 ha pond, having upland feeding ground. After 6 months, the experiment had to be discontinued, since growth and survival of the frog suffered heavily due to lack of insect food.

Problem : 17.4 Fish cum frog culture

Duration : Five years

Personnel : A. K. Mondal, P. Gopalakrishna, R. K. Jana, D. P. Chakraborty, V. Panigrahi and N. C. Mazumdar

A second experiment on joint rearing of frog and fish, was conducted during 1969. Early frogs of *R. hexadactyla* @ 6,000/ha were stocked along with early fingerlings of Indian major carps @ 4,000/ha and in the ratio of catla : rohu : mrigal : : 3 : 3 : 4, against suitable controls. The experiment has been concluded after a ten month rearing period. Frogs and fish were found to

grow to a size of 103.4 mm/139.2 gm (*R. hexadactyla*), 339.5 mm/375.5 gm (catla), 348.4 mm/408.8 gm (rohu) and 343.2 mm/390.0 gm (mrigal) in the experimental ponds, as against 103.7 mm/145.1 gm (*R. hexadactyla*), 356.5 mm/406.2 gm (catla), 345.7 mm/393.7 gm (rohu) and 326.1 mm/296.5 gm (mrigal) in the control ponds. The production of *R. hexadactyla* and fish was 423.0 and 1,430.8 kg/ha in 10 months respectively in the experimental ponds as against the individual production of 664.9 and 1,387.6 kg/ha of *R. hexadactyla* and fish respectively in the control ponds during the same period.

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

Specimens of the North American bull frog, *Rana catesbeiana*, received from Texas (USA), bred in the environmental and climatological conditions obtaining at Cuttack. Some of the tadpoles were reared up to juvenile stages in the laboratory. Tadpoles fed on roots of aquatic vegetation, required $1\frac{1}{2}$ months for their metamorphosis. The post-metamorphic forms which fed on worms, insects and other small animals, showed an average growth of 96 mm/94.4 gm in six months' observational period in the laboratory.

Project 18 : Sewage fed fisheries

Problem : 18.1 Ecology of sewage fed fisheries
Duration : Two years
Personnel : S. D. Tripathi, P. Ray, R. R. Khan and P. K. Chakrabarti

Two ponds, selected earlier, were rejected due to practical difficulties. A fresh set of ponds (productive and unproductive ponds both fed by raw sewage water and a fresh water pond) was selected for ecological studies from December, '68 onwards. Physico-chemical factors analysed were found to range as 19.1-29.30°C for temperature, 85-125 ppm for turbidity, 7.7-8.8 for pH, 3.5-16.3 ppm for DO, 22.9-63.4 for OC, 255-298 ppm for alkalinity, 176-710 ppm for chloride, 0.38-2.2 ppm for nitrate, 0.41-3.8 ppm for phosphate and 9.1-32 ppm for silicate in Gunadhar Babu's pond which is supposed to be productive pond. In Charubala's unproductive pond, the respective values were : 18.7-29.6°C, 85-125 ppm, 7.8-8.4 ppm, 1.87-8.4 ppm, 22.9-70.1 ppm, 264-327 ppm, 299-510 ppm, 0.55-1.0 ppm, 0.48-4.71 ppm and 8.4-15.4 ppm. In fresh water pond, however, the corresponding ranges were : 22.8-28.9°C, 111-112 ppm, 8.3-8.9, 5.6-8.37 ppm, 71-78 ppm, 323-411 ppm, 640-656 ppm, 0.68-0.69 ppm, 0.93-2.0 ppm and 13.0-19.0 ppm. Primary productivity in these three ponds ranged between 171-915, 179-652 and 264-354 mg C/m^3/hr respectively. Physico-chemical characteristics of the raw sewage which feeds the ponds, were : 117-362 ppm for turbidity, nil for DO, 29-68 ppm for OC, 29-68 ppm for

alkalinity, 282-1,113 ppm for chloride, 0.31-3.1 ppm for NO_3, 0.42-3.76 ppm for PO_4 and 19-32 for silicate.

Project 19 : Hilsa fisheries

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

Duration : Five years

Personnel: Ravish Chandra, V. R. Desai and Balbir Singh

Presence of hilsa larvae in the collections at Agiabirghat, Samneyghat, Sujabad and Saraswatighat during late winter months confirmed the late winter spawning of hilsa in this stretch. Larval abundance of hilsa at various centres on the Ganga and Yamuna rivers, commencement and duration of spawning season, peak period of spawning and the catch/hr of hilsa larvae are presented in table 33.

Table 33. Details of spawning period and larval abundance of *Hilsa ilisha* in the middle stretch of the Ganga river system

Centre	Spawning period	Peak spawning period	Catch/hr	Remarks
Vindhyachal	September-November	Middle of October	3,250	Catch declined to 3.6/hr by November
Sindhoraghat	September-November	Third week of October	1,31,223	Declined to 19.5/hr by November
Agiabirghat	September-November	Third week of October	7,000	Declined to 1.83/hr by November
Sujabad	October	Last week of October	5,750	Very much reduced by November
Mahewa	October	Middle of October	26,250	Declined to 0.33/hr by November

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

Duration : Five years

Personnel: K. V. Rao, B. N. Saigal, S. N. Sar and R. K. Bhattacharya

The annual production of hilsa from Sultanganj to Lalgola was estimated to be 179.13 t. Lalgola, Dhulion, Rajmahal and Bhagalpur accounted for 51.51, 31.72, 12.54 and 4.23% of the annual yield respectively. The production of hilsa at Bhagalpur registered a decline by 29.50% and at Lalgola an increase by 128.96% over that of the preceding year. Month wise landings indicated that the period, June to October, accounted for 92.9% of the total fish production at all the centres.

The intermingling pattern of the three sub-populations of hilsa, during the year, showed that slender variety contributed 65.00% at Bhagalpur, and only 17.10% at Lalgola. The broader variety accounted for 59.40% catch at Lalgola and 12.80% at Bhagalpur. The broad variety varied between 22.03-24.50% of catch at different centres. While at Bhagalpur and Lalgola, the slender and broader sub-populations respectively dominated over the other two varieties throughout the year, Rajmahal and Dhulian did not show any regular pattern of dominance. At Bhagalpur, the broader variety dominated in numbers during March (55.55%) and June (68.00%); the broad variety, in May (41.65%) and November (46.62%); and the slender variety, during the remaining part of the year. Slender sub-population dominated throughout the year at Dhulian, excepting January, when the broad variety accounted for 42.84%. At Lalgola, the broader variety dominated throughout the year excepting May when the broad variety was maximum (51.70%).

Investigations on the larval abundance of hilsa were continued in the stretch between Gangani and Lalgola. The spawning of hilsa was observed during the post-winter (February to April) and again in the monsoon (June to October) with peak spawning in the later half of March at Bhagalpur and in the early part of April at Rajmahal and Dhulian. Another spawning peak was observed in July at all the centres. The availability of 4 mm stage larvae at these three centres tends to show that spawning at a centre is independent of the other two. Surface and sub-surface collections, using 1/16″ mesh Midnapur type shooting nets at Bhagalpur during February to April, indicated higher concentrations of larvae in the surface zone as compared to the sub-surface and bottom strata.

Problem : 19.3 Hilsa fisheries of the river Godavari

Duration : Three years

Personnel: T. Rajyalakshmi (Mrs), P. L. N. Rao, G. R. M. Rao and L. H. Rao

Delimitation of spawning grounds: Observations on the delimitation of spawning grounds of the Godavari hilsa were limited to the stretch from the upper tidal limits of both the branches up to 7 km upstream of the Dowleiswaram anicuts, a distance of about 60 km. A few observations were also made at Rajahmundry and Devipatnam, located about 8 and 50 km respectively upstream of the anicuts. These observations confirmed those of the previous year, that hilsa spawn late in the season of migration; *i.e.*, by the 3rd week of September and continues to spawn up to November. Only at Kotipalli, early spawning was observed in August. The larval concentration was found to be poor in the Vasishta branch. Dowleiswaram appeared to be the main breeding area. Larvae were recorded for the first time at Rajahmundry and Devipatnam. There was evidence of large scale migration of hilsa breeders over the anicuts during September and October. The ovary size of the breeding stock was found to be smaller than that observed during the previous years.

Induced breeding: Induced breeding of hilsa by stripping was attempted for the second season in succession. Females were stripped and fertilisation was done with the sperms teased out from the testis of a killed male. Percentage of fertilisation was very low and no development occurred.

Problem : 19.4 Hilsa fisheries of the Hooghly-Matlah estuarine system

Duration : Three years

Personnel: Apurba Ghosh, M. V. Gupta, K. K. Bhanot and V. Gopalakrishnan

To delimit hilsa spawning grounds and to estimate spawning and survival rate, the stretch of the Hooghly estuary from Nawabgunj to Datrigram was taken up. Collections were made with shooting and tow nets at Nawabgunj, Jubilee Bridge, Tribeni, Balagarh, Kalna and Datrigram during monsoon (July, August and September). Analysis of the samples showed the abundance of *Hilsa ilisha* larvae and fry, at Kalna (106.79/net/hr) and Balagarh (95.91/net/hr) during September. The length range recorded at Balagarh was 4-30 mm and that at Kalna 13-33 mm. Larval concentration of *H. ilisha* was also observed further up beyond Kalna at Datrigram (45.0/net/hr) in September. Earlier observations, made during identical period, showed that very few *H. ilisha* larvae were available in the Hooghly estuary beyond Medgachi (near Balagarh); but the present observations revealed that the availability of hilsa larvae was more at Balagarh and at other centres, situated above Balagarh, than at the centres situated lower down, which might be due to the migration of the monsoon breeders in search of suitable spawning grounds.

Comparative efficiencies of shooting nets made of 1/8" mesh cloth and markin cloth were tested by operating one net of each type side by side at Balagarh. The catch/net/hr was estimated and 1/8" meshed net was found to be better with a catch rate of 143 postlarvae and fry of *H. ilisha*, while the closed net gave the value of only 10 numbers of the said species.

Problem : 19.5 Artificial propagation of *Hilsa ilisha* (Ham.)

Duration : Five years

Personnel: J. C. Malhotra, P. K. Mathur and M. Y. Kamal

Artificial fecundation through stripping: Investigations carried out during September and October at Varanasi and Sirsa on the Ganga river were highly successful. The results achieved through stripping were more encouraging than those in the preceding year. At Sirsa, 27 out of 28 strippings attempted were successful. The details of all the 28 experiments are given in table 34. In experiment Nos. 2, 3, 4, 8 and 27, more than one male were stripped, since none of the partly spent males yielded milt sufficient enough to fertilize all the eggs stripped from one female hilsa. In other experiment, as in the preceding year, it was observed that one ripe unspent male, after yielding a quantity of milt sufficient enough to fertilize the stripped eggs from a female, still had much

of the milt left in the testes. The rate of fertilization ranged from 20 to 90%. Wet method was tried on an experimental basis, but the rate of fertilization was only 5%. Further, it was observed that in dry method probably much more milt may be necessary to fertilise all the stripped eggs ; *i.e.,* it may be necessary to employ more than one ripe male for each gravid female.

Table 34. Details of stripping experiments

Sl. No.	Date	Time of stripping (hr)	Total length of female (mm)	Maturity stage	Total length of male (mm)	Maturity stage	No. of eggs stripped (lakh)	Percentage of fertilisation	Percentage of hatching
1.	12.10.69	16.35	485	G	390	R	8.0	85	10
2.	13.10.69	17.00	470	G	451	P.s.	9.6	70	25
					406	P.s.			
3.	13.10.69	17.25	450	P.s.	420	P.s.	3.6	80	25
					310	P.s.			
4.	15.10.69	16.30	470	G	425	P.s.	22.2	80	63.33
					366	P.s.			
					345	P.s.			
5.	15.10.69	17.15	476	G	435	R	10.5	0	0
6.	15.10.69	17.30	500	G	473	R	10.2	80	25
7.	16.10.69	17.25	496	G	445	R	6.6	24	85
8.	17.10.69	17.00	480	G	425	P.s.	8.4	85	65
					407	P.s.			
9.	19.10.69	17.15	—	G	—	R	18.0	90	20
10.	19.10.69	17.30	—	G	—	R	7.6	80	15
11.	20.10.69	18.00	460	P.s.	—	R	4.2	50	30
12.	20.10.69	18.05	475	P.s.	—	R	0.6	35	20
13.	21.10.69	16.45	480	G	405	R	9.6	35	10
14.	21.10.69	17.30	493	G	340	R	7.2	90	5
15.	21.10.69	18.15	480	P.s.	380	R	1.8	80	6
16.	21.10.69	19.00	505	P.s.	425	R	1.2	90	5
17.	21.10.69	19.30	470	P.s.	421	R	1.2	90	6
18.	21.10.69	20.00	480	P.s.	345	R	1.2	90	5
19.	21.10.69	20.15	504	P.s.	380	R	1.8	80	8
20.	21.10.69	20.00	490	P.s.	300	R	4.4	20	70
21.	22.10.69	17.55	—	G	—	R	6.0	90	80
22.	22.10.69	18.10	467	P.s.	395	R	1.0	92	75
23.	22.10.69	18.25	467	P.s.	395	R	3.0	65	5
24.	22.10.69	18.45	458	G	350	R	10.0	30	3
25.	23.10.69	17.20	459	G	350	R	8.0	25	25
26.	23.10.69	17.35	486	P.s.	425	R	2.0	80	20
27.	30.10.69	18.30	480	G	435	P.s.	18.2	70	5
					310	P.s.			
28.	4.11.69	17.50	469	P.s.	367	R	4.0	85	45

G = Gravid P.s. = partly spent R = ripe (oozing)

Dead parents were employed in three experiments, in addition to the above. In the first experiment, eggs stripped from a female which had died 1½ hr earlier, were treated with the milt from a live male, while in the second expriment, eggs from a live female were treated with the milt of a male which had died 90 minutes earlier. Fertilisation did not take place in both the cases. In the third experiment, eggs from a female which had died 20 minutes earlier were treated with the milt from a 'live' male and the rate of fertilisation was estimated to be 90%.

Experiments on hatching of fertilised eggs produced through stripping: These experiments were carried out by fixing markin cloth and muslin *hapas* in three different environments ; *viz.*, the river, sand pools left in the bed of the river after the floods had receded and freshwater nursery ponds. Experiments were also carried out for the segregation of dead eggs and egg shells, by employing double walled *hapas,* where the inner *hapa* was of 1/20″, 1/24″ or 1/28″ mesh bar. It was observed that *hapas* of 1/20″ and 1/24″ mesh bar proved too big in size, as all the hilsa eggs invariably passed through them, neither the eggs nor the newly hatched hilsa larvae passed through the *hapa* of 1/28″ mesh bar.

In riverine environment, 8 hatching experiments were carried out. The rate of hatching was estimated to range from 2 to 80%. It was observed that when the index of visibility of the river water as determined by the Secchi Disc, was 20 cm or below, the rate of hatching was of low order, but when this index was more, the rate of hatching was of a high order on a comparative plane.

To circumvent situations, when riverine environments were not favourable for hatching the fertilised eggs, experiments were carried out in pools left behind by the receding Ganga river after the floods. In these pools, the rate of hatching ranged from 20 to 80% in experiments 2 to 8, 12 and 13 (Table 34). During these experiments, the temperature of the surface water fluctuated between 26.5 and 30.4°C and with the exception of calcium, which varied between 184 and 195 ppm, the values of CO_3, HCO_3, CO_2, PO_4, Fe, Cl and DO showed no marked changes. During experiments 14-20 (Table 34), the water temperature registered a fall to 24.8°C and values of Ca decreased to 97.2 ppm, the rate of hatching ranging between 5 and 8%, with a sole exception of 70%.

Experiments were also carried out for the first time to hatch fertilised eggs of hilsa in freshwater ponds. Only three experiments (Nos. 9, 10 and 11, Table 34) were attempted in the nursery ponds at Taraon Fish Farm and the percentage of hatching varied between 15 and 30. Three preliminary experiments towards understanding the reasons for this low survival and evolving necessary measures to enhance survival were undertaken in the laboratory, wherein fertilised eggs of hilsa were hatched in the tap and river water alone and river water inoculated with Na and Ca salts. It was observed that while in tap water the percentage of hatching ranged between 65 and 70%, in river water it was 35 to 50%. In river water + Na, river water + Ca and river water + Na + Ca, the

ranges were 50-75, 50-60 and 50-60% respectively. Efforts were made to keep the temperature constant as far as possible, by using room heaters.

Rearing of hilsa hatchlings : Of the resultant hatchlings of hilsa (2.5-3.0 mm in length), 6 lakh @ 2 lakh/nursery (30 m × 15 m) were stocked in nursery ponds No. 2, 3 and 4 at the Taraon Fish Farm. Cow-dung and mustard oilcake were used as manures. Mahua oilcake @ 150 ppm was also added to pond 4. Ponds 3 and 4 were inoculated with trace elements ; like Co, Zn and Mn, some sand being also added to the bottom. Pond 3 was stocked on October 13, 1969, while ponds 2 and 4 were stocked on October 19 and 23 respectively. Total mortality occurred in pond 2, because of accidental ingress of predatory fishes. In ponds 3 and 4, 2.5-3.0 mm long hatchlings have grown to an average size of 50.1 and 53.0 mm in 80 and 70 days of pond life respectively. The nursery wise details are given in table 35. Both, the survival and growth of hilsa in pond are satisfactory.

Table 35. Detail of hilsa rearing in freshwater nursery ponds

Nursery No. 3						Nursery No. 4					
Date of hatching	Size of fry on hatching (mm)	Date of sampling	No. in sample	Length range (mm)	Average length (mm)	Date of hatching	Size of fry on hatching (mm)	Date of sampling	No. in sample	Length range (mm)	Average length (mm)
13.10.69	2.5-3.0	4.11.69	25	18.0-22.0	20.0	23.10.69	2.5-4.0	4.11.69	25	16.0-18.0	17.0
		7.11.69	25	18.0-23.0	21.0			7.11.69	25	18.0-20.0	19.0
		15.11.69	25	25.0-35.0	30.0			15.11.69	10	22.0-28.0	24.0
		23.11.69	25	35.0-50.0	43.0			23.11.69	25	25.0-35.0	30.0
		27.11.69	9	40.0-51.0	49.0			27.11.69	13	36.0-46.0	41.0
		5.12.69	6	47.0-51.0	49.0			5.12.69	17	43.0-50.0	50.0
		13.12.69	6	46.0-52.0	47.5			13.12.69	23	48.0-55.0	50.0
		20.12.69	8	45.0-54.0	49.0			20.12.69	13	49.0-59.0	53.0
		29.12.69	10	49.0-54.0	50.1			29.12.69	9	50.0-57.0	53.0

Transport of hilsa eggs and hatchlings : Fertilised eggs @ 1.5 lakh/bucket were successfully transported in open polythene buckets, containing about 5 l of river water, to a distance 40 km in *c.* 2 hr. The rate of mortality was estimated to range between 5-10%. Successful experiments were also carried out towards the transportation of hilsa spawn @ one lakh/bag under oxygen in sealed polythene bags, containing about 6 litres of river water. The mortality was estimated to vary from 10 to 30% for a distance requiring $2\frac{1}{2}$ hr to cover.

Problem : 20.1 Pollution in the Hooghly-Matlah estuarine system

Duration : Three years

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

20.1.1. Measurement of pollutional load with reference to sewage and industrial wasters.

Various hydrological factors ; *viz.*, turbidity, suspended solids, pH, DO, 5 day BOD and OC (30 minutes at 100°C) in respect of various types of industrial wastes are given in table 36.

Table 36. Characterisation of wastes during the year 1969.

Type of waste	Turbidity	Suspended solids (mg/l)	pH	DO (mg/l)	OC (mg/l)	5 day BOD at 20°C± 0.5°C(mg/l)
A	<85-> 1,000	40-7,492	5.2-> 10.5	0.0-7.0	18-31,300	15-21,600
B	<85-230	4-3,866	6.1-> 10.5	0.5-6.0	20-104	62-120
C	135-743	22-1,902	2.02-7.8	0.0-5.6	20-148	20-1,175
D	<85-120	2-78	7.2-7.3	6.2-6.7	37-43	20-43
E	<85-650	104-1,998	6.8-8.0	0.0-6.7	41-228	15-480

A=Biological wastes (tanneries, cotton, pulp & paper, yeast and distillery)

B=Miscellaneous organic chemical wastes (paint & varnish)

C=Wastes chiefly mineral in nature or partly mineral and partly organic (rayon, match, metal & steel)

D=Hydrocarbon waste (rubber)

E=Domestic wastes

The total pollution load calculated in terms of BOD was found to be 1.182 lakhs kg per day.

20.1.2 Measurement of toxicity of industrial wastes by bio-assays

(No progress during the period under report)

20.1.3 Studies on the effect of industrial wastes in the Hooghly estuary with special reference to productivity

Hydrological studies revealed no significant changes in the chemical constituents from that of the last year. No sign of pollution, either organic or inorganic in nature, was observed in the main river. The Hooghly water was maintaining mostly a constant pH (8.1), recording a slight fall during monsoon (June-August), which improved from September onwards along with the clarity of water. With the onset of monsoon, turbidity also increased (500-1,000 unit) and this resulted in a slight depression in DO (3.9-4.7 mg/l). Biochemical acti-

vity was poor (BOD below 5 mg/l). Other oxidisable substances were also indicating low values (COD mostly within 12 mg/l). The fast dissipation of the polluted wastes due to fast current during both the tides, turbulences in the water replenishment of oxygenated water and dilution probably kept the biochemical activity to its lowest level. Pollution was localised to the marginal area and a few metres below the outfall. (In 1968, a paper mill discharging maximum waste, showed nil DO and 25 mg/l BOD at the outfall region. The conditions, however, improved half a mile below when DO was 2.4 mg/l and BOD, 3.2 mg/l). During neap tide, pollution was felt in a wide area around the outfall of a sulphite paper mill, the current velocity in the river being 3.2-4.8 km/hr. Plankters and DO were 130/l and 80 mg/l above outfall, 40/l and nil at outfall, 90/l and 1.9 mg/l in moderately polluted water near mid-river, 110/l and 9.9 mg/l in mid-river and 70/l and 7.6 mg/l respectively below the outfall.

Primary productivity during the post-monsoon period ranged between nil-41 mg C/m^3/hr and was similar to that of the last year.

(c) Research contemplated

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

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

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

1.3 : Investigations to evolve a cheap and efficient balanced fish died, effective for all the important cultivated species, especially for adult stage and also to evolve suitable and efficient technique for feeding the above food

1.5: Experiments to ascertain the magnitude of fixation of nitrogen by blue-green algae in pond soils (alkaline and neutral) and to study the interaction between treatments: unsterilised control, sterilised control, unsterilised control + fertilizer, sterilised control + fertilizer, unsterilised control + algae, sterilised control + algae, unsterilised control + fertilizer + algae and sterilised control + fertilizer + algae

1.10: Application of a basal dose of lime @ 600 kg/ha and a mixed inorganic fertiliser N-P-K (18-8-4) @ 50 kg/ha every fifteen days for the total fertiliser dose of 600 kg/ha to determine the factors responsible for low and high productivities of fish ponds in acid soils of Tripura (India)

1.13: Estimation of fish population in ponds with the help of capture-recapture method by (i) determining the sample size required for clipping to get the best estimate with some standard net, (ii) exploring the latent-role of size range and gear selectivity to study the reason of estimation equation giving under-estimate and (iii) trying some more ponds having known population with more species of fish

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

Project 2 :. Induced fish breeding

2.2: Studies on effectiveness of pituitary glands of amphibians, mammals and fishes (other than carps) in inducing breeding of carps

Project 3 : Reservoir fisheries

3.1: Studies to relate primary productivity, plankton, benthos, and larger aquatic plants with fish production and to obtain optimum yield from the Tilaiya reservoir

3.2: Investigations to relate primary productivity, plankton, benthos, larger aquatic plants with fish production and to obtain optimum yield from the Konar reservoir

3.6: Scientific appraisal of nutritional resources of peninsular tanks with a view to obtaining maximum yield of fish by utilizing all feed niches and by supplementing nutrients where necessary and studies to ensure that available and stocked fish utilise food at all trophic levels to yield optimum production

Project 4 : Riverine carp spawn prospecting and collection techniques

4.1: Location of new spawn collection centres in West Bengal and assessment of their potentiality

4.2: Studies on improvement of filtration rate estimation technique, operation of specially designed *gamcha* and nets for segregation of spawn from debris and associates, during collection and experiments to test the effect of size of container, density of storage and effect of storage on spawn moratility and to determine optimum storage rate

Project 5 : Brackish water fish farming

5 2: Contour survey of Prentice and Daya islands

5.4: Salinity tolerence of major carp fingerlings

Project 6 : Freshwater prawn culture

6.2: Experiments and investigations to augment freshwater prawn supplies by animal husbandry techniques, to ascertain whether culture could be more advantageous than harvesting from rivers, to study the growth requirements of the prawn during its early life cycle in the natural environment, so as to be able to make use of the information in culture work and to locate seed collection centres

Project 9 : Selective breeding and hybridisation

9.2: In addition to frog Ringer's solution and GPC-5, experiments with coconut milk in preserving sperms of livestock for different periods, to test their viability and also with liquid nitrogen containers used by veterinary surgeons for artificial insemination

Project 13 : Cold water fish culture

13.2: Investigations on the problem relating to food and feeding habits of trouts

Project 14 : Riverine and estuarine fish catch statistics

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

Project 16 : Weed control

16.1: Standardisation of methods of control of emergent and floating weeds (5-40 kg/sq m) with hormone weedicides and yard trials with weedicide at 1-10 mg/plant and 1-20 kg a.i./ha for *Cyperus,* lilies and lotus

Project 17 : Frog farming

17.1: Experiments to determine the relative efficiency of various hormones like FSH, HCG and Progesterone in inducing ovulation in *R. tigrina* and *R. hexadactyla* and to study age and size specific fecundity of commercially important species of Indian frogs

Project 19 : Hilsa fisheries

19.3: Artificial propagation of the Godavari hilsa

3. Paper Published

The following papers were published by the staff of the Institute during the year 1969:

Barrackpore, Central Inland Fisheries Research Institute. 1968 and 1969
Bibliography of Indian Fisheries, **7** (4) and **8** (1-3) (*Mimeo.*).

———— 1969
Half-yearly Technical Progress Report, January-June 1969 : 55 p. (*Mimeo.*).

———— 1969
Breeding of *Rana catesbeiana*. *Fish. Technol. Newsl.*, Ernakulam **9** (4) : 17-19.

Basu, A. K. 1967
Un appareil de'chantillonnage pen coutexu. (Design of a new water sampler) *Trib. CEBEDEAU*, **306** (3) : 1-2.

Bhowmick, R. M. 1969
Rearing of breeders, sexing and segregation of cultivated fishes. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes*, Calcutta-Cuttack-Bombay, July 15 to August 18, 1969, (9) : 23 p. (*Mimeo.*).

———— 1969
Economics of induced breeding of Indian major carps and Chinese carps. *Ibid*, (20) : 13 p. (*Mimeo.*).

Chakrabarty, R. D. and M. K. Banerjee 1969
Otter trawling in the Hooghly estuary, West Bengal. *Proc. natn Acad. Sci. India* (B), **37** (4) : 389-400.

Chaudhuri, H. 1969
Breeding habits of cultivated fishes. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes*, Calcutta-Cuttack-Bombay, July 15 to August 18, 1969, (4) : 13 p. (*Mimeo.*).

———— 1969
Methods adopted for inducing breeding in fishes. *Ibid*, (8) : 16 p. (*Mimeo.*).

———— 1969
Techniques of hypophysation of Indian carps. *Ibid*, (11) : 15 p. (*Mimeo.*).

Das, P. R. 1969
A preliminary note on the toxicity of the plant *Derris trifoliata* Lour on fishes. *J. Indian pharm. Mfr*, **7** (4) : 197-200.

David, A., N. G. S. Rao and M. F. Rahman 1969
Preliminary survey report on the hydrobiology and fisheries of Nagarjunasagar, Andhra Pradesh. *Surv. Rep. cent. inl. Fish. Res. Inst.*, Barrackpore, (5) : 36 p. (*Mimeo.*).

David, A., P. Ray, B. V. Govind, K. V. Rajagopal and R. K. Banerjee 1969
Limnology and fisheries of the Tungabhadra reservoir. *Bull. cent. inl. Fish. Res. Inst.*, Barrackpore, (13) : 188 p. (*Mimeo.*).

Ghosh, A. K. and R. N. Pal 1969
Toxicity of four therapeutic compounds to fry of Indian major carps. *Fish. Technol.*, **6** (2) : 120-123.

Gupta, M. V. 1968
Studies on the taxonomy, biology and fishery of ribbon fishes (Trichiuridae) of the Hooghly estuarine system. 4. Fishery of *Trichiurus savala* Cuvier and *Trichiurus pantului* Gupta. *Proc. zool. Soc.*, Calcutta, **21** (2) : 137-147.

———— 1968
Observations on the facundity of *Polynemus paradiseus* Linn. from the Hooghly estuarine system. *Proc. natn Inst. Sci. India* (B), **34** (6) : 330-345.

———— 1969
Abnormalities in pelvic fins girdles of *Eleutheronema tetradactylum* Shaw. *Sci. & Cult.*, **35** (2) : 70-71.

Halder, D. D. 1968
Observations on the food of young *Hilsa ilisha* (Hamilton) around Nabadwip, in the Hooghly estuary. *J. Bombay nat. Hist. Soc.*, **65** (3) : 796-798.

Ibrahim, K. H. 1969
Techniques of collection, processing and storage of fish pituitary gland. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes*, Calcutta-Cuttack-Bombay, July 15 to August 18, 1969. (6) : 19 p. (*Mimeo.*).

———— 1969
Preparation, preservation and ampouling of fish pituitary extract. *Ibid*, (7) : 12 p. (*Mimeo.*).

Jhingran, A. G. 1969
The length-weight relationship and K. factor of *Gadusia chapra* (Hamilton) from the Ganga river system. *Proc. natn Acad. Sci. India* (B), **83** (3 & 4) : 249-263.

Jhingran, V. G. and P. Datta 1968
The inland fisheries resources of India. *J. Indian Soc. agric. Statists*, **20** (2) : 68-78.

Jhingran, V. G. 1969
Review of the present status of knowledge on induced breeding of fishes and problems for future research. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes*, Calcutta-Cuttack-Bombay, July 15 to August 18, 1969, (27) : 31 p (*Mimeo.*).

Jhingran, V. G. and A. V. Natarajan 1969
Derivation of average lengths of different age-groups in fishes. *J. Fish. Res. Bd Canada*, **26** (11) : 3073-3076.

Jhingran, V. G., A. V. Natarajan, S. M. Banerjea and A. David 1969
Methodology on reservoir fisheries investigations in India. *Bull. cent. inl. Fish. Res. Inst.* Barrackpore (12) : 109 p. (*Mimeo.*).

Kamal, M. Yusuf 1969
Studies on the age and growth of *Cirrhina mrigala* (Hamilton) from the river Yamuna at Allahabad. *Proc. natn Inst. Sci. India* (B), **35** (1) : 72-92.

Lakshmanan, M. A. V. 1969
Nurseries and their management. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes,* Calcutta-Cuttack-Bombay, July 15 to August 18, 1969, (17) : 25 p. (*Mimeo.*).

———— 1969
Problem of feeding hatchlings and fry. *Ibid,* (18) : 17 p. (*Mimeo.*).

Lakshmanan, M. A. V. and D. S. Murthy 1969
Raise fingerlings in ponds. *Indian Fmg,* **19** (4) : 43-44.

Malhotra, J. C., P. K. Mathur, M. Yusuf Kamal, Ravish Chandra and V. R. Desai 1969
Successful artificial propagation of *Hilsa ilisha* (Hamilton) near Allahabad. *Curr. Sci.,* **38** (18) : 429-430.

Pal, R. N. and V. Gopalakrishnan 1968
Preliminary trials on the toxicity of 'Algistat' to fish and algae. *Fish. Technol.* **5** (2) : 101-103.

Pal, R. N. 1969
Processing the pituitary gland for injection. *Indian Fmg.* **19** (8) : 35-36.

Parameswaran, S. 1969
Induced breeding of carps for production of quality fish seed. *Ibid,* **19** (7) : 24-26.

Rajyalakshmi, T. 1968
Try prawns in tanks and inland waters. *Ibid,* **18** (8) : 37-43.

Ramachandran, V. 1969
Transport of spawn, fry, fingerlings and breeders. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes,* Calcutta-Cuttack-Bombay, July 15 to August 18, 1969, (16) : 28 p. (*Mimeo.*).

Rao, A. V. Prabhakara 1967
A case of hermaphroditism with notes on two abnormal ovaries in the silver belly, *Gerres oyena* (Forskal) from the Pulicat Lake. *J. Mar. biol. Ass. India,* **9** (2) : 444-447.

Rao, R. M. 1969
Studies on the prawn fishes of the Hooghly estuarine system. *Proc. natn Inst. Sci. India* (B), **35** (1) : 1-27.

Ray, P. and A. David 1969
Poultry manure as potential plankton producer in fish nurseries. *Labdev* (B), **7** (3) : 229-231.

Saha, G. N. 1969
Relative efficiency of different nitrogenous fertilisers in fish pond soils. *J. Indian Soc. Soil Sci.*, **17** (1) : 51-57.

Singh, S. B. 1969
Ecological requirements for induced breeding of fishes. *FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes*, Calcutta-Cuttack-Bombay July 15 to August 18, 1969, (10) : 25 p. (*Mimeo.*).

——— 1969
Techniques of hypophysation of Chinese carps. *Ibid*, (12) : 17 p. (*Mimeo.*).

4. Extension

(a) *Result of immediate practical application*:

Fry and fingerlings of *Puntius pulchellus* (Day), expected to be available in Shimoga district of Mysore State, can be lifted and stocked in various tanks infested with submerged weed for both biological control of weeds and a substitute for Gangetic major carps. Herbivorous fish, *P. pulchellus*, can easily be introduced in weedy tanks in South India, specially in Mysore State, at a very low cost of collection and transportation.

Two excellent sources of quality fish seed have been located during the year at Bahiara (R. Son) in Bihar and Nirathanallur (R. Coleroon) in Tamil Nadu.

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

Wolffia sp., *Lemna* sp., *Spirodela* sp. and *Azolla* sp. having a density of 3.6-6.5 t/ha could be cleared economically by 1,000-2,000 grass carp (100-474 gm)/ha in a predator free pond (*c.* 0.5 ha) within 2-3 weeks. Similarly *Hydrilla* sp., *Najas* sp. and *Ceratophyllum* sp. infestation at 5.7-19.0 t/ha could be controlled by 1,000-1,250 grass carp (above 500 gm)/ha in a pond (*c.* 0.5 ha) in 1-6 weeks, while *Nechamendra* sp., *Ottelia* sp. and *Vallisneria* sp. may be cleared by 1,000-2,000 grass carp (1-2 kg)/ha. These experimental observations during the last two year, are likely to be highly economic to the pisciculturist. Further work is needed to assess the optimal size and stocking rate of the fish depending upon the nature of infestation of weed.

Bulk clearance (90%) of water hyacinth within 3 months (depending upon the season ; *i.e.*, quicker in summer and longer in winter) by a single application of 2, 4-D sodium salt solution as foliar spray, was achieved. About 30 mg of 2, 4-D per kg of live plant was sufficient for plants between 100-500 gm or above, the cost of clearance being Rs. 120-300/ha as against Rs. 300-900/ha by manual process. Further work in this line is needed for extension.

(c) *Publicity activities* :

In a press release made by the Director of the Institute towards the end of July, 1969, the usefulness of induced breeding of cultivated fishes in the development of inland fishery was explained, while a brief note on induced breeding work, giving some details of FAO seminar on induced breeding held in India, was also presented.

Two exhibitions of posters displaying certain aspects of the work of the Institute and institutional publications were arranged during July 15-18, 1969 and November 27-29, 1969 for the delegates attending the FAO/UNDP and Reservoir seminars. The captions of the posters were :

(i) Effect of light on the maturation of *C. reba*
(ii) Artificial propagation of hilsa
(iii) Grass carp a voracious eater of water weeds
(iv) Economics of composite culture of Indian and exotic carp
(v) Culture of fish food organism
(vi) Potentiality of induced fish breeding
(vii) Fish diseases and their control
(viii) Cultivable murrels and other air breathing fishes
(ix) Economics of rearing of carp fry to fingerlings size
(x) Induced breeding technique
(xi) Important gears and species of the Hooghly-Matlah estuarine system
(xii) Spawn prospecting during 1964-68 by CIFRI
(xiii) *Tilapia mossambica*
(xiv) Weed control
(xv) Water pollution studies in the river Hooghly
(xvi) Fisheries of the Mahanadi estuary
(xvii) Economics of riverine spawn collection
(xviii) Prawn fisheries of the Hooghly-Matlah estuarine system
(xix) Brackish water fish farming in lower Sunderbans
(xx) Spawn prospecting investigation in 1968
(xxi) Hybridization
(xxii) Fisheries of the Tungabhadra reservoir
(xxiii) Frog farming investigation
(xxiv) Biology of the Yamuna *Catla*
(xxv) Fish landings at important centres in the Ganga river system

Film shows were also arranged for the Scientists attending the seminars on 'Induced Breeding' and 'Reservoir Fisheries'. The subjects dealt with were :

"Techniques of Pond Culture and Hypophysation of Carps Employed at Central Inland Fisheries Research Substation at Cuttack" and "Bundh Breeding in Madhya Pradesh".

5. Conferences and Symposia

The following seminars were held during the year under report :

Seminar on Induced Breeding

The FAO/UNDP regional seminar on "Induced Breeding of Cultivated Fishes" was held during July 15 to August 18, 1969. The first session was held at the Central Inland Fisheries Research Institute, Barrackpore from July 15-18 ; the second session at Bhubaneswar/Cuttack from July 19 to August 8 and the third session at Central Institute of Fisheries Education, Bombay from August 10-18. The lectures and discussions of the second session were held at the Academy Council Hall of the University of Orissa, Conference room of the Orissa State Fisheries Department at Cuttack and Conference room of the Central Inland Fisheries Research Substation at Cuttack. The major part of demonstration and practical work were conducted in the laboratory and Killa fish farm of Central Inland Fisheries Research Substation at Cuttack.

The main purpose of the seminar was to impart up to date knowledge and skill on induced breeding of fish and to provide opportunities for exchange of experiences of various scientists of South East Asian Countries, so that the growing need of fish seed can be solved to some extent.

The seminar was organised by FAO/UNDP in collaboration with Government of India. Dr. V. G. Jhingran, Director of Central Inland Fisheries Research Institute, Barrackpore and Dr. S. W. Ling, FAO/UNDP (TA) Regional Fish Culturist, Bangkok were nominated Director and Co-Director respectively.

Seminar on Reservoir Fisheries

A seminar on "The Ecology and Fisheries of Freshwater Reservoirs" was held under the auspices of the Indian Council of Agricultural Research at the Central Inland Fisheries Research Institute, Barrackpore during November 27-29, 1969. Dr. N. K. Panikkar, Director, National Institute of Oceanography kindly consented to preside over the inaugural function. In the inaugural address (read in absentia) by Dr. B. D. Nag Chaudhuri, Member (Science) Planning Commission, stress was laid on the problem of protein mal-nutrition which has assumed serious proportions in certain sections of population. Though there has been some increase in fish production, per capita consumption of fish has not increased significantly. He emphasised on the need of study of ecology which is a multi-disciplinary study requiring scientist of various disciplines to be involved in a

complete study of the eco-system and not only the fishery biologist. In conclusion, he expressed the hope that the seminar will help in solving many problems and in harnessing the reservoirs for proper and fruitful harvest of fishes.

6. Summary

During the year, considerable progress was made in 18 out of 20 projects, while suitable action was taken to set up the remaining projects ; *viz.*, "Fish Farm Designing" and "Economics in Fishery Investigations".

Project 1 :

1.1: Composite culture of Indian and exotic carp fry in different combinations and @ 75,000 and 1,00,000/ha yielded 1,682-3,193 kg fingerlings/ha/6 months. Composite culture of fingerlings of Indian and exotic species in different combinations and @ 5,000/ha gave gross productions ranging from 1,690 to 2,080 kg/ha/6 months, whereas the same species stocked @ 4,300/ha along with 100 frogs/ha yielded 1,157 kg fish/ha/6 months.

1.2: Laboratory studies on the conversion ratio of mustard oilcake+rice bran, silk worm pupae and zooplankters into the flesh of Indian major carp spawn and fry did not give any conclusive result.

1.3: In laboratory jar experiments, boron @ 0.5-1.0 mg/fish/day and molybdenum @ 0.5 mg/fish/day supplied along with regular feed seemed to enhance the growth and survival of rohu hatchlings and fry in a short period, whereas selenium did not prove satisfactory.

1.4: In experiments conducted in the laboratory with urea, ammonium sulphate and calcium ammonium nitrate, each @ 20, 50 and 80 kg N/ha, using moderately acid soil containing high organic matter, the higher rates of all fertilizers gave higher primary productivity, with maximum in calcium ammonium nitrate. In yard trials using only the higher rates of fertilizers, survival and growth of rohu hatchlings, were maximum with urea in neutral soil, followed by ammonium sulphate and calcium ammonium nitrates in moderately acid soil and least in control.

1.5: Moderately acid soil rich in organic matter inoculated with *Anabaena* sp. gave increase of 12-80 mg N and 6-21 mg N/100 gm soil in unsterilised and sterilised soils respectively, soils treated with P + Ca + Mo giving the maximum increase. Although the increase in nitrogen was not consistent with soil treatments. sterilised soil + P + Ca + Mo + *Anabaena* sp. gave better survival and growth of rohu fry than unsterilised soil + P + Ca + Mo.

1.6: Experiments in cement cisterns, confirmed earlier findings that *Nitzschia* sp. and *Navicula* sp. could be successfully cultured by using 5-15-3:

ammonium sulphate—bone meal—potassium nitrate @ 230 ppm. With 75-15-3: N-P-K @ 230 ppm, there was profuse growth of *Chlamydomonas* sp. in glass jars. Mahua oilcake plus urea (2: 1) @ 900 ppm gave good growth of rotifers in cement cisterns, whereas poultry droppings plus urea (1:1) @ 600 ppm encouraged nitrate added to mahua oilcake or bone meal gave sustained growth of Ostracoda, Cladocera and Copepoda in glass jars.

1.7: Preparatory cultures of six algal forms were done. Stock cultures of *Chlorella* sp., *Navicula* sp. and *Gomphonema* sp. were achieved and their subcultures are being maintained. Threefold increase in cell counts of *Gomphonema parvulum* was observed when the light intensity was inrceased from 500 to 3,000 lux. *Cyclops* sp. was introduced in six different artificial media to produce mass cultures of zooplankton, but the eggs did not survive.

1.8: Four types of feed were prepared to test their nutritive value and *Cyprinus carpio* var. *communis* was used as an experimental fish. The increase in body weight was 0.123 gm with *Zygnema* feed, 0.093 gm with *Sirogonium* feed and 0.246 gm with *Mougeotia* feed, while the increase with fish meal feed and plankton used as controls, was 0.157 gm and 0.25 gm during 40 days' experiment. The growth with plankton and *Mougeotia* feed are alike. The latter feed can be utilised as artificial food for fishes.

1.9: To determine the response of unproductive pond soils from Lingipur (Orissa) and Lembuchara (Tripura), the fertiliser combinations $N_{80}P_{40}$ using ammonium sulphate and superphosphate were applied at 80 kg N + 40 kg P_2O_5/ha in four divided doses at an interval of 3 months. Results observed on primary productivity, dissolved nitrogen and dissolved phosphorus were 286.1 mg C/m^3/hr, 0.51 ppm and 0.79 ppm with fertilised soil of Lingipur, 74.3 mg C/m^3/hr, 0.03 ppm and 0.06 ppm with unfertilised soil of Lingipur, 311.8 mg C/m^3/hr, 0.49 ppm and 0.84 ppm with fertilised soil of Lembuchara and 84.1 mg C/m^3/hr, 0.04 ppm and 0.05 ppm respectively with unfertilised soil of Lembuchara.

1.10: To elucidate the factors responsible for low and high production of fish ponds, observation on average production of fish, primary productivity, organic content, ammonical nitrogen, nitrate nitrogen, organic nitrogen, inorganic phosphorus and organic phosphorus were recorded during the year as 2,895.0 kg/ha/an, 232.7 mg C/m^3/hr, 12.0 ppm, 0.171 ppm, 0.068 ppm, 0.791 ppm, 0.19 ppm and 0.35 ppm in productive Rajdharnagar pond (Tripura) and 384.0 kg/ha/an, 77.8 mg C/m^3/hr, 3.7 ppm, 0.31 ppm, 0.310 ppm, 0.136 ppm, 0.03 ppm and 0.03 ppm respectively in unproductive College Tilla pond (Tripura).

1.11: Three types of experiments conducted to prevent seepage rate of pond soil were : (i) leaching only with NaCl solution of different concentrations (ii) leaching with 0.01% NaOH and subsequently with 0.6% NaCl and (iii) leaching with a mixture of 0.01% NaOH and 0.2/0.4/0.6% NaCl. Minimum percolation rate obtained with the mixture of 0.01% NaOH and 0.6% NaCl was 0.40 cm/hr as against 16.00 cm/hr in control.

1.12 In an experiment in a small nursery pond, the seed powder of *Barringtonia acutangula* at 20 ppm killed a wide variety of predatory and weed fishes, thereby confirming earlier laboratory findings. In laboratory experiments, the bark powder of *Walsura piscidia* @ 10 ppm killed tilapia and murrel in two hours.

1.13: To determine the sample size of fish required for clipping to estimate fish population, an experiment was carried out in a pond with a fish population of uniform size. From the numbers clipped and the numbers recovered the percentage sample sizes for rohu, mrigal and tilapia were estimated as 5, 15 and 13, the error of variation being within 10%.

1.14: Preliminary laboratory experiments to determine the usefulness of reaction of fish seed to lights of different colours and intensities and to odours of feeds in segregating 2 to 15 days' old seed of catla, rohu and mrigal from mixed collections, did not yield conclusive results.

1.15: No progress during the year

1.16: Observations on the otoliths, scales, opercular bones and vertebrae of rohu of known age stocked in a pond, were conducted to assess their usefulness as age indicators. Length, weight, maturity and gut contents of samples of fish were simultaneously recorded. The study is in progress.

Project 2:

2.1: Gonadial maturity of major carps was accelerated by weekly injections of fish pituitary extract and human chorionic gonadotrophin. Spawning was induced much ahead of normal spawning season.

2.2: Synahorin in combination with fish pituitary extract did not give positive results when injected on a few sets of rohu and catla in September, probably due to the lateness of the season causing gonadial resorption in the recipients.

2.3: A ready-made fish pituitary injection material in ampoules was supplied to 14 induced breeding centres in India as a preliminary step towards the establishment of a pituitary bank. Successful results were obtained in three centres which have reported so far. Carp pituitary glands preserved in

acetone, dried at room temperature and kept under refrigeration for six months were found viable.

2.4: Though successful hatching of major carp eggs took place in newly designed hatching jars, the hatchlings died after two days in cisterns where they were transferred.

2.5: A preliminary experiment has been initiated in two ponds, each of which has been partitioned into two, to compare the growth, maturity and viability of induced bred and riverine spawn.

Project 3 :

3.1: During the year, the pooled average of pH, DO, free CO_2, total alkalinity, phosphates, nitrates, silica, ferric iron, air temperature, water temperature and transparency were 7.66, 8.41 ppm, 3.82 ppm, 34.58 ppm, 0.009 ppm, 0.071 ppm, 4.9 ppm, 0.048 ppm, 21.36°C, 23.45°C, 12.42 cm respectively in the Konar reservoir and 8.06, 8.40 ppm, 2.8 ppm, 53.2 ppm, 0.019 ppm, 0.063 ppm, 5.5 ppm, 0.029 ppm, 23.7°C, 23.65°C and 42.85 cm respectively in the Tilaiya reservoir. Mean primary productivity for the Konar reservoir was 333.2 mg $C/m^3/day$.

3.2: The ratio of phytoplankton and zooplankton in the Konar reservoir was 2.1 : 1 during January-June and 1 : 1.4 during July-December. The plankters mainly available were : *Microcystis* sp., *Diaptomus* sp. and *Cyclops* sp. in the first half of the year and *Keratella* sp., *Brachionus* sp., *Polyarthra* sp., *Filinia* sp., *Botryococcus* sp., *Oedogonium* sp. and *Spirogyra* sp. in the latter half. Plankters were more concentrated towards the surface than in bottom. The average number and weight of the bottom fauna ; *viz., Chaoborus,* chironomid larvae, dragonfly nymphs and aquatic Oligochaeta mainly, were 1,293/ sq m and 4.3 gm/sq m respectively. The ratio of phytoplankton and zooplankton in the Tilaiya reservoir was 1 : 1.8 while the plankton mainly comprised *Diaptomus* sp., *Cyclops* sp., *Difflugia* sp., *Keratella* sp., *Brachionus* sp., *Polyarthra* sp., *Microcystis* sp., *Botryococcus* sp., *Oedogonium* sp., *Spirogyra* sp., *Mougeotia* sp., *Synedra* sp., *Fragilaria* sp. and *Navicula* sp.

3.3: Gut analyses of *C. catla, C. mrigala, L. rohita, L. calbasu, P. sarana, L. corsula, L. boggut, C. reba, W. attu, M. seenghala, M. cavacius, C. gachua, N. notopterus, E. danricus, A. mola, O. cotio, B. barna, A. nama* and *G. giuris* from the Konar and Tilaiya reservoirs were continued to study the utilisation of available food resources by the fishes.

3.4: Pre-recruitment studies were conducted at Hurlung on the Konar river and Bindi on the Kakiya river. A total of 23,942 eggs in 944 hr could be collected at Hurlung. At Bindi, the water course shrank soon after the floods, to less than one metre in breadth and only 10 cm in depth, making it impossible for fishes to migrate and spawn. The rate of occurrence of eggs and the percentage composition of carps at Hurlung were noted. The fluctuation of flood levels, average duration of each flood and range of current velocity during flood in the seasonal Kakiya stream were recorded as 2-100 cm, 1-6 hr and 3.6-7.2 km/hr respectively. *A. nama* dominated *Khadijal* catch. Among major carps, only *L. calbasu* spawned in the Konar reservoir to a limited extent.

3.5: The estimated fish production in the Konar and Tilaiya reservoirs, during the year, were 2.79 and 13.398 t, being dominated by *C. mrigala*. Size ranges and modal lengths of mrigal, calbasu, catla and rohu were recorded while average length and weight of the species, excepting rohu, were noted. The fecundity study of major carps was continued. 4,751 fingerlings of catla, which were clipped and released in the Tilaiya reservoir in 1968, showed a rate of growth between 14.5-16.5 mm/month on recovery during 1969. 918 fingerlings of major carps were tagged and released in the Tilaiya reservoir during the year under report.

3.6: In the Konar reservoir average sized carps in the catch ; *i.e.*, mrigal (457 mm), calbasu (371 mm), catla (624 mm) and rohu (476 mm) occurred dominantly in gears with 50, 50, 105 and 50 mm mesh bars respectively. In the Tilaiya reservoir, gears with 60, 50, 50 and 105 mm mesh bars mostly caught average sized carps in the catch ; *i.e.*, mrigal (464 mm), rohu (375 mm), calbasu (395 mm) and catla (619 mm) respectively.

3.7 to 3.9: Experimental fishing with multimeshed gill nets with floats+ sinkers and floats only yielded 204.35, 188.04 and 517.54 kg of fish in the Loni, Govindgarh and Kulgarhi reservoirs respectively during the year. *M. seenghala* (50%) followed by *C. mrigala* (22.2%), *P. sarana* (7.9%) and *L. calbasu* (6.0%) in the Loni ; *C. catla* (56.9%) followed by *T. tor* (19.51%), *L. rohita* (11.2%) and *C. mrigala* (7.4%) in the Govindgarh; and *C. catla* (77.8%) followed by *L. rohita* (8.47%) *C. mrigala* (9.7%) and *P. sarana* (0.2%) in the Kulgarhi, dominated by weight the catches of respective reservoirs. Fishing in night and with nets without sinkers proved better in all the three reservoirs.

Hydrological studies were conducted for water transparency (21-87, 66.37-91.22 and 20.4-90.9 cm), pH (7-8, 8 and 8.1-8.3), total alkalinity (48-118, 39.21-53.9 and 47.75-140.1 ppm), CO_2 (3.5-6.4, 1.95-4.56 and 2.52-6.25 ppm), NO_3 (0.08-0.20, trace-0.033 and 0.152-0.31 ppm), PO_4 (0.06-0.18, trace-0.033 and trace-0.055 ppm) SiO_2 (5.0-12.2, trace-0.033 and 7.6-20.65 ppm) and dissolved oxygen (5.2-9.6, 7.58-10.64 and 7.94-10.38 ppm) in the Loni, Govindgarh and Kulgarhi reservoirs respectively.

Soil samples from the Loni, Govindgarh and Kulgarhi reservoirs, were analysed during the year as: pH, 6.4-6.8, 6.2-6.4 and 6.4; alkalinity, 0.235-0.623, 0.058-0.175 and 0.056-0.185 m.e.% ; chloride, 9.2-13.2, 9.6-11.9 and 9.2-12.2 m.e.%; calcium, 0.056-0.085, 0.076-0.1 and 0.07-0.1 m.e.% ; NO_3, 0.11-0.16, 0.12-0.16 and 0.14-0.18 m.e.% ; PO_4, 0.09-0.12, 0.17-0.42 and 0.11-0.16 m.e.% and organic matter, 1.84-3.0, 1.6-2.3 and 1.2-1.58% of the air dried, samples respectively.

Values of primary production in the Loni, Govindgarh and Kulgarhi, were 150-1,200, 460-1,031.25 and 281.25-1,549.37 mg $C/m^3/6$ hr respectively. The total plankton in these reservoirs varied as 11-365, 566-1,632 and 33-1,641 units/l respectively, while phytoplankton in the Loni and Govindgarh reservoirs and zooplankton in the Kulgarhi reservoir dominated. The plankton samples were analysed for qualitative estimation. The bottom fauna ranged as 502-2,946, 293-1,263 and 32-203 organisms/m^2 in the Loni, Govindgarh and Kulgarhi reservoirs respectively. Gut analyses for food of commercially important fishes of these reservoirs were undertaken and studies on sex ratio, maturity and fecundity were continued.

3.10: Primary productivity and plankton density in 4 tanks and 2 ponds in Mysore State ranged between 175-4,799 mg C/m^3/day and 18-2,060 units/l while the littoral and benthic fauna ranged from stray to 1,840 units/m^2 and thereby indicating carbon content in charred samples to vary between 34-2,437 mg/m^2. Due to disappearance of *Microcystis* sp. bloom in Bellandur tank in August and September, a fall in primary productivity and plankton density was recorded.

3.11: Physico-chemical factors in peninsular tanks and ponds ranged as 20.3-30.75 and 21.0-31.8°C temperature, 100-800 and 100-1,000 mg/l turbidity, 6.8-9.6 and 6.8-8.7 pH, 3.32-17.28 and 1.6-17.44 mg/l DO, 41-400 and 92-700 mg/l alkalinity, 26-114 and 32-156 mg/l hardness, 92-1,232 and 121-868 $\times 10^{-6}$ mhos at 25°C specific conductivity, 0.086-1.750 and 0.128-0.800 mg/l nitrate, 15-35 and 12-22.5 mg/l silica, trace-1.0 and trace-0.4 mg/l phosphate and 0.054-11.25 and 0.1-25.0 mg/l iron in water phase and 1.19-1.56 and 1.34-1.56 pH, 367.12-1,101.37 and 183.56-1,101.37 kg/ha calcium, 7.34-22.03 and 7.34-22.03 kg/ha magnesium, trace-4.59 and trace-4.59 kg/ha phosphorus and 2.75-18.36 and 2.75-18.36 kg/ha ammonia in soil phase.

3.12: Karpur tank was stocked with 24,000 fingerlings of murrel and 2,240 fingerlings of major carps for mixed culture while selected tanks and ponds were further stocked with carps for a study on population and fishery management. No spawn of *P. pulchellus* could be explored from the Anjanapur reservoir where 38 fingerlings of *P. pangasius* were introduced.

3.13: On resuming fishing after 6 months, Bellunder tank yielded 30-60 kg fish/day, the catch comprising yearlings of *Catla catla* and *Cyprinus carpio* which established themselves in the tank through breeding. With disappearance of

Microcystis sp. economic fishes were falling in population and forage fishes (mostly *Rasbora* sp.) started breeding in large scale while predator fishes were available in stray numbers.

Project 4 :

4.1: For conducting spawn prospecting investigation in Rajasthan, Bihar, Assam, Tamil Nadu and Mysore, pre-monsoon surveys of six river stretches including the Banas river were completed. At selected sites ; like, Baretha on the Parbati river, Bahiara on the Son river, North Gauhati on the Brahmaputra river, Nirathanallur on the Coleroon river and Sosale on the Cauvery river, detailed spawn prospecting investigation was conducted and the respective yield of spawn was 135, 3,120, 1,233, 2,239 and 25 ml along with 800 ml of eggs from Baretha and Sosale during the spawning season in 1969.

4.2: Flow of water through 1/16″ and 1/8″ meshed Midnapore type net became zero and 30-35% less of initial respectively in 8 hr of operation when turbidity and current velocity were 1,200 ppm and 1.5 km/hr. Catching efficiency of 1/8″ mesh net made of 6, 10, 14 and 18 m material were in the proportion of 1 : 2.7 : 4.4 : 1.5 respectively. The over-all efficiencies were 108% for 1/12″ meshed net and 159% for the 1/16″ meshed net, taking 1/8″ meshed net as a standard. Above efficiencies became 130 and 176% when data for the first 4 hr of operation were considered. Indices of spawn quantity and quality at Mahewapatti were 1,098 ml and 56% major carps.

4.3: Spawn export booking data from railway stations between Koelwar to Lalgola were collected and are being processed.

4.4: In pools, spawn from Bahiara, Nowgong and Mahewapatti were reared at a stocking density of 200/pool for 19 days in identical condition giving plankton and artificial feed (rice bran : m.o.c. : : 50 : 50) at equal, double and 3 times the initial weight of spawn stocked during the first five and subsequent 5 and 8 days. Respective average survival by number/size were 75/18.75 mm, 94/16.7 mm and 99/19.65 mm. Fry from above sources were reared to fingerling stage and were found to comprise catla, mrigal and rohu. Fry from the Son river grew more than those of *Bundh* bred in 92 as well as 147 days while those of the Yamuna river were discarded, being *L. bata* only.

Project 5 :

5.1: Study on seepage in fish farms of low salinity in Bakkhali, was completed last year. Studies on the effect of manuring with cow-dung and NPK and on salinity, primary productivity and water retentivity were continued in 1969. The central pond with 12‰ salinity, was stocked with mullet, young prawns and 650 carp fry (25-40 mm). *M. parsia, P. styliferus* and *P. indicus* grew

to 140-150, 85-95 and 150-160 mm respectively in 6 months. Acclimatisation of carps in 12‰ salinity was successful.

5.2: Contour survey for designs and layouts of fish farms were continued in Dia, Prentis and Henry's islands.

5.3: In model brackish water fish farm where *M. brevicornis, M. monoceros, P. indicus, P. monodon, M. tade* and *M. cunnesius* grew to 20, 20, 30, 30, 65 and 25 mm respectively in 4 months, the studies on physico-chemical characters of soil and water and plankton were continued.

5.4: No progress

5.5: Pilot investgations on different stocking rates and ratios of fish and prawn, their survival and growth, effect of artificial fertilisers and removal of uneconomic species for better production in brackish water fish farm were continued. Four sets of experimental rearing with (i) *M. parsia* fry at 25,000/ha + *L. calcarifer* fry and *E. tetradactylum* fingerlings at 1,375/ha, (ii) juveniles of *P. indicus, P. monodon, M. brevicornis* at 2,00,000/ha, (iii) *M. parsia* fry at 2,00,000/ha and (iv) *M. parsia* along with other fishes were conducted. Pilot investigations, to breed *M. parsia*, through hypophysation and stripping, were continued. For evolving suitable manuring and stocking rates, (i) physico-chemical characters of the farm pond and soil were determined ; (ii) urea, superphosphate, muriate of potash and m.o.c. were used in the farm individually and in combinations and subsequent reactions of these fertilisers were noted ; (iii) primary productions were recorded ; and (iv) average growth of *M. parsia* in different media and stocking rates were recorded.

5.6 Studies on the role of tides, during different lunar phases, on flooding of farm showed that a minimum of 2.21 m tidal amplitude was required for optimal water depth (1.52 m) in Kakdwip farm while inlet of the farm was 1.17 m above the lowest water level. A record was made on the availability of quality fish and prawn seed during various lunar phases. Measures were taken to control erosion of dykes due to rains and wind action. The experiment on the compatibility of *M. tade* and *P. monodon* under mixed culture were continued. To establish proper ratio between *M. parisa* and *L. calcarifer* for utilisation of food available, 3 sets of experiment were conducted, while a similar experiment with *E. tetradactylum* instead of *L. calcarifer* was taken up. Among different proportions of silt in clay in laboratory, a proportion of 75% silt gave best production of benthic algae.

5.7: Preferred food organisms for brackish water fishes were cultured in four media. *Cymbella* sp. and *Nitzschia* sp. were growing well in artificial sea

water. To study seasonal periodicity of periphytic organisms of pond No. 1, qualitative and quantitative analyses of periphytic organisms were done.

Project 6 :

6.1: Rearing of *M. malcolmsonii* in ponds provided with bamboo platform or *Ottelia* sp. were continued.

Project 7 :

7.1 & 7.2: Rearing 500 fingerlings of murrels were initiated. *A. testudineus* and one year old induced bred *H. fossilis* bred by hypophysation, while one set of *H. fossilis* spawned four times in 15 days. Fingerlings of both, *Anabas* sp. and *Heteropneustes* sp., could be produced.

Project 8 :

8.1: Fish and prawn seed collection centres were located at Kolaghat on the Roopnarayan river, Port Canning on the Matlah estuary and Diamond Harbour, Nurpur and Bakkhali on the Hooghly estuary.

8.2: The zoeal stages of *M. rosenbergi* could be reared up to the IV stage only. The postlarvae and juveniles of a few prawns could be identified.

8.3: The recruitment of larvae and juveniles in the Pulicat lake improved over last year in case of mullets, *Sillago sihama* and *Gerres* spp. while it decreased in *Elops saurus, Megalops cyprinoides, Chanos chanos* and prawns. The modes at 240, 300 and 435 mm of *Mugil cephalus* were attributed to the 1st, 2nd and 3rd year groups respectively. The feeding habit of mullet fry did not show any change. The sex ratio and size of mature mullets were recorded. Physico-chemical features of the lake were studied and the primary productivity ranged as 0.18-1.8 gm C/m^2/day.

Project 9 :

9.1: Among several hybrids of Indian carps studied, the feeding spectrum of catla × mrigal was observed to be considerably reduced while that of mrigal × catla was very much increased, thereby giving the latter an advantage over its parents.

9.2: Sperms of the common carp *Cyprinus carpio* survived only for three days in Ringer's solution, whereas they remained viable for 10 days in GPC-5

+ 1% glycerine at 1-10°C. Sperms of the mullet, *Mugil cephalus,* did not survive in water having low salinity.

9.3: The hybrid, silver carp × grass carp, produced in 1968, could be reared in ponds for $14\frac{1}{4}$ months. At $13\frac{1}{2}$ months, it attained an average size of 367.5 mm/450 gm. Its gill structure was intermediate between that of the parents and pharyngeal teeth were present as in grass carp. In one specimen the testes attained the I stage of maturity.

Successful hybridization between the mullets, *Liza troschelii* and *Mugil cephalus* showed the possibility of hybridization in this group of fishes.

Project 12 :

12.1: By induced breeding, 1.63 lakh of grass carp and 1.72 lakh of silver carp spawn were produced while spawning without stripping was also observed. The doses of hormone administered were 10-16 and 2-3 mg/kg in case of females and males respectively. Role of ecological conditions on induced breeding were studied.

12.2: In monoculture of silver carp for 6 months, a gross production of 2,010 and 1,550 kg/ha were obtained in two ponds stocked at 5,000/ha. In a fresh experiment with 4,000/ha stocking rate, the fish attained average weights of 583 and 416 gm in two ponds after 8 months.

12.3: Fingerlings of grass carp reared in plastic pools, consumed cut leaves of potato, cauliflower and cabbage in the order given. Inside *hapas* the fingerlings registered average increase in weights of 3.1, 2.5, 2.5 and 2.2 gm in one month when fed on leaves of radish, cauliflower, *Hydrilla* sp. and *Spirodela* sp. respectively.

Project 13 :

13.1: In brown and rainbow trouts, except in rare cases, no sign of whirling disease was recorded in hatcheries, when trouts were fed with partially boiled fish + liver + wheat middlings. Intramuscular administration of thiamine chloride at 1.5-2.0 cc failed to check whirling disease, probably because the disease was detected in late stage.

13.2: No progress

13.3: Considerable progress in improving the techniques of trout was achieved by adapting, dip treatment of alevins in 1:20,000 Malachite green

for 1 minute and 1:2,500 Acriflavin for 25 minutes and feeding of trouts with silkworm pupae powder, Aurofac A 2 and raw fish. In November, 22,379 eggs at Laribal and 32,747 eggs at Harwan were stripped and 94.06 and 87.61% fertilised eggs of brown trout which were produced, were stocked for hatching. Similarly 28,128 eggs of rainbow trout produced, were also stocked at 3,000, 2,000 and 1,000/tray where survival up to eyed ova were 89.14, 79.05 and 41.07% in control and 82.79, 87.54 and 73.01% in treated respectively. Mortality was due to blackening and pin-head conditions.

13.4: During the year, mirror carp spawn (3,86,275) produced through artificial breeding were cultured. Fry were fed at 4% and 2% of body weight, keeping suitable controls to compare growth and survival. The physico-chemical aspects of the ponds were noted.

13.5: Jhajjharkotli and Anji in the Tawi and Chenab systems respectively, were prospected for mahseer seed. At Jhajjharkotli, only hatchlings at 110/sq m of river area and at Anji, both, eggs and fry at 4-75 and 43-73/m^2 respectively, were available. Limnological studies of these sites were made.

13.6: Hazaratbal and Saidakadal were selected to assess productive potentiality of the Dal lake. Limnology and plankton of these two sites were studied. Respective fish catch/man-hour were in the ranges of 152-588 and 241-700 gm. The main species of fish recorded were: *S. esocinus, S. niger, S. curvifrous, C. carpio C. latius, L. dero* and *B. birdi.*

13.7: The angling pressures were 273 kg by 136 rods in the Sind stream and 681 kg by 343 rods in the Lidder stream during the year. Physico-chemical investigations were also carried at these streams. Plankton population varied between 11-397 units/l in the Sind stream and 50 units/l in the Lidder stream, being dominated by phytoplankton. Identification of plankters, insect and other aquatic life encountered, were done.

Project 14:

14.1: Inventry of 16 permanent *arath* and 28 seasonal *arath* were made in the stretches from Kalakankar to Mirzapur on the Ganga river and from Rajapur to Allahabad on the Yamuna river. The average variation of landings was 30% within *arath* and 88% between *araths,* while the same in case of regular *arath* and seasonal *arath,* separately, were 30 and 90% respectively. Earlier survey centres were closed and a new centre at Buxar was established to assess the change in fishing effort and catches from the Ganga river. Primary productivity were regularly recorded from three sites, one on the Yamuna river and other two on the Ganga river, but above and below the confluence.

14.2: Estimated landing of fish at Bhagalpur, Rajmahal, Dhulian and Lalgola was 400.08 t during the year. *H. ilisha* (179.13 t) dominated the catch, being followed by miscellaneous fishes (161.13 t), *W. attu* (21.33 t) and *C. catla* (12.55 t). Primary productivity at Bhagalpur varied between 150-1,410 mg $C/m^3/day$. Though no relationship of pH and water temperature could be established with primary productivity, maximum and minimum of the phytoplankton densities coincided with those of primary productivity.

14.3: Total yield of fishes from the Godavari river was 218 t, showing a declining trend since 1963. There was a gradual fall in the age group in the catch. Study on feeding revealed inter specific competition for food. Survival of *M. seenghala* and *S. childrenii* after recruitment for a couple of years, was very poor. Conservation measures ; like, legal bar on size limit, ceiling on number of operating gears and systematic stocking with fingerlings were recommended. The loss in weight of ovary in case of hilsa was noted. Tagging and marking of prawns were continued to assess the population.

14.4: The total estimated catch from the Hooghly-Matlah estuarine system was 8,343.1 t, being dominated by *H. nehereus* (18.5%), *H. ilisha* (13.6%) and prawns (13.3%), while chief contributing gears were bagnet (53.8%), driftnet (15.2%), large seine (10.1%) and small seine (9.9%). Simple random sampling was found to be superior to systematic sampling.

14.5: The total catch from the Pulicat lake was 1,140.7 t. An increase of 23.06% in the total catch was observed over that of the previous year, the main contributors being clupeids, prawns, catfishes and mullets. Stake nets contributed more than drag nets in contrast to that of the previous year.

Project 15 :

15.1: LC_{50} values of NaCl, $KMnO_4$, $K_2Cr_2O_7$ and Acriflavine, when tested on fry of major carps, were found to be 5,500-7,500, 37.5-48, 92.5-125 and 47.5-80 ppm respectively. None in 697 spawn of major carp examined, was infected. The percentage infection of 1,357 fry and 362 fingerlings by *Trichodina* sp., *Myxobolus* sp., *Thelohanellus* sp. and monogenetic trematodes was determined. 2,230 prawns were examined to study the rate of infection.

Project 16 :

16.1: Yard and field trials, during the year, confirmed that dose of 2,4-D for complete kill of weeds were depended on plant weight. For effective clearance of the higher weight groups of water hyacinth, an application rate of 30 mg active ingredient/kg plant weight were needed, while efficacy of spraying

played a great role. Yard trials indicated that prolonged control of regeneration of *Cyperus* sp. (51-100 cm group) could not always be achieved with 2,4-D at 2 mg a.i./plant and that at post-flowering stage it was difficult to control the plant effectively at low doses. In yard trials, 40% 2,4-D amine salt (Herbazol) @ 5 kg a.i./ha was found effective against *Nymphoides cristatum*. A field infestation of lotus was cleared with 80% 2,4-D sodium salt at 10 kg a.i./ha and 0.25% surf.

16.2: The density of *Microcystis* sp. in 4 ponds varied as 1,03,000-4,89,000 u/l in different seasons.

16.3: Granulated formulation of weedicides produced by indigenous means, proved useful in preventing the regrowth of weeds. In small scale field trials, Tafapon at 10 kg/ha adversely affected the aquatic grass, *Panicum* sp.

16.4: Ammonia, besides being a good weedicide for submerged weeds, like *Hydrilla*, seemed promising against water hyacinth.

16.5: Portion of a lake infested with *Scripus* sp., a pond with *Vallisneria* sp., *Hydrilla* sp., *Potamogeton* sp., *Ottelia* sp. and *Ceratophyllum* sp. along with thick layer of *Gladophora* sp. and another lake with *Vallisneria* sp., *Potamogeton* sp., *Hydrilla* sp., *Ceratophyllum* sp., *Nymphoides* sp. and *Nymphea* sp., were treated with $CuSO_4$ mud pellet with 4 doses @ 35 kg/ha ; 4 does @ 35 kg/ha ; and 4 doses @ 35, 10, 15 and 15 kg/ha respectively. Since then, the first two water bodies were free from weeds, while gradual clearing took place in the third one. To utilise eradicated weeds, jar experiments showed better growth of plankton with compost of *Eichhornia* sp. and *Spirodela* sp. than in control.

16.6: After $CuSO_4$ mud pellet treatment, vegetative or sexual reproduction of floating *Vallisneria* sp in aquaria did not occur, but rooting took place in contact with bottom soil. Mature fruits of *Ceratophyllum* sp. were collected and observations on epigean germination at different laboratory conditions were made.

Project 17 :

17.1: Pituitary extracts induced ovulation in 36 out of 37 sets of *R. tigrina* and in 2 sets of *R. hexadactyla*. Dosages were standardised for *R. tigrina*. Ovulation was also obtained in *R. tigrina* with progesterone alone and in combination with pituitary extracts. Artificial fertilization of eggs resulted in cent percent success. Preliminary studies on the fecundity of *R. tigrina* were completed.

17.2: Tadpoles of *R. tigrina* and *R. hexadactyla* were raised from fertilised eggs and were reared up to early frog stages in laboratory, yard and field experiments. Observations on their metamorphosis, survival and preferred food items were made. Post-hatching mortality in *R. tigrina* was checked.

17.3: Two experiments on frog farming were conducted with early frogs of *R. tigrina*/*R. hexadactyla* stocked @ 6,000/ha in fenced ponds. While the experiment with *R. tigrina* was abandoned after six months, a production of 664.9 kg/ha of *R. hexadactyla* was obtained in ten months.

17.4: 423 and 1,431 kg/ha of *R. hexadactyla* and Indian major carps were produced in a ten months' joint rearing experiment, in which early frogs and fingerlings were stocked at 6,000 and 4,000/ha respectively.

17.5: Rearing of tadpoles of *R. catesbeiana* to early frog and juvenile stages, together with observations on their metamorphosis, food and post-metamorphic growth rates under laboratory conditions, were successfully made.

Project 18 :

18.1: Studies on limnology of two sewage fed ponds and on the physico-chemical characters of the sewer feeding the ponds and of a control pond (unpolluted), were continued during the first half of the year while the problem was kept suspended in the second half of the year due to practical difficulties.

Project 19 :

19.1: Studies on spawning period of *Hilsa ilisha* with its peak period, rate of occurrence of spawn and larval abundance at Vindhyachal, Sindhoraghat, Agiabirghat, Sujabad and Mahewa, were continued. Catch/hr for spawn during spawning season was found to range between 3,250-1,31,223.

19.2: Annual landing of *Hilsa ilisha* in Sultangunj to Lalgola stretch was 179.13 t, while contributions from Lalgola, Dhulian, Rajmahal and Bhagalpur were 51.51, 31.72, 12.54 and 4.23% respectively. The intermingling pattern of three varieties of *Hilsa ilisha* were studied and investigations on larval abundance were continued.

19.3: Investigations to delimit spawning ground of Godavari-hilsa confirmed last year's observations. Hilsa spawned early only at Kotipalli in August. Larval concentration in Vasishta was poor. There was reduction in the size of ovary as compared to that of the last year. Large scale migration of hilsa over the anicuts, was observed during September and October. Attempts to breed Godavari-hilsa artificially for the second successive year, were made.

19.4: The stretch of the Hooghly estuary from Nawabgunj to Datrigram was investigated to study the spawing success of *Hilsa ilisha*.. Laıva! concentrations were observed at Kalna, Balagarh and Datrigram.

19.5: Hatchlings of hilsa were successfully produced during the year through artificial fecundation. Six lakhs of them were stocked in nurseries where they attained a size of 50.1 and 53.0 mm in 80 and 70 days respectively. Only 5-10% mortality was recorded when egg @ 1.5 lakh/bucket with 5 1 of river water were transported to a distance of 40 km within 2 hr. During transport of hilsa spawn under oxygen packing @ 1 lakh spawn in 6 1 of river water, the mortality was 10-30% after $2\frac{1}{2}$ hours journey.

Project 20 :

20.1: Hydrological factors of biological, miscellaneous organic chemical, mineral, semi-mineral + semi-organic, hydrocarbonic and domestic wastes of the Hooghly-Matlah estuary were studied. Studies on the effect of industrial wastes with special reference to productivity were also continued.

7. PERSONNEL

(a) *Retirement, promotions, transfers*

Retirement : No retirement during the year

Promotions : No promotion during the year

Transfers : The following research officers were transferred during 1969 :

Shri B. B. Pakrasi (Biologist)	:	From Barrackpore to Kakdwip
Dr. A. David (Fishery Scientist)	:	From Cuttack to Bangalore
Shri M. A. V. Lakshmanan (Junior Fishery Scientist)	:	From Panna to Cuttack

(b) *Honours and awards*

(Nothing to report for 1969)

(c) *Staff*

Director	:	Dr. V. G. Jhingran
Deputy Director	:	Dr. Y. R. Tripathi

1 Pond Culture Division (Cuttack)

1.1 Central Inland Fisheries Research Substation, Cuttack (Orissa)

Fishery Scientist	:	Dr. H. Chaudhuri (on FAO service), Dr. M. T. Philipose and Dr A. K. Mondal
Junior Fishery Scientist	:	Sarvashri V. Ramachandran, S. B. Singh, R. D. Chakrabarty and M. A. V. Lakshmanan
Assistant Fishery Scientist	:	Sarvashri R. M. Bhowmick, K. Raman, K. H. Ibrahim, S. Patnaik, G. N. Saha, P. R. Sen and T. Ramaprabhu
Research Assistant (Sel. Grade)	:	Shri A. K. Banerjee
Research Assistant	:	Sarvashri A. C. Nandy, D. K. Chatterjee, M. D. Rout, D. P. Chakraborty, D. S. Murthy, M. M. Bagchi, G. V. Kowtal, G. C. Panicker, P. C. Chakraborty, P. Gopalakrishna and R. K. Jena
Survey Assistant	:	Shri P. V. G. K. Reddy

1.2 Central Experimental Fish Farm, Panna (Madhya Pradesh)

Research Assistant	:	Shri C. Selvaraj

2 Riverine Division (Allahabad)

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

Fishery Scientist	:	Sarvashri H. P. C. Shetty and J. C. Malhotra
Assistant Fishery Scientist	:	Sarvashri K. K. Ghosh, Ravish Chandra, Dr. A. G. Jhingran and Shri D. V. Pahwa
Research Assistant (Sel. Grade)	:	Sarvashri V. R. Desai, S. N. Mehrotra and P. K. Mathur
Survey Assistant (Sel. Grade)	:	Sarvashri S. P. Singh, K. P. Srivastava and S. Jena
Research Assistant	:	Sarvashri M. Y. Kamal, M. R. Sinha, A. G. Godbole, S. D. Gupta, S. C. Pathak, B. Singh, S. K. Das and P. N. Jaitly
Survey Assistant	:	Sarvashri R. K. Sexena, S. K. Wishard and G. N. Srivastava

2.2 Central Inland Fisheries Research Unit, Bhagalpur (Bihar)

Junior Fishery Scientist	:	Dr. G. N. Mukherjee
Assistant Fishery Scientist	:	Shri B. N. Saigal
Research Assistant (Sel. Grade)	:	Shri K. V. Rao
Research Assistant	:	Sarvashri B. L. Pandey and R. N. Seth
Survey Assistant	:	Sarvashri S. N. Sar, R. C. Singh and R. K. Bhattacharya

2.3 Small Reservoir Unit, Rewa (Madhya Pradesh)

Junior Fishery Scientist	:	Shri S. J. Karamchandani
Research Assistant (Sel. Grade)	:	Shri G. K. Bhatnagar
Research Assistant	:	Sarvashri D. N. Misra, J. B. Rao, H. C. Joshi and Shri Prakash
Survey Assistant	:	Sarvashri M. D. Pisolkar and R. K. Dwivedi

2.4 Krishna Godavari Unit, Rajahmundry (Andhra Pradesh)

Junior Fishery Scientist	:	Smt. T. Rajyalakshmi
Assistant Fishery Scientist	:	Shri Y. Rama Rao
Research Assistant	:	Sarvashri P. L. N. Rao, G. R. M. Rao and L. H. Rao
Survey Assistant	:	Sarvashri T. S. Ramaraju, K. Subba Rao and M. Ranadhir

3 Estuarine Division (Barrackpore)

3.1 Estuarine Fisheries Research Substation, Barrackpore (West Bengal)

Fishery Scientist	:	Dr. V. R. Pantulu (on ECAFE service) and Dr. V. Gopalakrishnan
Junior Fishery Scientist	:	Shri P. Datta
Assistant Fishery Scientist	:	Dr. M. Subrahmanyam, Sarvashri P. Ray, A. Ghosh, H. A. Khan and Dr. C. S. Singh
Research Assistant (Sel. Grade)	:	Sarvashri S. B. Saha and B. B. Ghosh
Survey Assistant (Sel. Grade)	:	Sarvashri S. N. Datta and A. Chaudhury
Research Assistant	:	Sarvashri K. Alagaraja (on long leave), M. V. Gupta, R. M. Rao, N. K. Thakur (on long leave), K. K. Bhanot, S. K. Mukhopadhyaya, Shrimati K. K. Bhanot, Sarvashri G. C. Laha and P. U. Verghese
Survey Assistant	:	Sarvashri D. D. Halder, P. B. Das, B. K. Saha, R. N. De, A. R. Chaudhury and R. K. Chakraborty
Computor	:	Shri P. M. Mitra

3.2 Estuarine Fisheries Research Unit, Kakdwip (West Bengal)

Junior Fishery Scientist	:	Shri A. N. Ghosh
Research Assistant	:	Sarvashri P. R. Das, S. R. Ghosh, N. K. Das and L. K. Das
Survey Assistant	:	Sarvashri P. K. Pandit and H. S. Majumdar

3.3 Pulicat Lake Unit, Madras (Tamil Nadu)

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

4 Reservoir Fisheries Research Substation, Hazaribagh (Bihar)

Junior Fishery Scientist	:	Shri A. V. Natarajan
Assistant Fishery Scientist	:	Sarvashri S. P. Ayyar and B. V. Govind
Research Assistant	:	Sarvashri S. K. Sarkar, M. Ramakrishnaiah and M. A. Khan
Survey Assistant	:	Sarvashri B. Ray, B. K. Banerjee and S. L. Kar

5 Tank Fisheries Research Unit, Bangalore (Mysore)

Fishery Scientist	:	Dr. A. David
Research Assistant (Sel. Grade)	:	Shri N. G. S. Rao
Research Assistant	:	Shri S. Lakshmiraghavan

6 Coldwater Fisheries Research Unit, Srinagar (Kashmir)

Junior Fishery Scientist	:	Shri K. L. Sehgal
Research Assistant (Sel. Grade)	:	Shri K. V. Ramakrishna
Survey Assistant (Sel. Grade)	:	Shri M. J. Bhagat
Research Assistant	:	Sarvashri K. L. Shah, C. B. Joshi and Kuldip Kumar
Survey Assistant	:	Shri Shyam Sundar

7 Pathology Unit, Barrackpore (West Bengal).

Assistant Fishery Scientist	:	Shri R. N. Pal
Research Assistant	:	Shri A. K. Ghosh

8 Sunderbans Survey Unit, Kakdwip (West Bengal)

Biologist	:	Shri B. B. Pakrasi
Survey Assistant	:	Sarvashri D. K. De and M. K. Mukhopadhyaya
Overseer	:	Shri P. N. Bhattacherjee

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

Junior Fishery Scientist	:	Shri S. M. Banerjea and Dr. (Miss) E. Mitra
Research Assistant (Sel. Grade)	:	Sarvashri S. C. Banerjee, S. C. Thakurta and A. C. Banerjee
Research Assistant	:	Sarvashri R. K. Banerjee and M. K. Banerjee

10 Library and Documentation Unit

10.1 Sewage Fed Fisheries Unit cum Documentation Unit, Barrackpore (West Bengal)

Junior Fishery Scientist	:	Shri S. D. Tripathi (on other service)
Research Assistant	:	Shri R. R. Khan
Reference Collection Assistant	:	Shri P. K. Chakrabarti

10.2 Library

Librarian	:	Miss Anjali Ghosh

10.3 Studio

Senior Artist	:	Shri J. Ghosh

SARAT PRESS LTD., 10/2, RAMANATH MAJUMDAR ST., CAL - 9.