1987-88
ANNUAL REPORT

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

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(Indian Council of Agricultural Research)

BARRACKPORE-743 101 WEST BENGAL

INDIA

Credits

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VICE-PRESIDENT VISITS CICFRI PAVILION

The CICFRI Pavilion at Ramakrishna Ashram was visited by His Excellency, Shri R. Venketaraman, the Vice-President of India on 22nd February, 1987. The Vice-President was received by Dr. Arun G. Jhingran, Director, CICFRI who briefed His Excellency about the activities of the Institute in the areas of fisheries research, extension and training.

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BARRACKPORE

BRIEF HISTORY

The Government of India, in a memorandum brought out in 1943 stressed the need for having a separate central department in the best interest of the development of the fisheries resources of the country. This memorandum was later endorsed by the Fisheries Sub-committee of the Central Government Policy Committee on Agriculture, Forestry and Fisheries. Based on this, the Central Inland Fisheries Research Station was formally established on 17 March, 1947 in Calcutta under the Ministry of Food and Agriculture, Government of India. From the modest beginning as an interim scheme, the organisation has since grown to the status of a premier research institution in the field of inland fisheries in the country. By the year 1959, the Station acquired its status as Central Inland Fisheries Research Institute (CIFRI) and moved to its own buildings at Barrackpore, West Bengal.

Since 1967, the Institute is under the administrative fold of Indian Council of Agricultural Research (ICAR). The main objectives were to conduct investigations for a proper appraisal of inland fisheries resources of the country and to evolve suitable methods for their conservation and optimum utilisation. While fulfilling the above objectives, the Institute directed its research efforts towards understanding the ecology and production functions of inland water bodies available in the country like the river systems, lakes, ponds, tanks, reservoirs and ox-bow lakes. These studies have unravelled the complex trophic structure and functions *vis-a-vis* the environmental variables in different aquatic ecosystems.

The mandate of the Institute was later modified giving added emphasis on capture fisheries resources of the country and the Institute was rechristened as Central Inland

Capture Fisheries Research Institute (CICFRI) with effect from 1.4.87. Under the changed setup, the CICFRI is entrusted with the responsibility to conduct research on open water bodies where the fisheries management norms are closely associated with environmental monitoring and conservation.

MANDATE

The CICFRI has a mandate to conduct research for developing systems for monitoring and improving fish production in natural and man made inland water resources through stocking, optimum exploitation and conservation.

ORGANISATION

In order to achieve the above mandate, the research at CICFRI has been organized under three Divisions corresponding to the major fishery resources of the country. *The Riverine Division*, with its headquarters at *Allahabad*, strives to develop systems for effective management of the vast riverine fisheries resources of the country with adequate emphasis on the conservation of riverine environment. The research projects under the Division cover the rivers Ganga, Yamuna, Brahmaputra, and Narmada. *The Lacustrine Division* has its headquarters at *Bangalore* and the investigations being carried out at the Division aim at developing management norms for optimising fish yields from large tanks, lakes, and reservoirs. *The Estuarine Division* is based at *Barrackpore* and it covers the entire Hooghly-Matlah estuarine system and the Narmada Estuary. The Institute also conducts investigations on beels of West Bengal and Assam and the ox-bow lakes of the Gandak basin. Other areas covered include cage and pen culture systems in open waters, the ecology and production biology of inland molluscs, engineering aspects of fish passes in hydraulic structures and investigations on fisheries economics and statistics. The Institute's researches have been organized under 20 research projects and a Central Sector Scheme. The work programme of the Institute is carried out through its 15 research centres and 5 survey centres. The distribution of research and survey centres and different sections are shown in the organization chart.

IMPORTANT ACHIEVEMENTS

Bright prospects for overseas trade in inland molluscs

Bright prospects for developing an overseas trade in edible molluscs have emerged after the Anuga Fair, held in Cologne from 10-15 October 1987. A consignment of *Achatina fulica* supplied by the CICFRI and processed at a private food processing plant in Calcutta was exhibited at the Fair. The product evoked a warm response from the potential buyers of Europe.

The Institute has developed techniques to breed, rear and culture the giant African snails in indoor terraria as well as in field snail houses. There is also scope for collecting the snails from the wild, where the organisms are posing serious threat to the agricultural crops. The Institute's attempts are mainly directed towards promoting a foreign trade in edible snails with a view to containing the pest problem without involving chemical control. The snail is an exotic species introduced accidentally into the country. Control of their population in nature will be a boon to agriculture. However, in the event of the successful export trade for the species, these snails can be cultured in snail houses to meet their export demand.

Marine Products Export Development Authority (MPEDA) in close liaison with CICFRI is arranging to procure and export the snails. The Institute has already initiated steps to disseminate breeding and hatching techniques of the snails to entrepreneurs and exporters through training programmes.

Heavy metal monitoring in the rivers Ganga and Yamuna

Zinc (Zn), Copper (Cu), Chromium (Cr), Cadmium (Cd), Lead (Pb) and Mercury (Hg) were analysed in water samples collected from the banks, midstream and opposite banks near nine cities *viz.*, Rishikesh, Hardwar, Kanpur, Allahabad, Varanasi, Buxar, Patna, Barauni and Bhagalpur along the river Ganga and four cities *viz.*, Delhi, Mathura, Agra and Allahabad along the river Yamuna using Pye-Unichem SP 2900 atomic absorption spectrophotometer.

In the River Ganga, the highest values for all the metals were encountered in the samples collected just below the Pandu Nallah and tannery effluent outfall at Kanpur. Zn (285μg/l); Cu (178.9 μg/l); Cr (200 μg/l); Cd (13.7 μg/l); Pb (26·11 μg/l) and Hg (1·34 μg/l), were recorded at this point against the minimum background levels of Zn 71·6 μg/l; Cu 7.2 μg/l; and Cr, Pb, Cd and Hg below detectable levels at Hardwar. At Buxar and Allahabad also, Zn and Cu levels were considerably higher than the minimum background levels.

In the River Yamuna, maximum levels of Cu (63.3 μg/l), Cr (4·7 μg/l), Cd (22·5 μg/l), Pb (7.9 μg/l) and Hg (0·09 μg/l) were recorded at Agra. Maximum Zn level (85·1 μg/l) was recorded at Allahabad. Mean Zn, Cu, Cr and Pb concentrations at Delhi were observed as 68.0, 25·4, 0.625 and 4.35 μg/l. Effluents from the Najafgarh drain carrying domestic and trade wastes from the large areas of Delhi showed the presence of mercury (1.44 μg/l) at Wazirabad, the confluence point with the river Yamuna.

The metal concentrations in water at all the centres on the rivers Ganga and Yamuna did not exceed the drinking water standard limits prescribed by WHO except once in case of chromium at Kanpur and twice in case of cadmium at Kanpur and Agra. However, safe limits prescribed for fish and other aquatic life (Inland Water Directorate, Canada 197 a) have been frequently violated.

μg/l = ppb

Judicious use of pesticides

Static bio-assay experiments conducted by CICFRI at Barrackpore with quinalphos and endosulfan, the commonly used pesticides in agricultural fields, suggest that they are highly toxic to tiger prawn, *Penaeus monodon* at its early life stages. LC_{50} (24 hrs) values of quinalphos and endosulfan were 0.64 and 17·6 ppb for juveniles, 0.7688 and 7.53 ppb for post-larvae and 0.327 and 2.409 ppb for mysids. Respective LC_{50} (48 hrs) values for juveniles and post-larvae were 0.3235 and 0.514 ppb for quinalphos and 12.2 and 4.645 ppb for endosulfan.

Lower Sunderbans (West Bengal) are potential collection centres for the seed of the prized tiger prawn, which are also subjected to large-scale discharge of agricultural pesticides. Hence, the study indicates the need for judicious use of the above pesticides to ensure a continuous supply of the prawn seed.

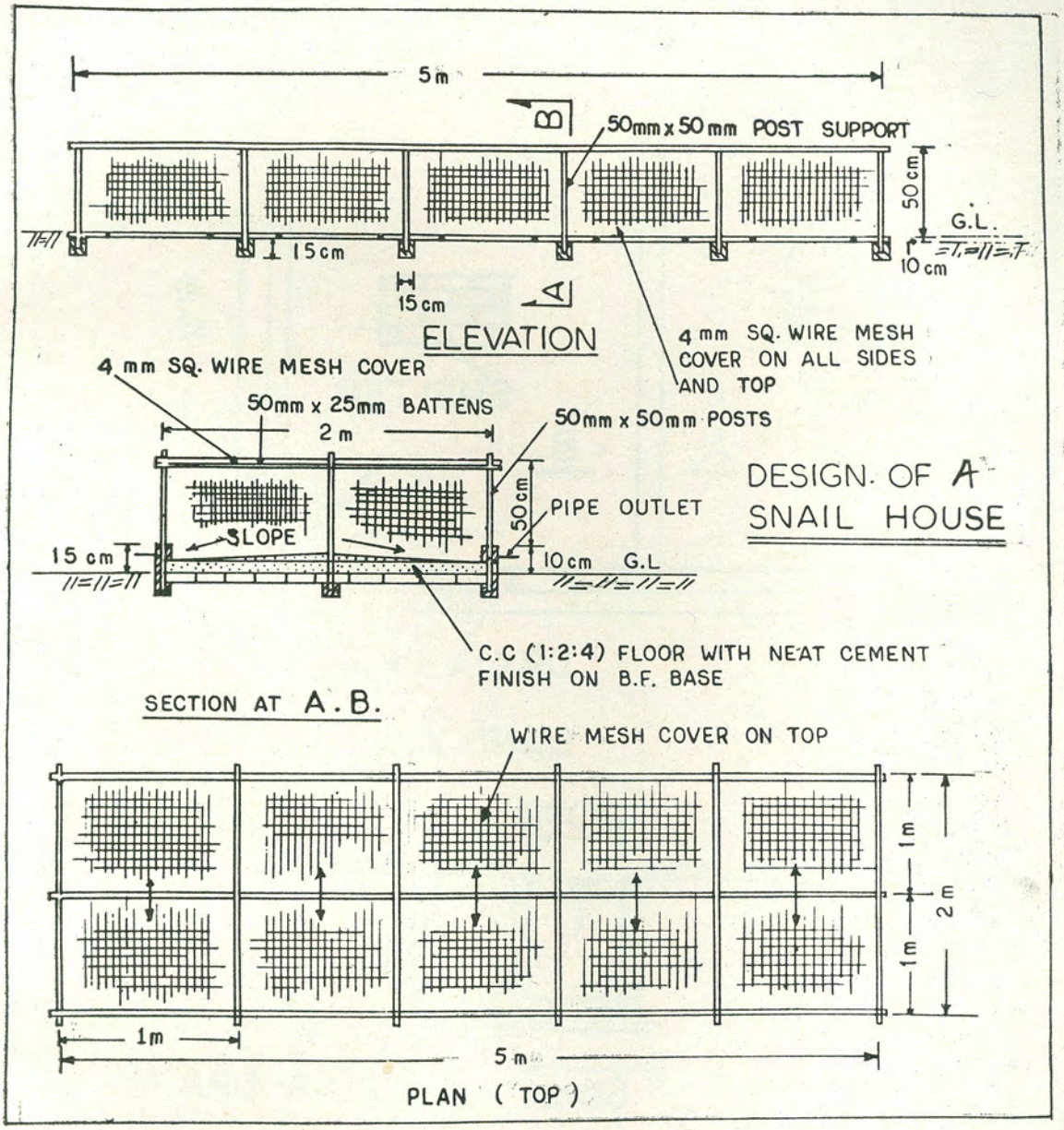
Biological indicators of gradient and high saline zones of Hooghly Estuary

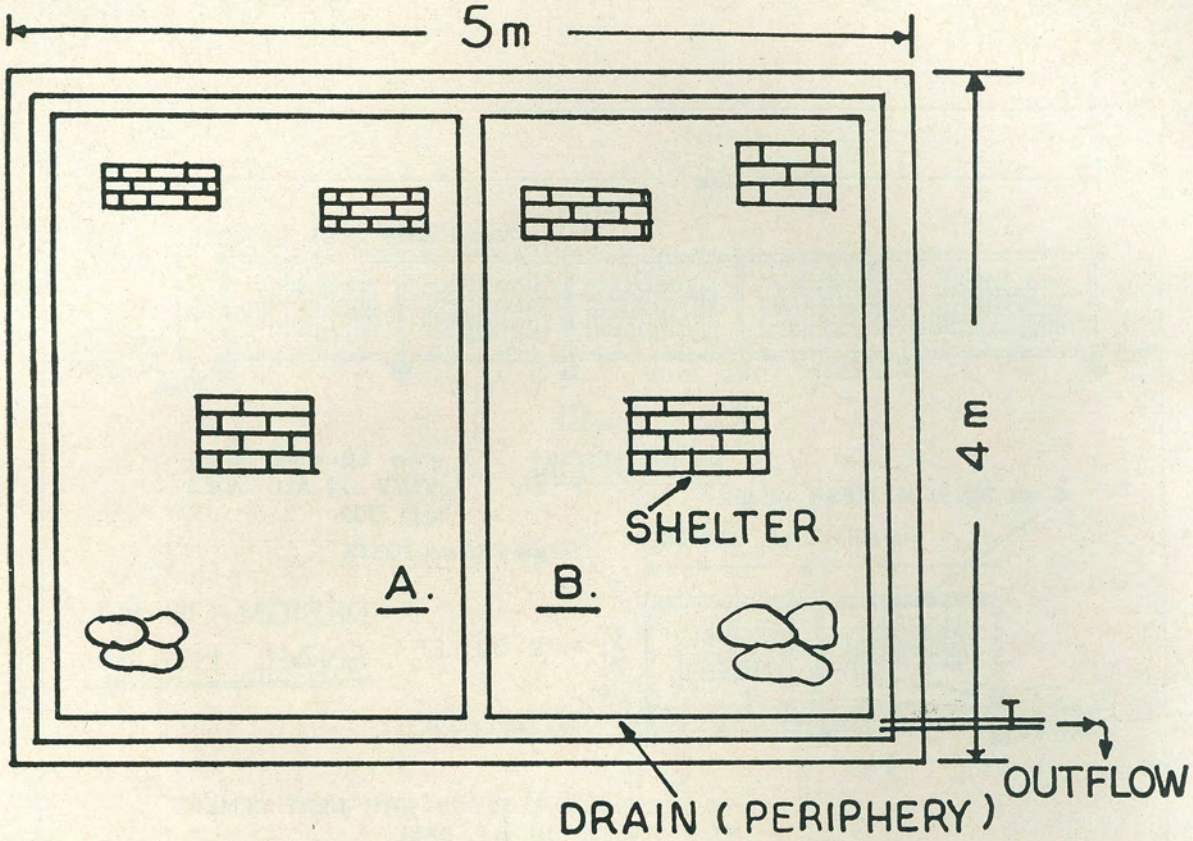
After commissioning of the Farakka Barrage, significant change in the salinity patterns have been noticed in the Hooghly Estuary. Besides the tidal amplitude, tidal ingress pattern and other hydrological features have also been influenced leading to a changed ecological environment. Salinity incursions which were felt beyond Barrackpore upto Nabadwip, prior to commissioning of Farakka Barrage, are now recorded upto Shalimar as is evident from chemical characteristics of estuarine water and also from the changed pattern of distribution of biotic communities. Among the plankters, *Coscinodiscus granii*, a diatom species, appears to have a direct correlation with salinity incursions and its distribution helps in demarcating spatio-temporal variations in salinity levels of the estuary. Similarly, high saline zone in the deltaic region has characteristic distribution of harpecticoid and pelagic copepods like *Longepede* sp. and *Euterpina* sp. respectively. These species also serve as indicators of high salinity zone in the coastal and deltaic regions of the Hooghly estuarine system. The species of *C. granii* has almost disappeared from freshwater zone (beyond Shalimar) of the Hooghly estuary.

Successive breeding of Hilsa ilisha

Success was again achieved in artificial breeding of anadromous hilsa, *Hilsa ilisha* of the River Ganga near Farakka Barrage in the second week of October 1987 by the scientists of CICFRI, Barrackpore. Eleven thousand hatchlings, produced in the first set of experiments, are being reared for further studies in the recirculatory filtering tanks at CICFRI, Barrackpore.

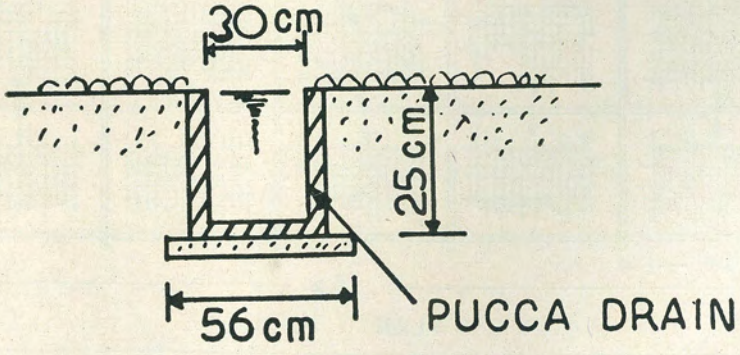
This repeated success in the artificial breeding of hilsa paves the way for restocking the upper stretches of the Ganga where hilsa fishery has depleted due to obstructions in its upriver migration posed by Farakka Barrage.


5m
B
50mm x 50mm POST SUPPORT
50 cm
G.L.
10 cm
15cm
15 cm
A
ELEVATION
4 mm SQ. WIRE MESH COVER ON ALL SIDES AND TOP
4 mm SQ. WIRE MESH COVER
50mm x 25mm BATTENS
2 m
50mm x 50mm POSTS
50 cm
PIPE OUTLET
SLOPE
15 cm
10cm G.L
C.C (1:2:4) FLOOR WITH NEAT CEMENT FINISH ON B.F. BASE
DESIGN OF A SNAIL HOUSE
SECTION AT A.B.
WIRE MESH COVER ON TOP
1m
2 m
1m
1m
5m
PLAN (TOP)



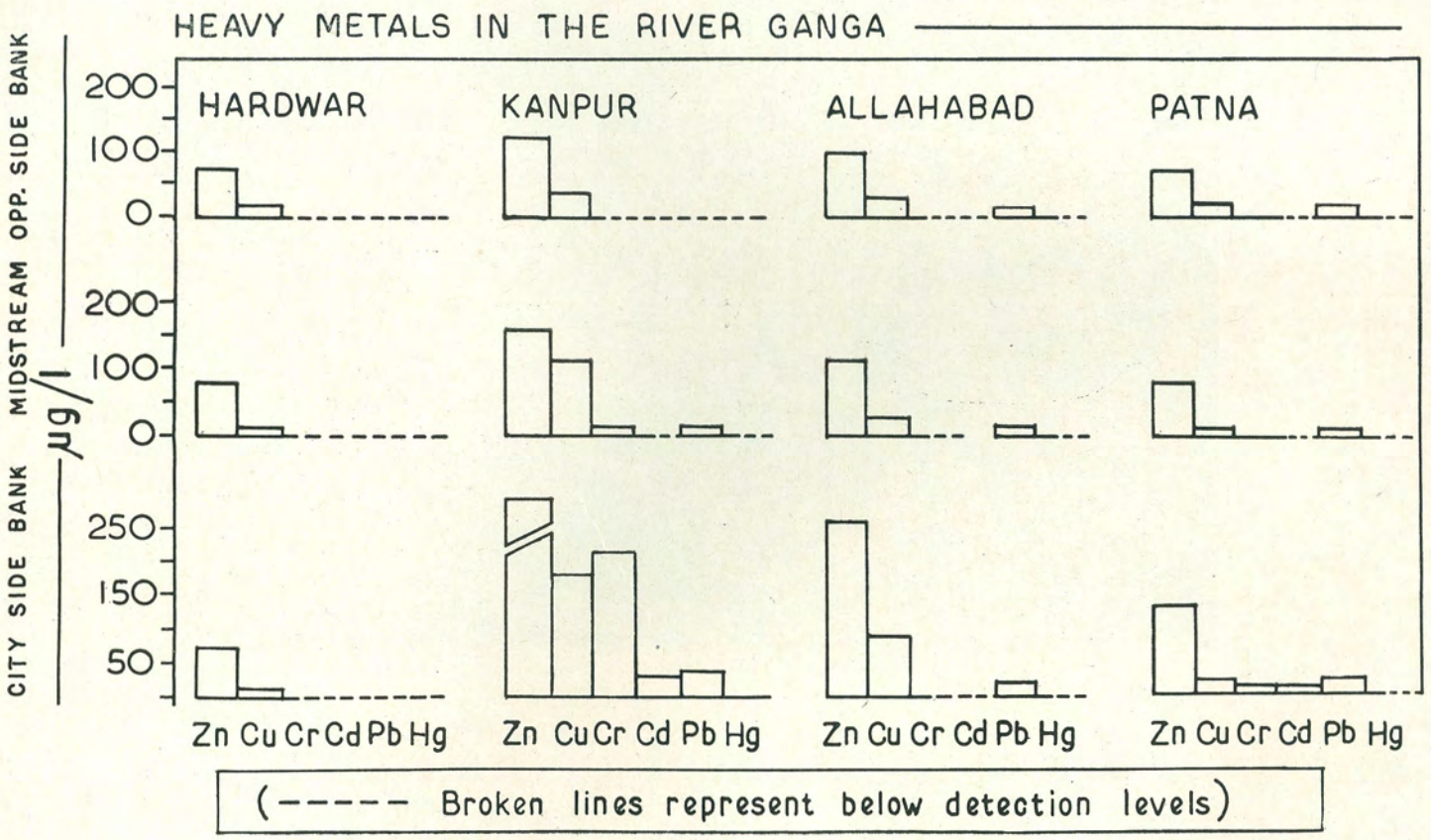
PLAN

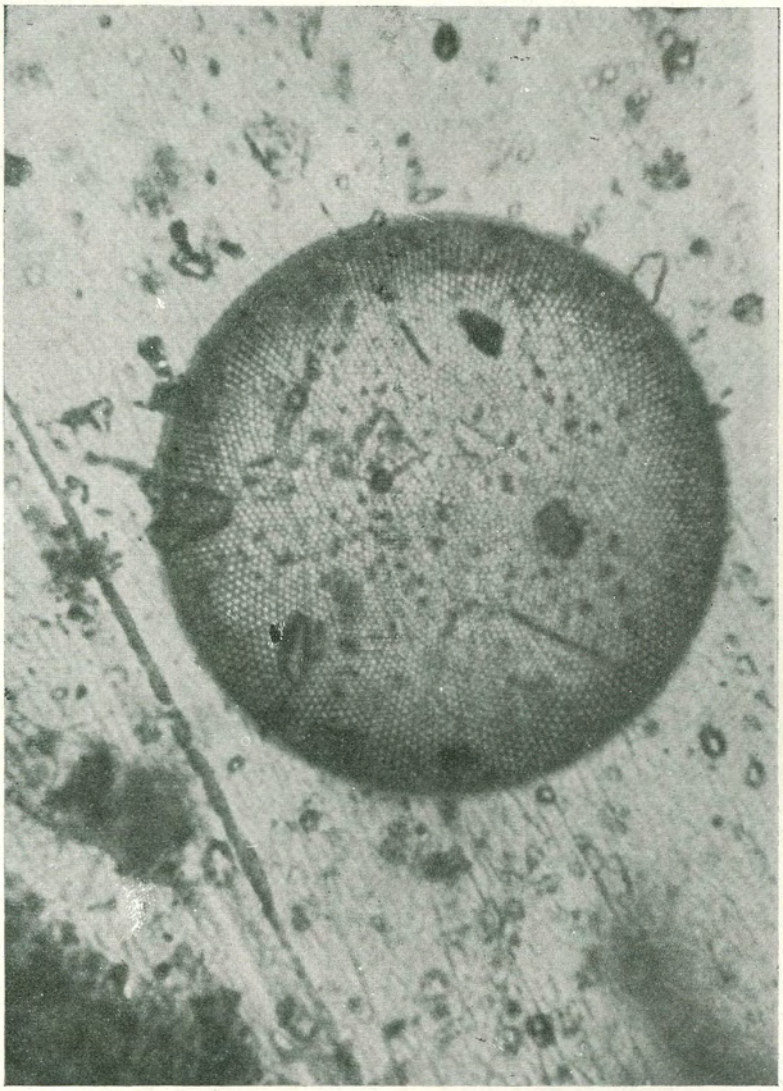
LAND AREA – 5m X 4m



SECTION AT A. B.

Design of a field plot for snail farming


HEAVY METALS IN THE RIVER GANGA
CITY SIDE BANK
MIDSTREAM
OPP. SIDE BANK
µg/l
HARDWAR
KANPUR
ALLAHABAD
PATNA
200
100
0
200
100
0
250
150
50
Zn Cu Cr Cd Pb Hg
Zn Cu Cr Cd Pb Hg
Zn Cu Cr Cd Pb Hg
Zn Cu Cr Cd Pb Hg
(----- Broken lines represent below detection levels)



Coscinodiscus granii, a biological indicator of salinity gradient in Hooghly estuary

वार्षिक रिपोर्ट 1987-88

केन्द्रीय अंतर्स्थलीय प्रग्रहण मत्स्यकी अनुसंधान संस्थान

बैरकपुर

संक्षिप्त इतिहास

भारत सरकार ने सन् 1943 में अपने एक ज्ञापन में देश के मत्स्यकीय स्रोतों के विकास हेतु एक केन्द्रीय विभाग की स्थापना पर विशेष बल दिया था। तत्पश्चात्, कृषि, वणिक तथा मत्स्यकी की केन्द्रीय सरकार नीति समिति की मत्स्यकी उप-समिति ने इस विषय का पृष्ठांकन किया था। इसके आधार पर 17 मार्च सन् 1947 में भारत सरकार के खाद्य तथा कृषि मंत्रालय के अधीन कलकत्ता में केन्द्रीय अंतर्स्थलीय मत्स्यकी अनुसंधान केन्द्र की स्थापना औपचारिक रूप में हुई। एक अन्तरिम योजना के रूप में प्रवर्तित यह अब अंतर्स्थलीय मत्स्यकीय क्षेत्र में एक प्रमुख अनुसंधान संस्थान बन गया है। यह केन्द्र सन् 1959 में एक अनुसंधान संस्थान का पूर्ण रूप ग्रहण कर बैरकपुर स्थित अपने निजी भवन में स्थानान्तरित हो गया। सन् 1967 से यह संस्थान भारतीय कृषि अनुसंधान परिषद (आई. सी. ए. आर.) के प्रशासनिक प्रबन्ध में है। इस संस्थान का मुख्य उद्देश्य देश के मत्स्यकीय स्रोतों के उचित मूल्यांकन हेतु अन्वेषण करना तथा इनके संरक्षण और समुचित उपयोग के लिए उपयुक्त पद्धतियों को विकसित करना था। उक्त उद्देश्यों की पूर्ति के दौरान यह संस्थान अपने अनुसंधानात्मक प्रयासों द्वारा विभिन्न प्रकार के जल-स्रोत जैसे : नदी, सरोवर, तालाब, जलाशय और चापझील के पर्यावरण तथा उत्पादन-क्रियाशीलताओं को सुलझाने का प्रयत्न कर रहा है। इन अध्ययनों द्वारा भिन्न-भिन्न प्रकार के वातावरण में जलीय-पारिस्थितिक तंत्र की जटिल पोषी संरचना तथा प्रकार्यों को सुलझाया गया है। संस्थान के अधिदेश में किंचित परिवर्तन कर देश के प्रग्रहण मत्स्यकीय स्रोतों पर विशेष ध्यान दिया गया तथा 1.4.87 से संस्थान का नामकरण केन्द्रीय अंतर्स्थलीय प्रग्रहण मत्स्यकी अनुसंधान संस्थान किया गया। पुनः प्रतिष्ठित के. अ. प्र. म. अ. संस्थान को उन उन्मुक्त जल क्षेत्रों में अनुसंधान कार्य करने का दायित्व सौंपा गया है जहाँ मत्स्यकीय प्रबन्ध प्रणाली पर्यावरणीय अनुकूलन तथा संरक्षण से संबद्ध है।

अधिदेश :

प्राकृतिक एवं मनुष्य द्वारा निर्मित अंतर्स्थलीय जल-स्त्रोतों में संग्रहण, उचित समुपयोजन एवं संरक्षण द्वारा मछली उत्पादन में वृद्धि के लिए अनुसंधान करने हेतु इस संस्थान की स्थापना की गयी है।

संगठन :

उक्त उद्देश्यों की प्राप्ति हेतु संस्थान के अनुसंधान कार्य को देश के मुख्य मत्स्यकीय स्रोतों के अनुरूप तीन प्रभागों के अन्तर्गत रखा गया है। **नदीय प्रभाग** अपने इलाहाबाद स्थित मुख्यालय से देश के नदीय मत्स्यकी स्रोतों की सम-प्रबन्ध पद्धतियों को विकसित करने के लिए, नदीय-पर्यावरण के संरक्षण में आवश्यक ध्यान देते हुए कार्य कर रहा है। गंगा, यमुना, ब्रह्मपुत्र और नर्मदा नदियाँ इस प्रभाग की मुख्य अनुसंधान परियोजनाओं के अंतर्गत आती है। **सरोवरीय प्रभाग** का मुख्यालय बैंगलोर स्थित है, तथा इसके अन्वेषणों का लक्ष्य बड़े तालाबों, सरोवरों और जलाशयों में मत्स्य उत्पादन बढ़ाने हेतु, प्रबन्ध पद्धतियों को विकसित करना है। बैरकपुर स्थित **ज्वारनदमुखी प्रभाग** पूरे हुगली-मातलाह ज्वारनदमुखी तंत्र और नर्मदा ज्वारनदमुख क्षेत्र में विभिन्न अनुसंधान योजनाओं का संचालन कर रहा है। यह संस्थान प० बंगाल और आसाम की 'बीलों' और गन्डक बेसिन के चापझीलों ('मन') पर भी अनुसंधानात्मक कार्य कर रहा है। इनके अतिरिक्त विवृत्त जल क्षेत्रों में केज तथा पेन कल्चर, अंतर्स्थलीय मोलस्कों की पारिस्थितिकी एवं उत्पादन प्रक्रिया, हाइड्रालिक संरचनाओं से मत्स्य पारगमन के अभियांत्रिक पहलुओं तथा मत्स्यकी के आर्थिक और सांख्यिक विषयों पर भी अनुसंधान कार्य हो रहा है। इस संस्थान के अनुसंधान कार्य को 20 अनुसंधान परियोजनाओं तथा 1 केन्द्रीय सेक्टर योजना में विभाजित किया गया है।

मुख्य उपलब्धियाँ

गंगा और यमुना नदी में भारी धातुओं का सर्वेक्षण :

गंगा नदी के नौ तटवर्ती प्रमुख शहरों से जैसे ऋषिकेश हरिद्वार, कानपुर, इलाहाबाद, बनारस, बक्सर, पटना, बरौनी और भागलपुर तथा यमुना नदी के चार तटवर्ती शहरों से जैसे दिल्ली, मथुरा, आगरा और इलाहाबाद के मध्य-धारा तथा आमने-सामने वाले किनारों से लिए गए पानी के नमूनों में पॉइ यूनिकैम एस पी 2900 एटॉमिक एब्सौर्पशन स्पैक्ट्रोफोटोमीटर द्वारा भारी धातुओं का अनुमापन किया गया है।

कानपुर के पान्डु-नाला तथा चर्म-परिष्कारशाला से प्रवाहित निस्सार प्रवाह के समीपवर्ती क्षेत्र से प्राप्त किये गये गंगा नदी के नमूनों में सभी धातुयें अत्यधिक मात्रा में पायी गयी। हरिद्वार में पाये गये निम्नतम् पृष्टभूमिक स्तर जैसे : Zn 71·6 μg/l, Cu 7·2 μg/l और Cr, Pb, Cd, Hg मूल्यांकन स्तर से भी कम के विपरीत उपर्युक्त स्थान में Zn 285μg/l, Cu 178·9 μg/l, Cr 200 μg/l, Cd 13·7 μg/l, Pb 26·11 μg/l और Hg 1·34 μg/l पाया गया है। बक्सर तथा इलाहाबाद में भी Zn और Cu का स्तर निम्नतम् पृष्ठभूमिक स्तर से बहुत अधिक पाया गया है।

यमुना नदी में धातुओं का अत्याधिक स्तर Cu (63·3 μg/l), Cr (4·7 μg/l), Cd (22·5 μg/l), Pb (7·9 μg/l) और Hg (0·09 μg/l) आगरा के निकट पाया गया है। इलाहाबाद में Zn का स्तर (85·1 μg/l) अत्यधिक रहा है। दिल्ली में औसतन Zn, Cu, Cr और Pb का स्तर क्रमश: 68·0, 25·4, 0·625 और 4·35 μg/l पाया गया है। नजफ़गढ़ नाला, जो दिल्ली के बड़े-बड़े क्षेत्रों से घरेलू तथा व्यवसायिक निस्सार पदार्थों को प्रवाहित करता हुआ वज़ीरवाद के पास यमुना में विलीन होता है, उस स्थान पर पारे (Hg: 1·44 μg/l) की उपस्थिति देखी गयी है यद्यपि पेय-जल के लिए भारी-धातुओं की निर्धारित मात्रा का उल्लंघन केवल कानपुर व आगरा (Cr & Cd) में हुआ है। मछली तथा अन्य जल-जीवों के लिए निर्धारित सुरक्षात्मक स्तरों (इनलैंड वाटर डायरेक्टोरेट, कनाड़ा 197ए) का प्राय: सभी जगहों में उल्लंघन हुआ है।

अंतर्स्थलीय मोलस्कों (स्नेल) के विदेश व्यापार की दिव्य-सम्भावनाएँ :

सन् 1987 में 10-15 अक्तूबर तक कोलॅन में हुए "अनुगा" मेले के बाद खानेयोग्य मोलस्कों के विदेश व्यापार की सम्भावनाऐं उमड़ पड़ी है। के. अ. प्र. म. अ. संस्थान द्वारा संग्रहित तथा कलकत्ता स्थित एक निजी प्रोसेसिंग प्लांट में संसाधित मोलस्कों को मेले में प्रदर्शित किया गया। यूरोप के खरीदारों ने इस उत्पाद के प्रति काफ़ी उत्सुकता प्रकट की है।

इस संस्थान ने प्रयोगशाला में अफ्रिकन् स्नेल (घोंघा) के प्रजनन, संवर्धन तथा पालन-विधा की नयी तकनीकों को विकसित किया है। इन घोंघों को उन खेतों से भी प्राप्त करने के अवसर हैं जहाँ ये कृषि उत्पादन क्रिया को अत्यधिक हानि पहुँचाते हैं। इस संस्थान के प्रयास खाने-योग्य घोंघों के विदेशी-व्यापार को बढ़ावा देने के पक्ष में हैं ताकि रसायनों के उपयोग के बिना इन पर नियंत्रण पाया जा सके। ये घोंघे विदेशी जाति के हैं जो संयोगवश देश में उपलब्ध हुये हैं। इनकी बढ़ती संख्या पर नियंत्रण कर पाना कृषि क्षेत्र के लिए एक बड़ी उपलब्धि होगी। यदि इस जाति का सफलतापूर्ण विदेशी व्यापार हो तो इनकी निर्यात माँग को पूरा करने के लिए 'स्नेल हाउस' में इनका पालन-पोषण किया जा सकता है।

मैरीन प्रोडक्टस एक्सपोर्ट डेवलपमेंट अॅथारिटी इस संस्थान के सहयोग से इन घोंघों को प्राप्तकर निर्यात करने में प्रयत्नशील है। यह संस्थान उपकर्मियों तथा निर्यातकों को घोंघों के प्रजनन तथा अंडजोत्पत्ति तकनीकों में प्रशिक्षण देने के लिए एक कार्यक्रम तैयार कर रहा है।

कीटनाशकों का विवेकपूर्ण उपयोग :

साधारण तौर पर उपयोग में लाये जानेवाले क्विनालफ़ौस तथा एन्डोसल्फ़ान् पर बैरकपुर स्थित के. अ. प्र. म. अ. संस्थान द्वारा किये गये स्थैतिक विषमापन प्रयोगों से यह ज्ञात होता है कि ये कीटनाशक पदार्थ बागदा झींगा **पीनियस मोनोडोन्** की प्रारम्भिक अवस्थाओं के लिए काफी घातक होते हैं। क्विनालफ़ौस और एन्डोसल्फ़ान् के एल.सी$_{50}$ (24 घंटे) तरुण झींगो के लिए क्रमश: 0·64 और 0·327 पी.पी.बी, पश्चडिम्भकों के लिए क्रमश: 0·7688 और 7·53 पी.पी.बी. तथा माइसिस के लिए 0·327 और 2·409 पी.पी.बी. रहा है। इसी तरह क्विनालफ़ौस के एल.सी$_{50}$ (48 घंटे) तरुण झींगों तथा पश्चडिम्भकों के लिए क्रमश: 0·3235 और 0·514 पी.पी.बी. तथा एन्डोसल्फ़ान् के लिए क्रमश: 12·2 और 4·645 पी.पी.बी. रहा है।

सुन्दरवन के निचले क्षेत्र ही बागदा झींगे के बीज प्राप्ति का प्रमुख केन्द्र हैं लेकिन इन क्षेत्रों पर ही कृषि कीटनाशकों का अत्यधिक प्रभाव पड़ता है। अत: यह अध्ययन उपर्युक्त कीटनाशकों के विवेकपूर्ण उपयोग की आवश्यकता की ओर

ध्यान आकृष्ट करता है जिससे झींगों के बीज निरंतर प्राप्त होते रहें।

हुगली ज्वारनदमुख के प्रवण तथा उच्च लवणीय क्षेत्र के जैव-सूचक :

फ़रक्का बांध के निर्माण के बाद हुगली ज्वारनदमुख की लवणीयता में उल्लेखनीय परिवर्तन पाया गया है। ज्वारीय आयाम के अतिरिक्त ज्वारीय अंतःक्रमण तथा अन्य जलजैविक गुणों के प्रभाव से पारिस्थितिक वातावरण में परिवर्तन हुआ है। फ़रक्का बांध निर्माण के पूर्व लवणीयता का जो प्रभाव बैरकपुर के बाद से नबद्वीप तक पाया जाता था अब वह शालीमार तक ही रह गया है। ज्वारनदमुखी जल के रसायनिक अभिलक्षण तथा बदलती जीव जाति संरचना से इसकी पुष्टि होती है। प्लवकांशों में डॉयटम जाति के **कोसिनोडिस्कस ग्रेनी** का लवणीय परिवर्तन से सीधा सम्बन्ध प्रतीत होता है, तथा इनकी व्याप्तता ज्वारदनमुख के लवणीय स्तरों की भिन्नताओं का निर्धारण करने में सहायक होती है। उसी तरह डेल्टा क्षेत्र के उच्च लवणीय परिक्षेत्र में हरपेक्टीकोयड और पेलाजिक कॉपीपौड्स जैसे क्रमशः **लॉउफ़ोंटा** और **यूटरपिना** जातियाँ अभिलक्षणिक रूप से व्याप्त हैं। ये जातियाँ हुगली ज्वारनदमुख के तटवर्ती तथा डेल्टा क्षेत्र की उच्च लवणीयता को परिलक्षित करती है। हुगली ज्वारनदमुख के अलवणीय जल परिक्षेत्र (शालीमार के आगे) से **सी. ग्रेनी** जाति पूर्णतः लुप्त हो गयी है।

हिल्सा-इलिशा का अनुक्रमिक प्रजनन :

विगत वर्षों की भांति इस वर्ष (1987) भी गंगा नदी की उद्धावी हिलसा **हिल्सा-इलिशा** के कृत्रिम प्रजनन में पुनः सफलता प्राप्त की गयी है। प्रारम्भिक प्रयोगों से प्राप्त किये गये ग्यारह हजार अंडजों का आगे के अध्ययन के लिए के. अ. प्र. म. अ. सं. के बैरकपुर स्थित पुनः संचारन व्यवस्थित तालाबों में पालन किया जा रहा है।

गंगा के ऊपरी परिक्षेत्रों में फ़रक्का बांध से उत्पन्न अवरोध के कारण हिल्सा मत्स्यकी का ह्रास हो रहा है। यह सफलता इस क्षेत्र में हिलसा के पुनः संग्रहण का मार्ग प्रशस्त करती है।

COLLABORATION

The Institute had several collaborative research projects in different fields of fisheries with a view to developing the fisheries resources by pooling the information and expertise available in different national and international organizations.

National

Contribution to Ganga Action Plan

The Ganga Action Plan authorities work in close liaison with the Institute in utilizing the technologies available for waste recycling and also for understanding the impact of wastes on the biota of the Ganga River System.

The impact of pollution from industrial, municipal and agricultural runoff at various points of the river has been investigated by the Institute and the data form a part of the baseline information for Ganga Action Plan. The Institute's technology for recycling the sewage waste through aquaculture is a basic component of the Ganga Action Plan and projects are already afoot in constructing the sewage-fed fish farms along the Ganga basin for which the modular design has been provided by the Institute.

Inter-Institutional Collaboration on Hilsa

A collaborative research project has been prepared by the CICFRI, Barrackpore, Central Marine Fisheries Research Institute, Cochin and Central Institute of Fisheries Education, Bombay to have a proper appraisal of the dynamics of hilsa populations in Indian Ocean, their breeding and feeding habits, migratory traits, etc. The information will help acquiring fuller knowledge of the biotic potential of the species since practically there is no information available on the marine phase of the life history of hilsa.

Fishing Gear Technology for Reservoirs

The Institute is to take up a joint research project with Central Institute of Fisheries Technology, Cochin for developing suitable fishing crafts and sampling gears for operation in reservoirs. The joint venture will help in designing and indentifying more effective gears for fishing in various reservoirs.

Wildlife Society of South India (WLSSI)

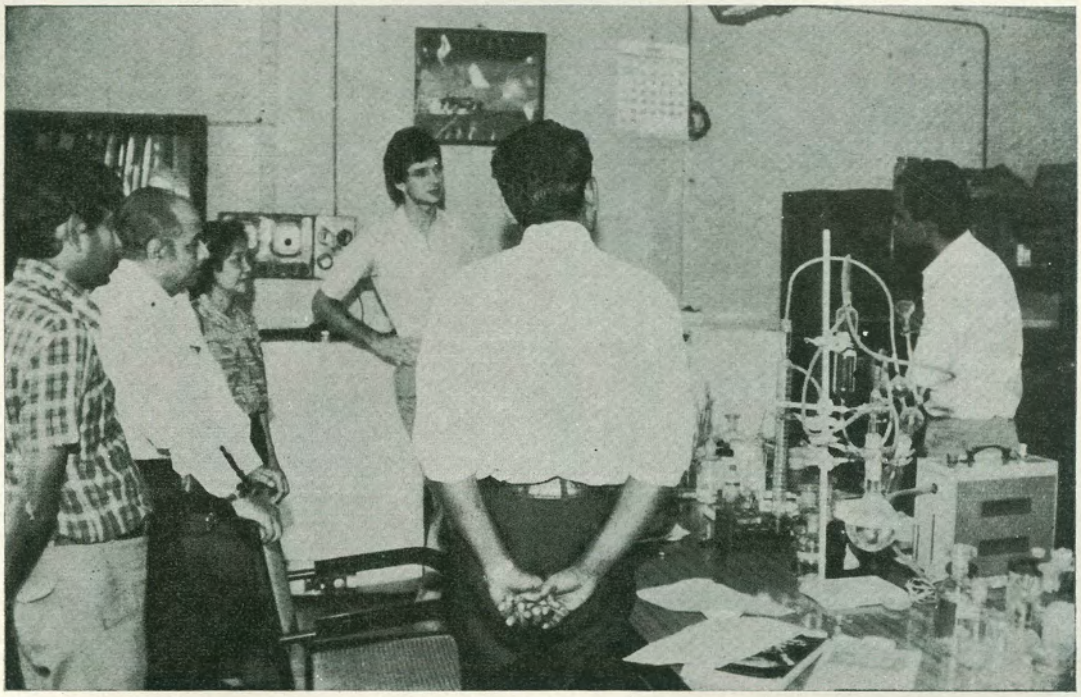
The Wildlife Society of South India, based at Bangalore has taken up the fisheries management of Nalliguda Reservoir near Bangalore with the technical collaboration of CICFRI. The society will provide all inputs required for implementation of the CICFRI management technology in this reservoir.

Similar arrangement has been made with the *Tamil Nadu Fisheries Development Corporation* in developing Aliyar reservoir fisheries. The TNFDC has placed the seed rearing farm at Aliyar at the disposal of CICFRI where the stocking material is being raised.

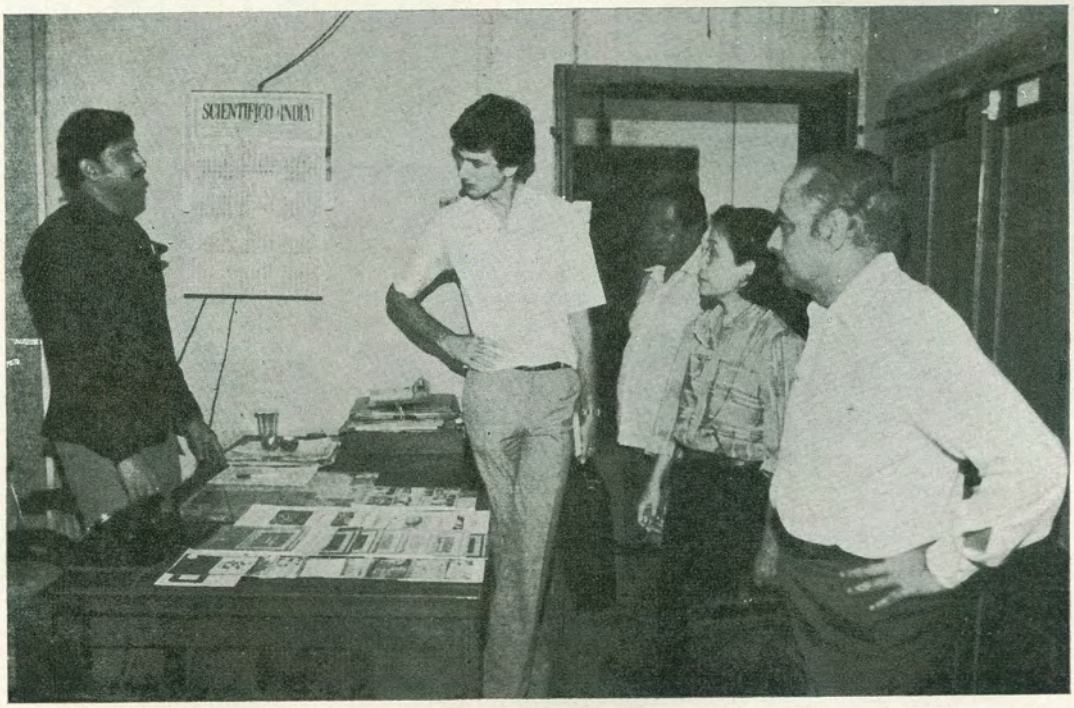
NABARD to Assist Beel Fisheries

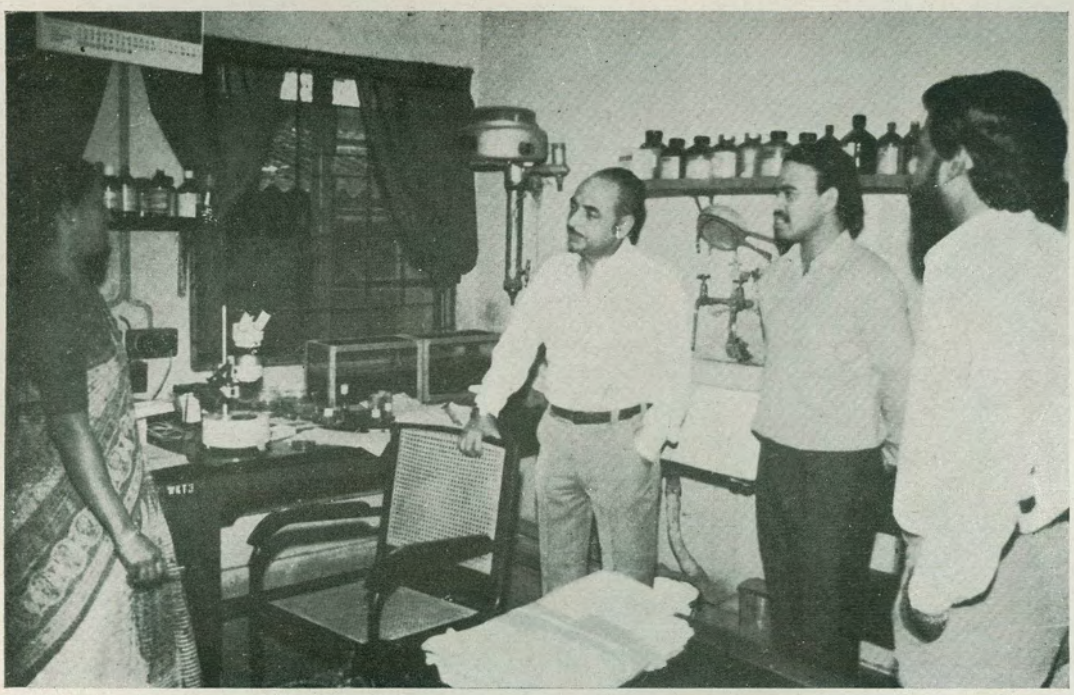
The National Bank for Agriculture and Rural Development and CICFRI are finalising a joint research and development venture in the area of development of beel fisheries in West Bengal. The NABARD has agreed to float loans to the beel co-operative societies and to pursuade the State Government to increase the share capital of the societies in selected beels so that the management measures suggested by CICFRI can be implemented to increase the fish production.

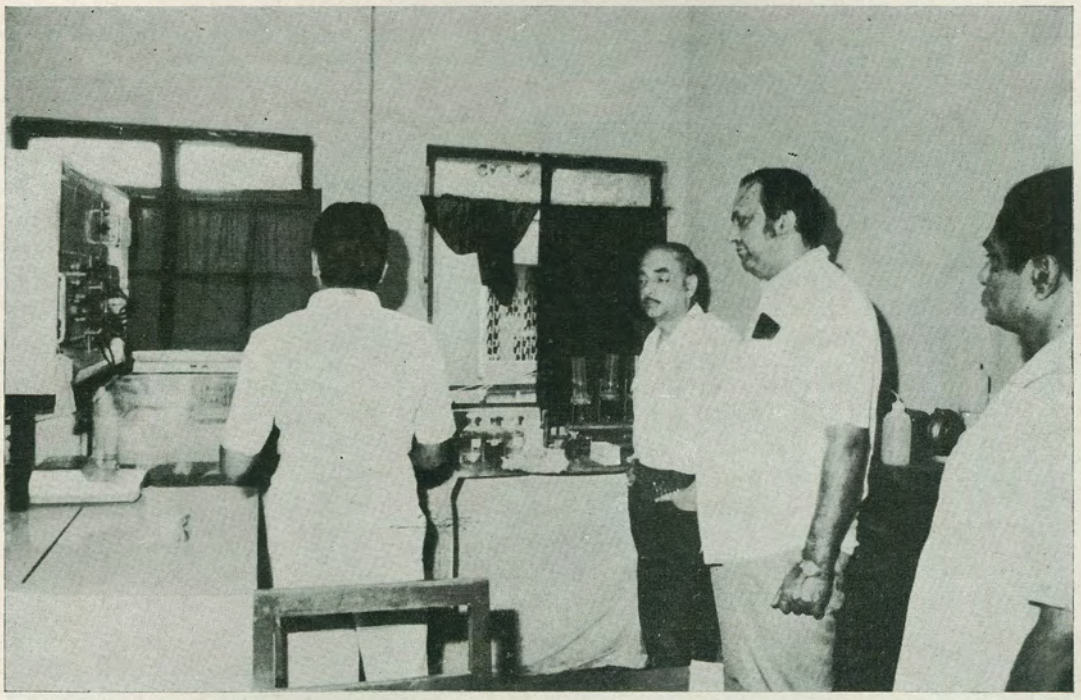
Dr. M. Phillips and Mrs. Sopa Areerat visiting various laboratories of CICFRI.



Dr. Michael Phillips and Mrs. Sopa Areerat of Network of Aquaculture Centres in Asia (NACA) visited the Institute in connection with the Ulcerative Fish Disease Syndrome, an epidemic fish disease prevalent in Asia.







Shri A. K. Patnaik, IAS, Director of Fisheries, Karnataka (top) and Shri Sujit Banerjee, IAS, Secretary, Fisheries, West Bengal (bottom) visiting different laboratories of the Institute.

HILSA HATCHERY AT FARAKKA

The hilsa hatchery at Farakka is coming up as a joint venture by CICFRI and the Farakka Barrage Authorities. The hatchery is based on CICFRI's technology of artificial fecundation and seed rearing of hilsa while the Farakka Barrage Authorities have agreed to provide the essential infrastructure facilities.

CONSULTANCY SERVICES PROVIDED BY CICFRI

Project on Integrated Fisheries Development of North Eastern States-A CICFRI—AFC collaborative venture:

The Central Inland Capture Fisheries Research Institute has been assigned as consultants by the Agricultural Finance Corporation (AFC) for preparing a massive fisheries development master plan for the North Eastern States. The project covers all the seven North Eastern States and Union Territories *viz.*, Assam, Meghalaya, Mizoram, Nagaland, Manipur, Tripura and Arunachal Pradesh. The project envisages to develop the vast fisheries resources available in the region such as rivers, ox-bow lakes, natural lakes, reservoirs, upland lakes and mountain streams. Possibilities of developing paddy-cum-fish culture of integrated farming systems are also covered under the project.

The Institute also acted as a Consultant of the *National Productivity Council, Guwahati* for preparation of a project on *Integrated Co-operative Development Project (Fisheries Section) for District Naogaon, Assam.*

Consultancy services was also offered by the Institute to *Agricultural Finance Corporation* in preparing projects on *Fisheries Development of Rudrasagar Lake and Gumti Reservoir in Tripura.*

Dr. A. K. Laal, Scientist at Bhagalpur Centre worked as an associate along with Prof. J. S. Dutta Munshi, Project Leader, under CSIR project at Bhagalpur University entitled *Studies on the toxic effect of heavy metals, acids and alkalies on aquatic organisms and bioassay of water qualities of the riverine eco-system of the Subarnarekha.*

International

Collaboration between *Bangladesh Agricultural Research Council* (*BARC*) and CICFRI has been sought in developing the fisheries sector benefitting both the countries. A collaborative project on hilsa is on the anvil.

Mr. Woli, *FAO Fellow from Sudan* had been trained at this Institute on various aspects of inland aquaculture. The training programme also included discussions, field visits, film shows on fish culture, etc. The duration of the programme was for 6 months from October 1986 to March 1987.

The CICFRI is in a regional research collaboration programme of the *Network of Aquaculture Centres in Asia* on the *Relationship Between Ulcerative Syndrome in Fish and Environment.* The research project designed for an initial period of 12 months will concentrate on impoundments in and around irrigated and rainfed rice field environments. Earlier (3-30 November, 1987) Dr. Manas Kr. Das, Scientist of this Institute was trained at the National Fisheries Institute, Bangkok, Thailand to work on environment monitoring and ulcerative syndrome in fish through a course sponsored by NACA. The regional research programme is a collaborative venture in which 11 Asian countries are participating.

MANPOWER DEVELOPMENT

Shri S. Paul, Scientist-2 was trained in Aquaculture Economics and Socio-economic in Bangkok under UNDP Project, NACA from 7th May to 5th June 1987.

Dr. M. K. Das, Scientist-2 was trained in Environment Monitoring and Ulcerative Syndrome in Fish at NIFI, Bangkok from 3rd to 30th November 1987.

Shri G. N. Saha, Scientist-3 of this Institute underwent training course on Human Resources Management held at NAARM, Hyderabad from 8th to 23rd April 1987. Similar training course was also attended by **Sarvashri Apurba Ghosh and B. B. Ghosh,** Scientists from 5th to 17th October 1987.

Shri F. Manna, T-II-3 underwent 5 days' Training Course on CDS/ISIS Information Retrieval System conducted by the Indian Association of Special Libraries and Information Centre, Calcutta sponsored under the NISSAT Programme from 11th to 15th May 1987.

Shri P. K. Katiha, Scientist-1 of this Institute underwent XXVth Foundation Course on Agricultural Research Management held at NAARM, Hyderabad for 5 months commencing from 9th June 1987.

Shri Mahadev Choudhury, Scientist-1 participated in Summer Institute on Modern Quantitative Techniques in Fisheries Research held at CIFE, Bombay from 14th to 25th July 1987.

Shri S. K. Mondal, Scientist-1 was trained in third short-term training course on Use of Computer in Agricultural Research held in IASRI, New Delhi from 1st to 28th September 1987.

Sarvashri H. Chaklader and **F. Manna,** T-II-3 were trained in Management Technique for Information Handling in Technical Cell/Section conducted by the NAARM Hyderabad, from 14th to 19th September 1987.

Shri Ravish Chandra and **Dr. K. K. Vass,** Scientists-3 of this Institute were trained in Agricultural Research Project Management for Heads of Divisions and Senior Scientists of ICAR Institutes, held at NAARM, Hyderabad, from 31st August to 11th September 1987.

Shri P. K. Chakraborty, Scientist-2 of this Institute underwent UNESCO sponsored Regional Introductory Training Course on Estuarine Research held in Calcutta in collaboration with the Dept. of Marine Sciences, University of Calcutta from 14th to 28th September 1987.

Dr. V. K. Unnithan, Scientist-2 underwent training on Radio immunoassay and its Clinical Applications held in Bhabha Atomic Research Centre, Bombay from 12th October to 27th November 1987.

Shri R. A. Gupta, Project Chief, Central Sector Scheme for Inland Fisheries Statistics participated FAO/DANIDA/ICAR National Training Course on Fish Resource Assessment held at CMFRI, Cochin, from 2nd to 29th November 1987.

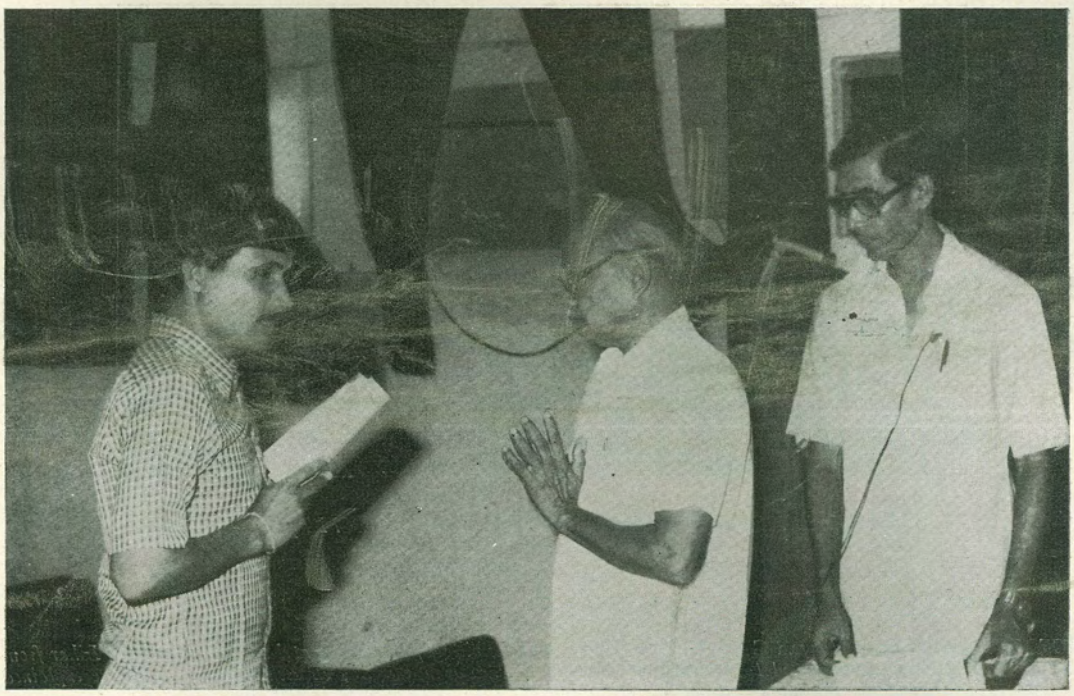
Mrs. Anjali De, T-5 attended the Workshop on Scientific Communications and Bibliometrics organised by Indian Institute of Chemical Biology (CSIR) Calcutta from 15th to 26th Feb. 1988.

VIGYAN GAON KI AOR

Shri Lahtan Singh, Minister for Agriculture, Govt. of Bihar at the CICFRI pavilion at Munger.

CICFRI participated in the Vigyan Gaon Ki Aor *(Science towards village) Exhibition at Munger (Safiabad), Bihar from 13-20 February, 1987. An estimated 1·5 lakh visitors turned up to learn about the CICFRI technologies. They were explained about the Institute's contributions to the research and development in inland aquaculture.*

TRAINING COURSE ON FISHERIES EXTENSION



A training programme on Fisheries Extension was organised at CICFRI from 18-27 August 1987 for the benefit of State Govt. officials belonging to the states of West Bengal, Orissa, Assam, Bihar, Manipur, Mizoram, Nagaland and Tripura. The picture shows, Shri Swapan Chowdhury, Fisheries Extension officer from Tripura receiving certificate at the successful completion of the training from Shri A. K. Ghorai, IAS (Retd.) Ex-Secretary, Govt. of West Bengal.

HONOURS, AWARDS ETC.

Dr. Arun G. Jhingran, Director, CICFRI, has been nominated a *Member of the Fishery Sub-group* under the Agriculture Study Group of *West Bengal Science & Technology Committee.*

Dr. Ajoy Kr. Ghosh, Scientist of the Institute has been nominated as a *Member of the Committee, VIIIth National Congress of Parasitology* under the auspices Calcutta School of Tropical Medicine, Calcutta.

Shri Y. S. Yadava, Scientist at Guwahati Centre of CICFRI was awarded the *Degree of Doctor of Philosophy* by the University of Guwahati for his thesis entitled *Studies on the limnology and productivity of an ox-bow lake in Dhubri district of Assam (India).*

Dr. G. N. Chattopadhyay, Scientist of this Institute has been elected a *Fellow of the Institution of Chemists (India).*

Shri Ajoy Kumar Ghosh, Scientist was awarded the *Ph.D. Degree* by the University of Calcutta for his thesis entitled *Some important diseases of Indian major carps of West Bengal and their control measures with special reference to Argulus sp. infection.*

TRANSFER OF TECHNOLOGY

Extension and Nation-Building Activities

The CICFRI has been actively engaged in extending fishery management technologies directly to the farmers and entrepreneurs as well as through Government agencies, financial institutions and voluntary organisations. During 1987-88 the extension wing could establish several new contacts for its transfer of technology programme in addition to those which were already covered under the extension activities in the preceding years.

The major extension activities of the Institute during the year are listed below:

Training programmes

Training in techniques of fisheries management was imparted to progressive fish farmers through various programmes. During 1987-88, five major training programmes were conducted by the Extension Section benefiting 94 personnel. The details are as follows:

A fifteen-day course on fish breeding, nutrition and pollution investigations was arranged during 31 March-14 April, 1987 at

Sl. No.	Subject	Period of training	Beneficiaries
1.	Composite fish culture	2.2.87	8 fish farmers of Arunachal Pradesh.
2.	Brackishwater aquaculture	16-25 Feb., 1987	15 fish farmers of SADP, Kakdwip, West Bengal.
3.	Carp culture	6-16 April, 1987	21 fish farmers of New Barrackpore, West Bengal.
4.	Brackishwater aquaculture	13-18 July, 1987	18 field-level workers of SADP, 24 Parganas, West Bengal.
5.	Fisheries extension	18-27 August, 1987	22 fisheries extension officers from eight states.

the Institute for a Research Scholar from Osmania University, Hyderabad. Similarly, two research scholars from Govt. College, Ajmer, Rajasthan were trained at the Institute for investigations in fish pathology. The course lasted from 4th to 16th May 1987.

EXHIBITIONS

CICFRI participated in five major exhibitions in various parts of the country. It is estimated that these pavilions had a total of 2·9 million visitors from all walks of life. A good number of them consisted of farmers and rural folk.

The exhibitions were

* *Science exhibition* at Chandanpukur, West Bengal held during 23-26 January 1987;

* *Vigyan gaon ki aur* at Munger (Safiabad), Bihar during 13-20 February 1987;

* *Agricultural exhibition* at Ramakrishna Mission, Nimpith, West Bengal during 22-26 February 1987;

* *Our India* exhibition at Kohima, Nagaland between 7 and 15 March 1987; and

* *CICFRI exhibition* at Barrackpore during 25-29 April 1987 commemorating the National symposium on riverine fisheries.

In addition, CICFRI supplied its exhibits for display at the following exhibitions:

—Science exhibition at Chandanpukur, West Bengal on 23.9.87;

—Kanchrapara Utsav '87 from 14 to 17 October 1987;

—Exhibition at KVK, Ramakrishna Mission Ashram, Nimpith on 27.10.87; and

—Exhibition at Udainarayanpur organised by the Directorate of Fisheries, West Bengal.

Fish Farmer's Days: CICFRI organised/participated in Fish Farmers Day at Nandabhanga village, South 24 Parganas on 17.7.87; Agapur (New Barrackpore) on 15.8.87; Udainarayanpur, Howrah on 12.10.87; and Bhola (Kamarkundu), Dist. Hooghly on 23.2.1988. Discussions were held with 730 fish farmers on fish farming techniques and the associated problems encountered by the farmers.

A special Fish Farmers' Day was organised by CICFRI on 20.11.87 on the eve of *Quami Ekta Week*. About 50 fish farmers participated in the deliberations held with CICFRI scientists at Khas Balanda (Haroa), West Bengal.

Women's Day: Keeping in view the VII-plan priority towards participation of rural women in socio-economic development, a *Women's Day* was arranged by CICFRI on 24.11.87 at Nandabhanga (Namkhana, South 24-Parganas). More than 300 women participated in the day long exposure to agricultural activities. Aquacultural and horticultural techniques were demonstrated to them to reduce the drudgery of rural womenfolks and for imparting them new skills for gainful employment.

The National Science Day was organised at the Institute under the auspices of the Extension Section on 29.2.1988.

National Oilseeds Demonstration Programme: Fifteen farmers were selected at Naukpul Village under Habra Block II (West Bengal) under the NODP. The

programme is being implemented in a 4 ha area with the B-9 variety of mustard. The plants are at flowering stage and are showing encouraging results.

The Section made arrangements for film-shows on fisheries management. Field visits, discussions with scientists, laboratory visits and demonstration programmes was also organised for 755 personnel who visited the Institute during the year, of which about 450 were fish farmers. Rest of them were students, field level workers, officials, scientists, dignitaries and visitors from abroad. Advices were given to 156 fish farmers, 19 entrepreneurs, 42 organisations and 4 financial institutes who approached the Institute for various kinds of assistance on fishery development programmes. Fish farms at Army, Airforce, Ramakrishna Mission and Rajbhawan were visited by the extension scientists to render necessary advisory services. Besides, the extension scientists delivered 27 extension lectures during 1987-88 for the benefit of farmers, state officials, visitors and voluntary organisations.

Bulletins: The following three bulletins of the Institute were released by the Section in 1987.

Bulletin No. 49: Fishing gears of the middle Hooghly estuary.

Bulletin No. 51: Culture of giant freshwater prawn.

Bulletin No. 52: Training in fisheries extension.

LIBRARY & DOCUMENTATION SERVICE

Library

The library served as the nerve centre of the Institute with its vast holding of 5,913 books, 4,124 reprints, 747 maps and 2,561 miscellaneous publications. It keeps exchange relationship with more than 300 research organisations and universities at national and international levels. In addition, the library acquired 71 Indian and 49 foreign journals and 115 books during the year. The library preserves an attractive collection of pamphlets, bulletins, brochures, theses, photocopies and a core of grey literature. It also extends its services to any research worker or developmental agency on request.

The total expenditure incurred by the library during the year was Rs. 2,53,250 58.

Reprography Services

The Section maintains an active unit for photography and reprography services. Photographs, reprints and photocopies were supplied to the scientists of the Institute as well as of other research institutes and universities free of cost.

The Section also maintains a duplicating (cyclostyling) and binding unit to serve the various units of the Institute.

Technical Reports

More than 30 technical reports on the progress of research activities of the Institute were compiled and sent to the ICAR. Research publications of the Institute scientists were scrutinised before publication in various journals. Technical queries regarding the

activities of the Institute from various quarters of the country and abroad were attended to by the Section.

Information Services

Research Project Files

Annual progress reports of all the research projects and the contribution of scientists of the Institute were recorded in the Primary Project Files and Scientists' Files. Research progress monitoring is one of the major responsibilities of the Section.

Publications

The following departmental publications were brought out by CICFRI during the year April 1987 to March 1988.

Reports

Annual Report for the year 1986-87.
All India Co-ordinated Research Project on Air-breathing Fish Culture. Final Report (1971-85). Fisheries Research Information Series No. 5, 1987. *Aquaculture Extension Manual—Mancheneeti Chepala Pempakamulo Sadaranamuga Vachhu Vyadulu Vati Nirdharna Mariyu Nivarana* (*In Telgu*)

Abstracting Service

Abstracts of the scientific papers on Indian fisheries published in different journals were prepared and published as 'Indian Fisheries Abstracts'.

Seven bimonthly CICFRI Newsletters were published by the Section. This service is meant for a large cross section of the population comprising research workers, farmers, extension personnel etc.

Newsletters

CICFRI Newsletter, Vol. 9(3-6), 1986, Vol. 10(1-2) and special issue 1987.

Bulletins

Bulletin No. 49*:* Fishing gears of the upper and the middle Hooghly estuary by P. M. Mitra *et al.*

Bulletin No. 50*:* The impact of effluents from Harihar Polyfibre and Gwalior Rayon Factories on the aquatic life in the River Tungabhadra near Harihar in Karnataka—A Report by H. C. Joshi & P. K. Sukumaran.

Bulletin No. 51*:* Culture of giant freshwater prawn by M. Subrahmanyam.

Bulletin No. 52*:* Training in Fisheries Extension—Training Programme Organised in Commemoration of the 40th Anniversary of Independence.

Bulletin No. 54*:* Common insects of fresh water ponds and their control by Krishna Mitra and Kuldeep Kumar.

Miscellaneous Publications

Symposium on the Impact of Current Land Use Pattern and Water Resources Development on Riverine Fisheries, April 25-27, 1987. Abstracts and Proceedings.
Research Plan and Perspectives—Research Audit 1987-88.
Research Project Programme 1987-88.

NATIONAL SYMPOSIUM ON RIVERINE FISHERIES

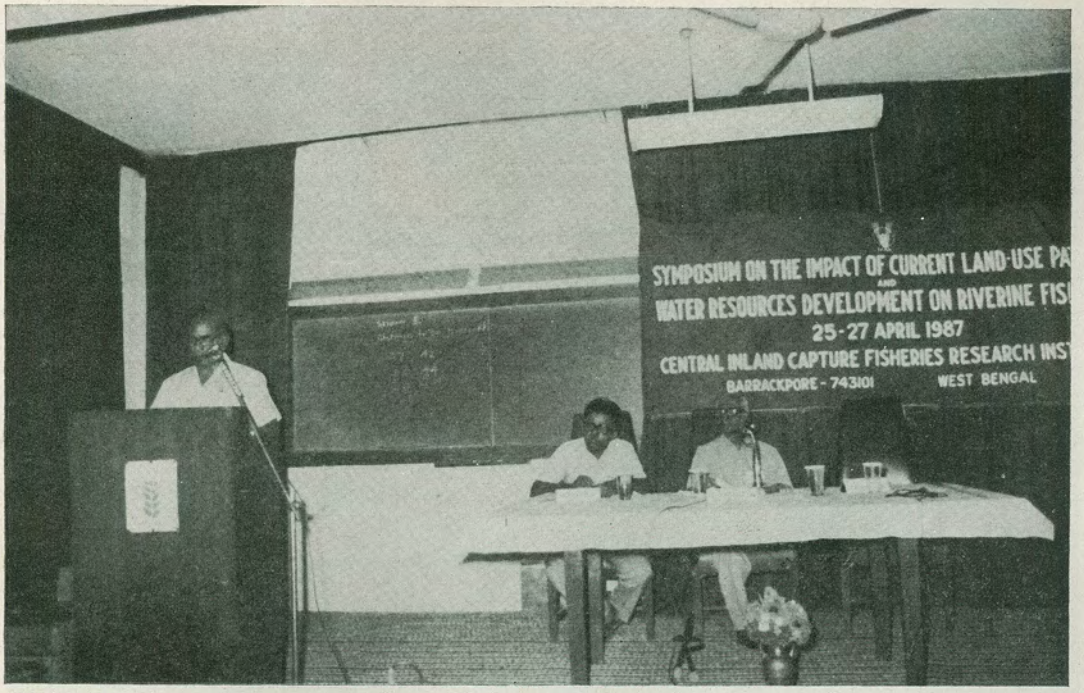
A National Symposium on the 'Impact of Current Land use Pattern and Water Resources Development on Riverine Fisheries' was organised by CICFRI at Barrackpore from 25-27 April 1987. His Excellency, Prof. Nurul Hasan, Governor of West Bengal inaugurated the Symposium. While inaugurating the Symposium Prof. Hasan told "There cannot be a place more appropriate than Barrackpore as the venue for this important symposium. Barrackpore and CICFRI have acquired a reputation for bringing out many significant technologies in developing the inland fisheries of the country. Research should ensure that people are provided not only with enough to eat but also with food of quality. Fishery experts have a definite role to play in this direction".

"Capture and Culture Fisheries have to go hand in hand to foster fisheries development"—Kironmoy Nanda

Prof. Nurul Hasan, Governor of West Bengal (right) and Shri Kironmoy Nanda, Minister for Fisheries at the inaugural ceremony.

Shri Kironmoy Nanda, Hon'ble Minister for Fisheries, Government of West Bengal presided over the inaugural function. Dr. S. N. Diwivedi, Adll. Secretary, Department of Ocean Development, Government of India, delivered the key-note address. Dr. M. Y. Kamal, Assistant Director General, ICAR welcomed the delegates and Dr. Arun G. Jhingran proposed vote of thanks to the delegates and other dignitaries.

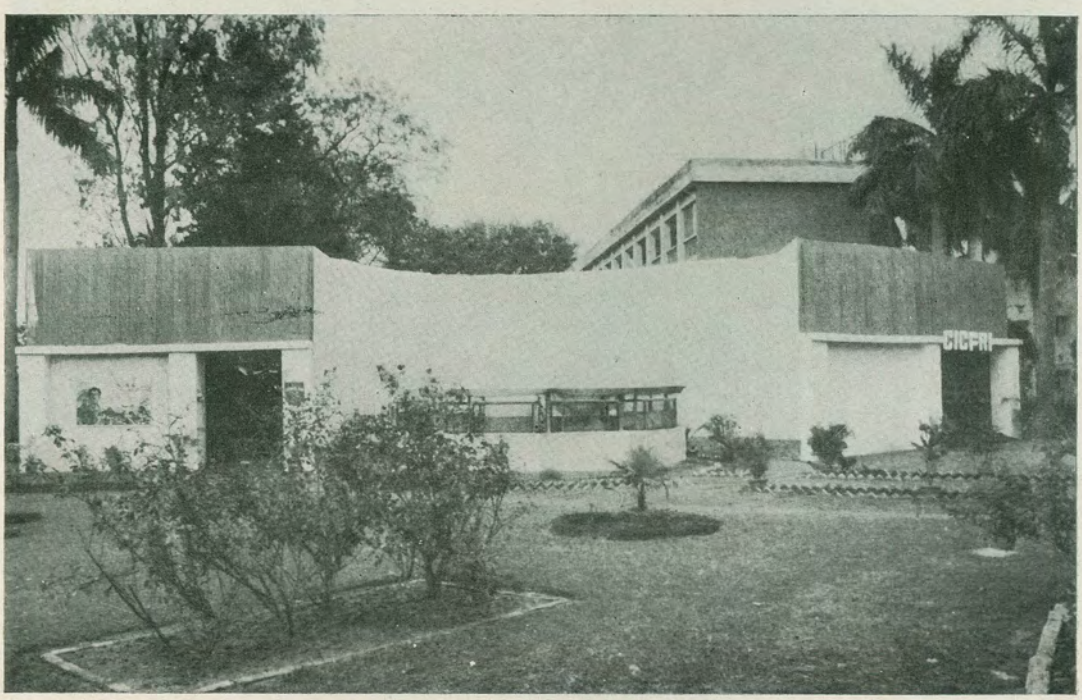
▲ *The Governor inaugurates the symposium*



▲ *A technical session in progress.*

EXHIBITION AT CICFRI

(Above): The Governor also inaugurated an exhibition, commemorating the symposium. (Below): A panoramic view of the pavilion.



(*Above*) *Dr. Arun G. Jhingran briefs the Governor about the activities of the Institute at the exhibition.*
(*Below*) *A section of the delegates attending the technical sessions.*

THE WORLD ENVIRONMENT DAY

The Institute observed World Environment Day on 5th June, 1987 and resolved to work for the cause of a clean and healthy environment. The Institute observed the day and a talk was delivered by Dr. A. K. Ghosh of Zoological Survey of India, Calcutta.

CONFERENCES, SYMPOSIA, ETC.

The following important Meetings/ Symposia, etc. were organised by the Institute during April 1987 to March 1988.

National Symposium on the Impact of Current Land Use Pattern and Water Resources Development on Riverine Fisheries from 25th to 27th April 1987.

Annual Staff Research Council Meeting of the Institute from 2nd to 4th June 1987 at Barrackpore.

World Environment Day on 5th June 1987.

Management Committee meeting on 14th June 1987.

1st meeting of the Institute's Joint Staff Council held on 7th July 1987.

Training course on Fisheries Extension from 18th to 27th August 1987 for Fisheries Extension Officers of West Bengal, Orissa, Assam, Bihar, Manipur, Mizoram, Nagaland and Tripura.

General body meeting of the Inland Fisheries Society of India on 7th September 1987.

Hindi Day celebrated on 14th September 1987.

Meeting of Project Leaders and Senior Scientists at Barrackpore on 26th October 1987.

Special Meeting of the Institute Joint Staff Council held on 17th November 1987.

Quami Ekta Week Celebration on 19.11.1987.

ICAR Regional Committee No. II—9th Meeting held on 8th and 9th February, 1988.

The National Science Day celebration on 29th February 1988.

The scientists of the Institute participated in various conferences/symposia/seminars and meetings held during 1987-88 wherein they presented their research findings and exchanged views with the delegates. List of scientists who participated/presented papers in such gatherings is furnished below:

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Regional Seminar on Environmental Problems and Management (16 January 1987)	Sponsored by Dept. of Forests and Environment Govt. of Bihar	Impact of pollution on fisheries of River Ganga at Bhagalpur	A. K. Laal
International Workshop on Management of Agricultural Extension for Poverty Alleviation (23 February 1987)	NIRD, Hyderabad	Scope of agriculture extension in alleviation of poverty in W. Bengal	U. Bhaumik, P. K. Pandit & B. K. Banerjee
Seminar on Current Status of Agro-based Technologies and Futuristic Approaches to Rural Industrialisation (7-9 February 1987)	Narendra Dev University of Agriculture & Technology, Faizabad	Inland fisheries—A need for close linkages between research & development	S. Paul
National Symposium of Algae (31 March 1987)	Dept. of P.G. Studies in Botany, Karnataka University	The periphyton of Govind Sagar Reservoir and allied waters of H.P., I. Abundance and periodicity of diatoms	B. C. Jha
Workshop on Development of Beel Fishery in Assam (21-22 April 1987)	Assam Agricultural University, Guwahati	Ecology & management of beels in Assam—A case study of Dhir Beel	A. G. Jhingran & V. Pathak
-do-	-do-	Studies on the ecology of an ox-bow lake in context to the development of beels in Assam	Y. S. Yadava
-do-	-do-	An analysis of fish catch statistics of Dhir beel, Assam	M. Chowdhury
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Status, dynamics and exploitation of Indian shad *Hilsa ilisha* (Hamilton) of the Ganga	A. G. Jhingran & R. A. Gupta
-do-	-do-	A reappraisal of the fisheries ecology of the Ganga river system	A. G. Jhingran & R. A. Gupta
-do-	-do-	Non-fishing human interventions affecting fishery potential of the Ganga system	P. Ray and A. G. Jhingran

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Impact of Farakka Barrage on the hydrological changes and productivity potential of Hooghly estuary	Babu Lal
-do-	-do-	Status of industrial pollution in the Hooghly estuary due to disposal of trade effluents from Haldia Oil Refinery Complex	M. M. Bagchi, B. B. Ghosh and S. K. Majumdar
-do-	-do-	Better land use through brackishwater aquaculture in coastal monocropped areas	A. K. Bandyopadhyay, C. R. Biswas, G. N. Chattopadhyay, Apurba Ghosh and P. K. Chakraborti
-do-	-do-	Preliminary study on the impact of some industrial wastes on some groups of micro-organisms in the Hooghly estuary	R. K. Das, M. M. Bagchi and B. B. Ghosh
-do-	-do-	Some observations on organic pollution status of the Mathabhanga-Churni river system in West Bengal	B. B. Ghosh, M. K. Mukhopadhyay and M. M. Bagchi
-do-	-do-	Impact of damming on the fisheries of river Sutlej	B. V. Govind
-do-	-do-	Effect of Farakka Barrage on the seasonal abundance of prawn and fish seed from the lower stretch of Hooghly estuarine system, West Bengal	D. D. Halder, D. K. De, H. S. Majumder and B. N. Saigal
-do-	-do-	Toxicity of quinalphos and endosulfan to different life stages of tiger prawn *Penaeus monodon*	H. C. Joshi, M. K. Mukhopadhyay and D. Nath
-do-	-do-	Preliminary observations on the efficacy of fish locks in the Farakka Barrage	A. B. Mukherjee
-do-	-do-	Toxicity behaviour of heavy metals on estuarine organisms	M. K. Mukhopadhyay, B. B. Ghosh & M. M. Bagchi
-do-	-do-	Role of reservoirs in enriching the fishery of rivers	M. Ramakrishniah

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Impact of the silted Bidyadhari river basin on aquaculture, agriculture and urbanisation	G. N. Saha, G. C. Laha, S. C. Thakurta and S. K. Chatterjee
-do-	-do-	Hydrological studies of stormwater channel draining Calcutta metropolis effluent into the Kulti estuary	R. K. Banerjee, H. C. Joshi, B. B. Ghosh and A. Sengupta
-do-	-do-	Physico-chemical changes in Hooghly estuary around Kakdwip due to freshwater release from Farakka	A. R. Chowdhury
-do-	-do-	Spawn yielding potentiality of a stretch of river Yamuna near Allahabad in relation to floods	R. K. Dwivedi, K. P. Srivastava, Ravish Chandra & N. K. Srivastava
-do-	-do-	Enrichment of nutrient concentration associated with high turbidity during monsoon months in river Yamuna at Allahabad	S. N. Mehrotra
-do-	-do-	A comparative study of energy dynamics of open and closed beels in Ganga and Brahmaputra basins	V. Pathak
-do-	-do-	Ecology and faunal association of intertidal mangrove habitants in the Hooghly-Matlah estuarine system	Apurba Ghosh, P. K. Chakraborti, K. R. Naskar, G. N. Chattopadhyay, D. Nath and M. L. Bhowmik
-do-	-do-	Trophic status of certain Indian rivers and reservoirs using algae as indicators	B. C. Jha
-do-	-do-	Phytoplankton constituents as indicators of water quality—A study of Hooghly river	A. C. Nandy, M. M. Bagchi, S. K. Majumder and B. K. Saha
-do-	-do-	The impact of Farakka Barrage on the plankton ecology of the Hooghly estuary	A. C. Nandy, S. K. Majumder, R. K. Chakraborty, B. K. Saha and G. P. Bhattacharya
-do-	-do-	Riverbed vegetation in the tidal estuary of Sunderbans and its impact on Brackishwater fisheries	Kumud Ranjan Naskar

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Variation in plankton structure in lower zone of the Hooghly estuary after a decade of Farakka Barrage operation	B. N. Saigal, M. K. Mukhopadhyay and M. M. Bagchi
-do-	-do-	Changes in phytoplankton species diversity indices due to artificial impoundment in river Krishna at Nagarjunasagar	V. V. Sugunan
-do-	-do-	Observations on some biological aspects and fishery of *Hilsa ilisha* (Ham.) of river Brahmaputra	M. Chowdhury, Ravish Chandra and V. Kolekar
-do-	-do-	Artificial fecundation of *Hilsa ilisha*—A possible approach to revitalize its depleted fishery	D. K. De and M. Sinha
-do-	-do-	Studies on catch statistics, age and growth, mortality and survival rates of *Labeo calbasu* of river Yamuna at Allahabad	M. A. Khan, R. K. Tyagi and Balbir Singh
-do-	-do-	Impact of artificial impoundment on the breeding behaviour of riverine catfish *Silonia childreni*—A case study in Nagarjunasagar reservoir on river Krishna	G. K. Vinci
-do-	-do-	Impact of developmental activities on the fisheries of river-bed lake Kolleru with special reference to fish health	A. K. Ghosh, R. N. Pal, M. Ramkrishniah, K. Subba Rao and M. B. R. Murty
-do-	-do-	Wanton destruction of early juveniles of commercial fish species in the upper Hooghly estuary	H. C. Karmakar, S. K. Mandal, R. N. Pal and G. C. Laha
-do-	-do-	Effect of Farakka Barrage on the spawning and fishery of Indian shad *Hilsa ilisha* (Ham.)	Ravish Chandra, K. P. Srivastava and R. K. Saxena
-do-	-do-	Studies on riverine resources management through agro-forestry	A. K. Chattopadhyay, J. G. Chatterjee, S. R. Das and D. Sanfui

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Possibilities of utilising the estuarine wetlands of West Bengal, India through rice-based aquasystem	G. N. Chattopadhyay, Apurba Ghosh and P. K. Chakraborti
-do-	-do-	Riverine aquacapture resources of Bihar with reference to the impact of brick industries on the Ganga fisheries around Patna	V. R. Chitranshi, Dhirendra Kumar and M. P. Singh
-do-	-do-	Impact of the bheri ecosystem on the parasite fauna of estuarine fishes of deltaic West Bengal	M. K. Das, R. N. Pal and P. B. Das
-do-	-do-	Fish germplasm conservation and genetic stock improvement	P. Das, P. C. Mahanta, D. Kapoor, P. K. Pandit and U. Bhaumik
-do-	-do-	Fishery of river Ganga around Patna and its conservation	Dhirendra Kumar, V. R. Chitranshi and M. P. Singh
-do-	-do-	Waste recycling through fish culture in estuarine wetlands—A productive method of land use	Apurba Ghosh, K. M. Das, G. N. Chattopadhyay, P. K. Chakraborti, Amitabha Ghosh, K. R. Naskar, R. K. Das and S. K. Mandal
-do-	-do-	Large scale destruction of estuarine fish and prawn seed resources in Hooghly-Matlah estuarine system	S. R. Das, A. Mukherjee and R. K. Chakraborty
-do-	-do-	Multiple utilization of polluted zones of River Ganga	A. K. Laal, S. K. Sarkar and A. Sarkar
-do-	-do-	Present status of riverine fisheries—An economic appraisal	S. Paul
-do-	-do-	Ecological transition and its impact on fishery of Kulia beel in Ganga basin	S. B. Saha, M. J. Bhagat and V. Pathak
-do-	-do-	Role of man made lakes in the fisheries development of Tripura with particular reference to the Gumti reservoir	B. Roy and V. V. Sugunan

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Symposium on the Current Land Use Pattern and Water Resources Development on Riverine Fisheries (April 25-27, 1987)	CICFRI, Barrackpore	Management and conservation of riverine major carp fishery around Allahabad	Balbir Singh, R. K. Tyagi and M. A. Khan
-do-	-do-	Changes in primary production and trophic status of a Kashmir ox-bow lake, consequent to man made modifications in the environment	K. K. Vass
National Seminar on Management of Information System in Management of Agricultural Extension (6-10 July 1987)	National Institute of Rural Development, Rajendra Nagar, Hyderabad	Information management for the development of inland fisheries	P. K. Pandit
Summer Institute on Modern Quantitative Techniques in Fisheries Research (23 July 1987)	CIFE, Bombay	Quantitative indices for assessing fish productivity of reservoirs and lakes	A. G. Jhingran
-do-	-do-	Quantitative assessment of fish productivity in reservoirs through bioenergetics	V. Pathak
Warmwater Aquaculture Conference (11-14 August 1987)	California Polytechnique State Univ., Sari Luis, Obispo	Arguloid parasites of importance to Indian major carps	A. K. Ghosh, N. C. Dutta and G. C. Laha
State Seminar of Non-governmental Organisations on Environment (15-16 August 1987)	Indian Council of Rural Youth, Calcutta	—	V. K. Unnithan
Foundation course on Rural Development for the Block Development Officers of Arunachal Pradesh (17 August 1987)	National Institute of Rural Development at Regional Centre, Guwahati	Planning for fisheries development in agriculture in Arunachal Pradesh	Y. S. Yadava
Symposium on Limnology in India (24-26 August 1987)	Sponsored by U.G.C. at Kashmir University	Physico-chemical complexes of Indian waters	K. K. Vass
National Symposium of Research & Development in Marine Fisheries (16-18 September 1987)	CMFRI, Cochin	Planning for fisheries development search for appropriate policy instrument	A. G. Jhingran and S. Paul
-do-	-do-	Migratory winter bag-net fishery in coastal waters of the Hooghly estuary	B. N. Saigal & P. M. Mitra

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
Study Circle—175 of IASLIC, Calcutta (19 September 1987)	IASLIC, Calcutta, held at CICFRI, Barrackpore	Information needs in fisheries research—An overview	V. K. Unnithan
Symposium on the Role of Scientific Research and its Management in Accelerating Socio-economic Transformation (19-20 September '87)	National Academy of Agricultural Research Management, held at IARI, New Delhi	—	A. G. Jhingran
57th Annual Session of National Academy of Sciences, India (8-10 October 1987)	NASI, held on Bhartidasan University, Triuchirapalli	Role of benthic fauna in development of lake fisheries	D. N. Singh
National Seminar on Training Strategies for Human Resources Development in Agriculture (29-30 October 1987)	A.P. Agricultural University, Rajendranagar, Hyderabad	Training needs of fisheries extension personnel and fish farmers	P. K. Pandit, U. Bhaumik & B. K. Banerjee
First Biennial Conference of the Allahabad Mathematical Society (14-16 November 1987)	Allahabad Mathematical Society, Allahabad	Bayes estimator of the Maxwell's velocity distribution function	R. K. Tyagi & S. K. Bhattacharya
VIIth All India Seminar on Ichthyology (20-22 November 1987)	Academy of Ichthyology held at Visva Bharati University, Santiniketan	Some observations on the fisheries of a catfish *Pangasius pangasius* of River Padma during 1978-83	B. L. Pandey
-do-	-do-	Problems & potentials for development of inland capture fisheries of India	A. G. Jhingran
-do-	-do-	—	V. V. Sugunan & M. Sinha
First Indian Fisheries Forum, Mangalore (4-8 December 1987)	Asian Fisheries Society held at College of Fisheries, Mangalore	Management of Indian reservoirs for fisheries development	A. G. Jhingran
-do-	-do-	Limnological status of Ox-bow lakes in W. Bengal, India	M. J. Bhagat, V. Pathak & S. B. Saha
-do-	-do-	Large scale production of sliver carp and grass carp seed at Badampudi, Andhra Pradesh	J. B. Rao and R. M. Rao
-do-	-do-	—	B. V. Govind and P. K. Sukumaran

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
First Indian Fisheries Forum, Mangalore (4-8th December, 1987)	Asian Fisheries Society held at College of Fisheries, Mangalore	Age and growth, fisheries and population of *Mystus aor* (Hamilton) of Nagarjunasagar reservoir	M. Ramakrishniah
-do-	-do-	Rice-fish culture in high rainfed coasted saline soils—A case study	G. N. Chattopadhyay, Apurba Ghosh, C. R. Biswas, P. K. Chakraborti and A. K. Bandyopadhyay
-do-	-do-	Recent study on the status of arguloid parasites in aquaculture	A. K. Ghosh & N. C. Dutta
-do-	-do-	Hydrobiology of irrigated paddy fields with reference to fish culture	G. N. Saha & K. V. Ramakrishna
-do-	-do-	Nitrogen status in aquatic eco-system and its utility as fertiliser in freshwater aquaculture	G. N. Saha
-do-	-do-	Monitoring water quality of fish ponds receiving water as fertilisers	R. K. Banerjee, K. V. Srinivasan and S. K. Mandal
Symposium on Environment pollution and Pesticide Toxicology (10-12th December, 1987)	Academy of Environmental Biology, India, held at Jammu	Ecology and production biology of Indian Reservoirs	A. G. Jhingran
-do-	-do-	Effect of DDT and Aldrin on survival and reproduction of *Ceriodaphnia cornuta* Sar Cladorcera	M. A. Khan, R. A. Gupta and Peer Mohamed
-do-	-do-	Effect of low level of DDT of freshwater gastropod *Lymnaea luteola*	H. C. Joshi
IXth International Symposium on Tropical Ecology (11-16th December, 1987)	Department of Botany, Banaras Hindu University, Varanasi	Ecology and Management of Kashmir Himalayan Lakes	K. K. Vass
VIIth National Congress of Parasitology (10-12th February, 1988)	Indian Society of Parasitology in The School of Tropical Medicine, Calcutta	An incident of *Ichthyophthyrius* sp. on the climbing parts of *Anabas testudineus* (Bloch) and its impact on some aspects of haematology	B. Halder, N. C. Dutta and A. K. Ghosh

Conferences/ Symposia	Organized by	Papers presented	Authors/ Participants
1	2	3	4
D.S.T. Workshop on Science and Technology for Development (15-17th February, 1988)	Imphal, Manipur	Some perceptives in development and management of inland fishery resources of the North Eastern Region of India	A. G. Jhingran
Workshop on Industrial and Sewage Effluent: Environmental Hazards and Remedies (22-24th February, 1988)	Society for the Advancement of Environmental Sciences, Lucknow held at Vigyan Bhavan, New Delhi	Aquaculture as a potential system of sewage disposal—A case study	A. G. Jhingran and Apurba Ghosh
-do-	-do-	Biomonitoring of hazardous substances in the Hooghly estuary	B. B. Ghosh H. C. Joshi and M. K. Mukhopadhyay
Rice-fish Farming Systems Workshop, Ubon, Thailand (21-25th March, 1988)	(1) Dept. of Agriculture, Thailand (2) International Centre for Living Aquatic Resources Management (ICLARM) (3) Central Luzon State University and (4) International Rice Research Institute	Rice-fish farming system in India: past, present and future	Apurba Ghosh

VISITORS

A large number of distinguished personalities including national leaders visited the Institute during 1987-88. They included His Excellency Prof. Nurul Hasan, Governor of West Bengal and Shri Kironmoy Nanda, Hon'ble Minister of Fisheries, Government of West Bengal. They honoured the Institute by inaugurating and presiding over the symposium on "The impact of current land use pattern and water resources development on riverine fisheries". The following is the list of other distinguished visitors who visited the Institute's Headquarters and its different centres.

Acharya, R. M. (Dr.)	..	Deputy Director General (AS), ICAR, New Delhi
Agarwal, V. S.	..	Member, Governing Body, ICAR, New Delhi
Areerta Sopa (Miss)	..	National Inland Fisheries Institute, Kasetsart University Campus, Bangkok, Thailand
Arora, C. L. (Dr.)	..	Assistant Director General, ICAR, New Delhi
Arora, S. K. (Maj)	..	Base Hospital, Barrackpore
Atapattu, R. A.	..	Ministry of Fisheries, Colombo-10, Sri Lanka
Atwal, S. S.	..	Member, Governing Body, ICAR, New Delhi
Bajpai, P. (Dr.)	..	D.A.V. College, Kanpur
Banerjee, Sujit	..	Secretary, Fisheries Department, Government of West Bengal, Calcutta
Bhattacharjee, A. R. (Dr.)	..	Head of Division of Animal Science, ICAR Research Complex, EAA, Old Goa
Bora, L. C. (Dr.)	..	Associate Director, Assam Agricultural University, Assam
Bora, P. C. (Dr.)	..	Vice-Chancellor, Assam Agricultural University, Assam
Borthakur, B. C. (Dr.)	..	Vice-Chancellor, Assam Agricultural University, Guwahati
Chakraborty, P. C.	..	Joint Director of Fisheries, Government of West Bengal
Chowdhuri, H. (Dr.)	..	FAO Expert, SEAFDEC, Philippines
Das Gupta, A. B.	..	Vice-Chairman, West Bengal Science and Technology Committee, 6, Camac Street, Calcutta
Das Gupta, D. (Dr.)	..	Vice-Chancellor, B.C.K.V.V., Kalyani
Das Gupta, N. K. (Prof.)	..	Institute of Radio Physics and Electronics, University of Calcutta
Das, P. (Dr.)	..	Project Director, NBFGR, Allahabad
Dassemayake, G. S. Shelton	..	Ministry of Fisheries, Colombo, Sri Lanka
Datta Munshi, J. S. (Dr.)	..	Department of Zoology, Bhagalpur University
Datta, N. C. (Dr.)	..	Department of Zoology, University of Calcutta
Dayaratne, P. D. (Mrs.)	..	Marine Biological Resources Division, National Aquatic Resources Agency, Colombo-15, Sri Lanka

Dehadrai, P. V. (Dr.)	..	Deputy Director General (F), ICAR, New Delhi
Doloi, P. C. (Dr.)	..	Dean, Directorate of Extn. and Edn., Assam Agricultural University, Assam
Dubey, G. P. (Dr.)	..	Fisheries Consultant, Indore
Dwivedi, S. N. (Dr.)	..	Additional Secretary, Department of Ocean Development, Govt. of India
Espinet Herbert	..	Economic Counsellor, Economic Office of Cuba, New Delhi
Ghosh, A. K. (Dr.)	..	Joint Director, ZSI, Calcutta
Ghosh, S. N.	..	IIT, Kharagpur
Gupta, P. D. (Dr.)	..	Dy. Director, ZSI, Jabalpur
Gupta, T. K. (Dr.)	..	Director of Research, BCKVV, Kalyani
James, P. S. B. R. (Dr.)	..	Director, CMFRI, Cochin
Jaques Trichireau	..	IFREMER, Paris
Jhingran, V. G. (Dr.)	..	Ex-Director, CIFRI
Johri, V. K.	..	Director of Fisheries, Uttar Pradesh
Jones, S. (Dr.)	..	Ex-Director, CMFRI, Cochin
Kakoti, N. (Dr.)	..	Dean, Assam Agricultural University
Kamal, M. Y. (Dr.)	..	Asst. Director General, ICAR, New Delhi
Kaul, G. L. (Dr.)	..	Asst. Director General, ICAR, New Delhi
Kharb, M. S.	..	Asst. Director of Fisheries, Govt. of Haryana
Kulkarni, C. V. (Dr.)	..	Ex-Director of Fisheries, Govt. of Maharastra
Kumar, B.	..	Dy. Director of Fisheries, Govt. of U.P.
Kumar Kuldeep (Dr.)	..	Chief Warden of Fisheries, Govt. of H.P.
Lahiri, A. K. (Dr.)	..	Conservator of Forests, West Bengal
Le Xan	..	Scientist, Fisheries Department, Vietnam
Magodia Ajit	..	Joint Commissioner of Fisheries, Govt. of Gujarat and Managing Director, Fisheries Development Corporation, Gujarat
Mahapatra, C. R.	..	Dy. Secretary, ICAR, New Delhi
Maji, C. C. (Dr.)	..	Asstt. Director General (ESM), ICAR, New Delhi
Mammen, T. A. (Dr.)	..	Tropical Fisheries Consultancy Services, Delhi
Manna, A. K.	..	Extension Officer, R. K. Mission Ashram, Mansadwip, Sagar
Mathur, P. B. (Dr.)	..	Asst. Director General, ICAR, New Delhi
Mathur, P. N. (Dr.)	..	Asst. Director General (Extn.), ICAR, New Delhi
Matty, A. J. (Prof.)	..	Head, Aquatic Nutrition Unit, Institute of Aquaculture, Stirling University, U.K.
Mehra, P. K.	..	Fisheries Consultant, New Delhi

Menon, A. G. K. (Dr.)	..	ZSI, Madras
Michael George, R. (Dr.)	..	Prof. of Zoology, NEH University, Shillong
Mitra, Arunava (Dr.)	..	IIT, Kharagpur
Moitra, B. N. (Dr.)	..	Head, Agri. Engineering, IIT, Kharagpur
Moulik, S. K. (Dr.)	..	Additional Director of Animal Husbandry, Govt. of West Bengal
Mukherjee, N. (Dr.)	..	Director, JARI, Barrackpore
Mukherjee, S. K.	..	Member, W.B. Science & Technology Committee, 6, Camac Street, Calcutta
Nguyen Chanh	..	Provincial Deputy Chairman, Vietnam
Nguyen DoMich	..	National Project Director, UNDP, Vietnam
Nguyen Du	..	Provincial Vice-Chairman, Vietnam
Orlando Santiesteban	..	Economic Counsellor, Economic Office of Cuba, New Delhi
Pandey, S. N. (Dr.)	..	Director, JTRL, Calcutta
Pathak, S. C. (Dr.)	..	Manager (T), NABARD, Bombay
Pati, T. (Prof.)	..	Pro Vice-Chancellor, University of Allahabad
Patnaik, A. K.	..	Director of Fisheries, Govt. of West Bengal
Pattanayak, S. K.	..	Director of Fisheries, Govt. of Karnataka, Bangalore
Petre, E. (Prof.)	..	Prof. of Zoology, Eving Christian College, Allahabad
Phillips Michael (Dr.)	..	Institute of Aquaculture, University of Sterling, Scotland
Prashad, R. N. (Dr.)	..	Director, ICAR Research Complex, NEH Region, Shillong
Puri, P. S. (Dr.)	..	Prof. of Statistics, University of Washington DC, USA
Rai, M. M. (Dr.)	..	Dean, Faculty of Agriculture, Jawaharlal Agricultural University, Jabalpur
Randhawa, N. S. (Dr.)	..	Secretary, DARE, Govt. of India & Director General, ICAR, New Delhi
Raychaudhury G. K. (Dr.)	..	Dean, College of Veterinary, Science, Assam Agricultural University, Guwahati
Roy, B.	..	Director of Fisheries, Govt. of Tripura
Roy Choudhury, N. (Maj.)	..	Base Hospital, Barrackpore
Roy, D. J. (Dr.)	..	Zonal Co-ordinator, ICAR Lab to Land Programme, BCKVV, Kalyani
Roy, G. L. (Dr.)	..	Director of Extn. Edn., BCKVV, Kalyani
Roy, J. K. (Dr.)	..	Director, CRRI, Cuttack
Roy, M. (Dr.)	..	Assistant Director General, ICAR, New Delhi
Roy, Pranab	..	Director, DARE, New Delhi
Sadaphal, M. N. (Dr.)	..	Assistant Director General (CSC), ICAR, New Delhi
Saikia, J.	..	Chairman, Assam Fisheries Development Corporation, Guwahati

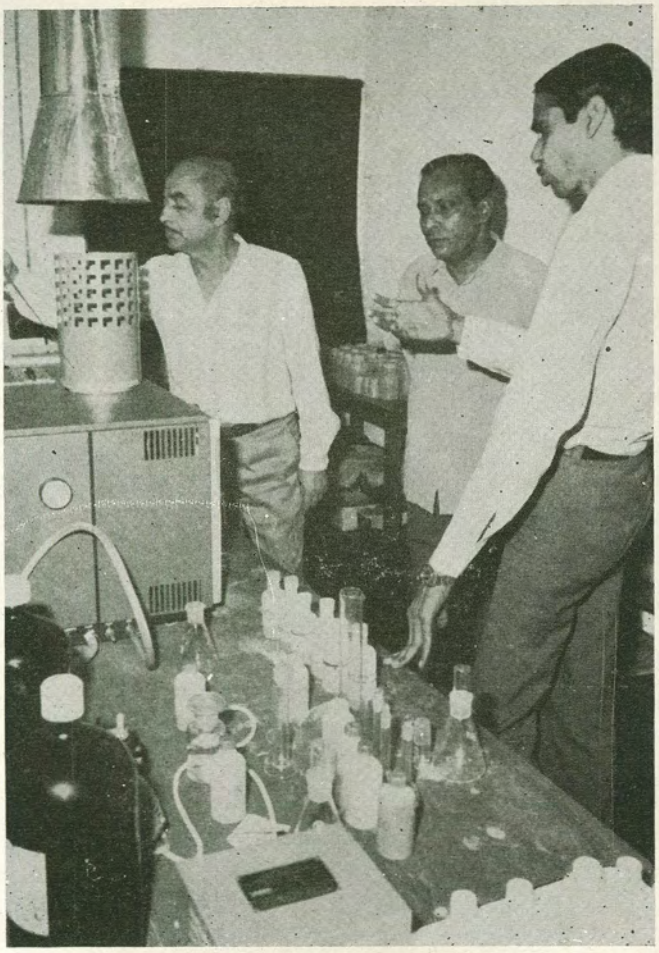
Sarkar, H. L. (Dr.)	..	Ex-Prof., Visva Bharati University
Satiraju, M.	..	Sub-Editor, Fishing Chimes, Visakhapatnam, A. P.
Saxena, B. S. (Dr.)	..	Professor, College of Fisheries, Mangalore
Sengupta, H. (Dr.)	..	CSSRI, Canning
Sengupta, K. (Dr.)	..	Joint Director of Agriculture, Government of West Bengal
Sharma, D. N.	..	Director, Department of Public Enterprises, Government of Assam, Guwahati
Sharma, H. N. (Dr.)	..	Assam Agricultural University, Assam
Siddiqui, A. M. (Prof.)	..	Dean, Faculty of Life Science & Chairman, Department of Bio-chemistry, A.M.U., Aligarh
Siddiqui, E. S. (Dr.)	..	Director, Rice Research Institute, Hyderabad
Silas, E. G. (Dr.)	..	OSD, CIBA, Madras
Singh, Hanuman (Dr.)	..	Reader, Bio-Chemistry Department, Manipur University, Imphal
Singh, Rajinder (Col.)	..	Command Hospital (E.C.), Calcutta
Singh, Surjit (Capt.)	..	Command Hospital (E.C.), Calcutta
Singh, Tombi, H. (Dr.)	..	Professor, Department of Life Science, Manipur University, Imphal
Singh, Virendrer (Brig)	..	Commander, Calcutta Sub-Area, Alipore
Sinha, R. (Dr.)	..	Dean, BCKVV, Kalyani
Som, M. G. (Prof.)	..	Dean, BCKVV, Kalyani
Sreekrishna, Y. (Dr.)	..	Director, CIFE, Bombay
Srivastava, O. P. (Dr.)	..	Reader, Allahabad University
Srivastava, U. S. (Prof.)	..	National Academy of Sciences, Allahabad
Swarup Krishna (Prof.)	..	Department of Zoology, Gorakhpur University, Gorakhpur
Talwar, P. K. (Dr.)	..	Dy. Director, ZSI, Calcutta
Thampy, C. J. (Dr.)	..	National Bureau of Soil Survey and Land Use Planning, Calcutta
Tomy, W. A. (Dr.)	..	Consultant Biologist, Rotterdam, Netherlands
Tran Le Thieu (Dr.)	..	Vietnamease Official
Tripathi, S. D. (Dr.)	..	Director, CIFA, Dhauli
Tripathi, Y. R. (Dr.)	..	Ex-Director of Fisheries, Government of Uttar Pradesh
Vardia, H. K.	..	J.N.K.V.V., Jabalpur (M.P.)
Varghese, B. G.	..	Former Editor, Indian Express
Vo Dinn Tam (Dr.)	..	Vietnamease Official

VISITORS

Top: Dr. H. Choudhury, the renowned Aquaculture Expert and ex-CIFRI scientist, who is presently at FAO/NACA visited and addressed the scientists on 8.6.87.

Bottom: Mr. Espinet Herbert and Mr. Orlando Santiesteban (L. to R.) Councillors, Economic Office, Cuba visited the Institute on 2.12.87.

Top: Maj. S. P. Roy Choudhury, Maj. Surinder Singh, Maj. Gurinder Singh Capt. C. H. Chopra, military officers (from left to right) in discussion with the Director, CICFRI.
(Bottom) Prof. A. J. Matty, Head, Aquatic Nutrition unit, Institute of Aquaculture, Sterling University, U.K. visited the Institute on 26.11.87 and addressed the scientists.



Shri V. K. Johri, Director of Fisheries, U.P. paid a visit to the Institute. He went around the different laboratories to appraise himself with the research activities. The picture shows Dr. Arun G. Jhingran, and Dr. H. C. Joshi explaining the functioning of AAS to Mr. Johri (centre).

Farm Women being trained in net making under a training programe for women

FINANCE

For the year 1987-88 (Rs. in Lakhs)

	BE. 1987-88 Rs.	RE. 1987-88 Rs.	Actual Expenditure 1987-88 Rs.
Plan :	55.00	50.00	50.04
Non-plan :	176.29	139.50	158.52
Total :	231.29	189.50	208.56

CENTRE-WISE LIST OF ONGOING PROJECTS 1987-88

BARRACKPORE	F/C/A/4 FC/A/6 FC/A/13 BF/B/2 BF/B/3	BF/B/8 BF/A/2 AN/A/7 AN/A/9 AN/A/10	CSS/1
ALLAHABAD	FC/B/7	FC/A/2	
BANGALORE	FC/A/7	FC/A/12	
BHAGALPUR	FC/B/7		
BILASPUR	FC/A/7		
CALCUTTA	BF/B/2	BF/A/2	
CANNING	BF/B/3	BF/B/8	
DIAMOND-HARBOUR	BF/B/3	BF/A/2	
DIGHA	BF/B/3	BF/A/2	
ELURU	FC/B/5		
GUWAHATI	FC/B/9	FC/A/3	
LALGOLA	FC/B/7		
MUZAFFARPUR	FC/A/5		
PATNA	FC/B/7		
POLLACHI	FC/A/10		
PUNE	FC/A/7		
RAIDIGHI	BF/B/3		
RAIPUR	FC/A/7		
SRINAGAR	FC/B/1		
ULUBERIA	BF/B/3		

Research projects merged during 1987-88

1. FA/A/13 : Cage culture of Fishes in Tanks. Merged with FC/A/7
2. AN/B/6 : Ecology and control of aquatic insects Merged with FC/A/4

Research projects completed during 1987-88

1. FA/B/7 : Certain physiological aspects of reproduction in carps with special reference to purification and assay of gonadotropin.
2. FC/B/8 : Water pollution investigations in Rihand Reservoir.
3. BF/A/11 : Economics of brackishwater fish farming.

ONGOING PROJECTS

PROJECT FC/B/1
ECOLOGY OF MOUNTAIN LAKES: FISHERY LIMNOLOGY OF COLD-WATER WULAR LAKE

Personnel:
K. K. Vass, Shyam Sunder, Harbhajan Singh, Usha Moza

Duration: 1983-88

Location: Harwan, Srinagar

The sampling in the lake was carried out at Bandipore (Sector I) and Wutlab-Sopore (Sector II), each comprising 3 stations.

Catch Statistics

At Laharwalpore, Kanibathi and Kunis stations of Sector I, the fish catch in summer and autumn months mainly comprised exotic carps, *Cyprinus carpio communis* and *Cyprinus carpio specularis* forming 75-85% of the total catch. The main gear used was cast net. Some increase in schizothoracid fishery was noted in winter and spring. The experimental fishing gave a yield of 0·900-1·45 kg/man/hr by cast net during summer and 1·25-2·25 kg/man/hr during spring and winter. The average total catch from Sector I ranged from 125-425 kg per day. The main schizothoracid species encountered were *S. niger*, *S. esocinus*, *S. plagiostoma* and *S. curvifrons*. The gear used were cast net and long line.

In Sector II (Wutlab), summer fishery was represented by *C. carpio specularis* and *C. carpio communis*. But from late October and November, schizothoracid fishery also registered notable catch. The landings from cast net ranged from 900-1,300 g/man/hr and from long line fishing 600-1,000 g/man/hr. The daily total catch ranged between 1,125 and 1,485 kg. The gears used were, cast net, long line and spear (Narooch).

Phytoplankton

The three stations covered under Sector I for the study were Baniyar, Laharwalpora and Kanibathi. During spring season, the lowest (6,000 μ/l) and the highest (54,400 μ/l) productions were recorded at Baniyar. In summer, the range was 6,500-33,000 at surface and 16,500-24,600 at bottom in Sector I while in autumn the range was 7,500-25,500 at surface and 12,500-2,87,000 at bottom.

In spring, under Sector II, 3 stations (4, 5 and 6) were covered and under each station pelagic and littoral zones were sampled. The minimum density of plankton (36,000 μ/l) was recorded at station 6 in the pelagic zone and the maximum density (1,36,400 μ/l) was recorded at the same station in the littoral zone.

In summer, the observed range was from 34,200 μ/l (bottom) to 62,500 μ/l (surface) at the pelagic zone while at littoral zone it was recorded from 23,400 (bottom) μ/l to 90,000 (surface).

In autumn, the plankton density ranged from 36,000 μ/l (pelagic zone) to 77,000 μ/l (littoral zone). Almost similar trend was observed in winter too.

Zooplankton

In Sector I, the zooplankton density ranged from 23-48 μ/l while in Sector II the density was 21-62 μ/l.

Macrobenthic Population

Benthos population ranged from 300-947 μ/m^2.

Physico-Chemical Parameters

All important parameters of the aspect were studied.

Primary Productivity (Gross)

At different stations of Sectors I and II, the productivity (in $mgC/m^2/h$) ranged as follows:

SECTOR I

	Baniyar	Laharwalpara	Kanibathi
Surface	18-56	45-115	28-67
Bottom	23-39	45-98	21-43

SECTOR II

	Station-4	Station-5	Station-6
Surface	34-78	18-97	21-85
Bottom	8-53	17-48	21-67

Though significant amount of carbon was fixed, detritus foodchain was dominant in the system.

PROJECT FC/B/5
STUDIES ON THE ECOLOGY AND FISHERIES OF KOLLERU LAKE ECOSYSTEM AND DEVELOPMENT OF SUITABLE MANAGEMENT MEASURES FOR OBTAINING SUSTAINED FISH PRODUCTION

Personnel:

Ch. Gopalakrishnayya, R. M. Rao, K. V. Rao, M. Ramakrishniah, J. B. Rao, T. S. R. Raju, K. S. Rao, P. S. C. Bose, Ch. G. Rao & S. Kotaiah

Duration: 1986-1991
Location: Eluru

Fish yield: Fish landing data were collected regularly at three centres, Eluru, Akiveedu and Bhimavaram, once in a week at each centre. Based on the data collected from April to December 1987, the production during the year (from April '87 to March '88) was estimated at 1,861·43 t as compared to 1,528·39 t during the year 1986-87, thus registering a rise of 21·79% over that of the preceding year. Out of this total, Eluru contributed 38·97%, Akiveedu 49·89%, Bhimavaram 11·14%.

Eluru and Akiveedu centres recorded increase in the landings when compared to previous year. The increase at these two centres was 56·60% and 28·20% respectively. Bhimavaram registered considerable decline of 43·78%.

An examination of the catches from Kolleru lake at different centres revealed that perches, catfishes, murrels, prawns and carps formed the bulk of the fishery contributing more than 90% to the total yield. Among catfishes, *Heteropneustes fossilis* formed the bulk in the fishery followed by *Mystus gulio* and *Wallago attu.*

Bhimavaram centre was responsible for higher landings of prawns followed by Akiveedu. Prawn landings were minimum at Eluru among the prawns *Metapenaeus monoceros* dominated, while *Penaeus indicus, Macrobrachium malcolmsonii, M. rude, M. rosenbergii* were represented in the catches in considerable quantities.

Anabas oligolepis was the sole dominant species among the perches, though *Lates calcarifer* was also recorded in low quantities occasionally at Bhimavaram. *Channa striatus* and *C. punctatus* were represented among murrels in higher quantities at Eluru and Akiveedu. Major carps were recorded at Eluru and Akiveedu, while they were absent at Bhimavaram. *Labeo rohita* dominated in the landings.

The important species that are sent to other parts of the country from Kolleru lake are *H. fossilis, A. oligolepis, C. batrachus* and *C. striatus,* major carps and prawns. The main

exporting centres are Eluru, Kaikalur, Akiveedu, Bhimavaram, Tadepalligudem and Narsapuram. *H. fossilis*, *A. oligolepis*, *C. striatus* and *C. batrachus* were exported in live condition; while the other species under ice packing. Based on eight-month (April '87 to November '87) data, a total of 1,149 41 tonnes of fish and prawns was estimated to have been exported during the year of April '87 to March '88.

Biological studies: 65 specimens of *C. catla*, 9 of *L. rohita*, 3 of *C. mrigala*, 2 of *P. sarana* and one of *L. calbasu* obtained from Akiveedu and Bhimavaram were examined for their food and maturity. All were juveniles and immature. Most of the specimens of all the species had either empty guts or contained detritus. The length range of the specimens examined is given below:

Catla	.. 105-210 mm/59-130 g
Rohu	.. 161-200 mm
Mrigal	.. 158-163 mm
P. sarana	.. 170 mm
Calbasu	.. 150 mm

Forty specimens of *H. fossilis* (120-172 mm) were examined. Their stomachs mainly contained annelid remains.

294 specimens of *M. gulio* and 10 specimens of *M. cephalus* were examined. The former ranged from 80 mm to 114 mm in total length. Males and females in advanced stages of maturity were observed during the last quarter of the year. *M. cephalus* ranged between 147 mm and 270 mm.

Anabas oligolepis occurred in the size range of 65-170 mm with the dominant size being 95-135 mm. Maturing specimens occured from the month of March and ripe ones during May-August. A fully mature ovary had a single mode of mature eggs at 0·75 mm. Food consisted mainly of seeds of aquatic plants, rice grains, plant matter, detritus and insects.

Anabas testudineus occurred significantly only during May-July. Maturing males occurred in the size range of 85-150 mm and females 85-205 mm.

Though *Channa punctatus* occurred in the size range of 75-250 mm, the size group 100-200 mm formed the mainstay in the fishery. Maturing and mature specimens (110-240 mm) occurred almost throughout the year. A fully mature ovary has a single mode of mature eggs at 0.96 mm. Food consisted mainly of fish like, *P. sophore*, *G. giuris*, *L. thermalis*, *E. machnata* etc.

86 species belonging to 40 families were so far recorded from the lake and its connected Upputeru drain.

The list of prawns encountered during the period under report included—

1. *Macrobrachium rosenbergii*
2. *M. malcolmsonii*
3. *M. rude*
4. *M. scabriculum*
5. *M. lamarrei*
6. *M. villosimanus*
7. *Penaeus monodon*
8. *P. indicus*
9. *Metapenaeus monoceros*
10. *M. dobsoni*
11. *M. brevicornis* and the crab, *Scylla serrata*

Bottom biota: Animals encountered from the bottom collections from July to November '87 were segregated in four broad groups, *viz.*, oligochaetes, polychaetes, gastropods and bivalves. Animals identified were *Tubifex*, *Aeolosoma* and *Branchiobdellids* (Oligochaeta), *Pleurocera*, *Viviparus*, *Goniobasis*, *Gyraulus*, *Helisoma*, *Bullinous* and *Lymnaea* (Gastropoda), *Sphaerium*, *Pisidium* (Bivalve) and Nereis (Poly-

chaeta). Bottom collections obtained from Upputeru drain near Tadinada showed the presence of nereids which usually occur in brackish and saline waters.

Macrovegetation: The net weight of the macrophytes collected during October to November '87 ranged from 930 to 1685 g/m² at Pedayedlagadi, 1500 to 2600 g/m² at Chinayedlagadi, 1800 to 2150 g/m² at Polaraju drain and 750 to 1500 g/m² at Tadinada. Common macrophytes identified include *Eichhornia crassipes*, *Typhas angustata*, *Vallisnaria spiralis* and *Scirpus articulatus*.

Plankton: Plankton collected during the months of July, August and September '87 were analysed for the observation of diurnal variation for all the four field stations. In general, production of plankton was poor ranging from trace to 0.65 cc by volume for 50 litres of water filtered, and 3 to 57 units per liter by number. Phytoplankton appeared to be dominant (15 to 92%) over zooplankton (8 to 85%) at all the centres. Common plankters encountered in the collections comprised *Spyrogyra*, *Microcystis*, *Rivularia*, *Diatoma*, *Spirulina*, *Synedra*, *Ulothrix*, *Euglena*, *Volvox*, *Fragillaria*, *Mougeotia*, *Oscillatoria*, *Asterionella*, *Phormedium*, *Pediastrum*, *Gyrosigma*, *Nostoc*, *Chaetophora*, *Anabaena* and *Closterium* (Phytoplankton) and *Cyclops*, Nauplius, *Diaphanosoma*, *Daphnia*, *Filinia*, *Keratella*, *Brachionus*, *Eubranchipus* and *Coscinodiscus*.

Physico-chemical features

The physico-chemical features as observed during the year at various points of Kolleru lake are given below.

	Pedayedlagadi	Chinayedlagadi	Polarajudrain	Tadinada
Dissolved oxygen (ppm)	Nil-8·00	—	1·53-7·12	1·54-13·40
Free CO_2 (ppm)	6-44	Nil-50	4-40	5-9
Phenolpthalene Alkalinity (ppm)	Nil	Nil	Nil	Nil
Methyl organic alkalinity (ppm)	152-290	146-248	140-400	87-260
Primary productivity (mg C/m³/1 h)	Nil-20·66	Nil-194·24	13·94-92·98	Nil-92·98

PROJECT FC/B/7
INVESTIGATIONS ON FACTORS RELATING TO DECLINE IN FISHERY OF RIVERS GANGA AND YAMUNA

Personnel:

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Duration: 1986-1991

Location:

Riverine Division, Allahabad/Patna/Bhagalpur/Lalgola Research Centres.

Sub-Project A: **Production structure, breeding biology and recruitment of Hilsa ilisha.**

Allahabad

During the year an estimated total of 1,735·72 kg of hilsa was recorded at Sadiapur, forming only 1·5% of the total catch whereas in 1986, the catch of hilsa was 1,955·07 kg.

Arrivals of hilsa in commercial catches were of a higher magnitude during post-monsoon months. The mean lengths estimated for 1986 and 1987 were 364 and 396 mm respectively which indicated that IIIrd size-group dominated in the catches during both the years.

At Daraganj fish assembly centre, a total of 216 kg of hilsa was landed which formed 0·7% of the total catch.

A record collection of 1499 specimens of hilsa larvae, all with yolk sac present, was made at Madhuka during October which indicated intensive breeding around Allahabad. The breeding period lasted from September to October. In December, young fry of hilsa, ranging from 20-24 mm, were recorded at Madhuka and Sirsaghat.

Fry/fingerlings of hilsa were not available in the commercial catches, either at Sadiapur or at Daraganj fish assembly centres.

Looking at the trend followed during 1986 and 1987, meagre landings of hilsa are expected during January to March 1988 around Allahabad. Since the monsoon was late this year and the floods, both in Ganga and Yamuna touched a lower level than normal the chances of winter spawning of hilsa, as observed last year, are bleak.

Patna

Around Patna, the availability of hilsa spawn was nil during the year which indicated that hilsa has not bred in the middle stretch of the river Ganga. The hilsa juvenile fishery was observed to be nil. However, only seven adult specimens of hilsa were recorded on October 30, 1987, caught near Ghaghaghat, Patna. Their size ranged from 210 to 380 mm, with an average weight of 0·390 kg.

Hilsa catch was available though poor in Ballia, Mokamah, Nayagaon, Bakhtiarpur and Monghyr but was nil in Patna and Chhapra. The range of hilsa catch was from 0·5 to 1·3 kg.

Bhagalpur

Hilsa bred in the upper stretches of Ganga at Bhagalpur. The juveniles caught were of 90-150 mm size range; Hilsa spawns were available from the '*Kols*' during pre-winter as well as post-winter periods. A few mature specimens (250-340 mm) were also caught.

Sub-Project B: **Estimation of biological and population parameters of commercially important fish species.**

During the period under report the fish landings at Sadiapur, Daraganj, Patna, Bhagalpur and Lalgola fish landing centres were estimated at 87·00, 27·90, 46·56, 76·37 and 73·23 respectively. The species-wise breakup is given in Table 1.

The analysis of length frequency data collected at Sadiapur centre indicated an upward shift of size groups for all of the commercially important species. At Patna, the landings of *C. catla* and *L. rohita* were dominated by higher age groups while the catches of *C. mrigala* and *L. calbasu* were dominated by II and III age groups. The landings of large cat-fishes were dominated by II and III age groups. At Bhagalpur, *C. mrigala* was dominated by II year class while *C. catla* was dominated by III year group. *M. aor* and *W. attu* were always from the higher age groups.

At Allahabad aging of *M. aor* through hard parts indicated formation of two rings in the opercular bones and the vertebral centra in the length range of 400-420 mm.

For studies on catch per unit of effort, three small stretches, two on river Ganga and one on river Yamuna were taken up. The gear-wise estimated catches per boat are given in Table 2.

Table 1: Fish Landing at Different Centres (in tonnes)

Species	Sadiapur	Daraganj	Patna	Bhagalpur (Sept.-Dec.)	Lalgola (Sept.-Dec.)
C. mrigala	4·77	1·91	0·56	0·34	0·64
C. catla	2·50	0·20	2·84	1·46	1·30
L. rohita	3·44	0·20	2·01	0·38	0·41
L. calbasu	13·18	0·57	2·21	0·11	0·99
Major carps	23·89	2·88	7·62	2·29	3·34
M. aor	7·01	2·87	6·13	7·69	4·19
M. seenghala	7·20	4·28	4·15	2·78	0·38
W. attu	2·69	1·01	3·31	30·16	3·44
Selected catfishes	16·90	8·16	13·59	40·63	8·01
H. ilisha	1·75	0·22	0·00	0·35	17·49
Miscellaneous	44·46	16·64	25·35	27·04	25·32
Total	87·00	27·90	46·56	67·34	54·16

Table 2: Gearwise average catch per boat (kg)

Centra	Gill net	Drag net (small)	Hook & Line	Cast net	Spear
Lavain (Ganga)	3·20	22·70	—	—	1·50
Allahabad (Yamuna)	3·90	32·00	2·20	—	—
Patna (Ganga)	6·23	10·48	4·34	1·20	—

Sub-Project C: **Studies on the breeding and recruitment of selected commercial and non-commercial fishes.**

Allahabad

Investigations were conducted at Madhuka and Chilla near Allahabad on Rivers Yamuna and Ganga respectively to study the spatio-temporal variations in the availability of major carp spawn. Due to the drought conditions that prevailed in the area, the river did not experience any significant floods in the months of July and August. However, in the second week of September, River Yamuna touched a peak of 7·5 m above summer level. A total of 400 ml of spawn was collected using one shooting net during day time from 0600 hrs to 1800 hrs.

The average percentage of major carp, as revealed by microscopic analysis, was estimated at 58% while minor carps and others constituted 42%.

Plastic pool rearing denoted the average percentage of major carps to be 68%, *C. mrigala*, *C. catla*, *L. rohita* and *L. calbasu* constituting 28·5%, 16·5%, 21·2% and 2·3% respectively.

A stretch on River Yamuna upto 25 km from Allahabad was surveyed and 10 numbers of deep pools were identified.

Patna

Spawn prospecting investigations were carried out at Maiyipur (Fatuha) for a period of 45 days from 10.7.87 to 23.8.87. During the period of observations, four minor floods were experienced and spawn was available in the receding phase.

A total of 164·9 ml (0·85 lakhs) of spawn was collected. About 25·42 per cent decline in the spawn yield was recorded this year over the preceding year.

Percentage of major carps, minor carps, catfishes and prawns were 11·0, 44·0, 10·0 and 35·0 per cent respectively. Drastic decline in quality spawn by 58 (major carps) and 23 (catfishes) per cent was recorded this year over the preceding year.

Bhagalpur

This year abundance of spawn exhibited erratic trends due to poor and late monsoon. During the period of observations four spurts were experienced in the river. The catch/net/hour for four different spurts ranged from 50-90 ml. The species-wise percentage composition of spawn was as follows:

Carps—50-60%; Misc. 40-50%; individual species were, *L. rohita* (75%), *C. mrigala* (22%), *L. calbasu* (3%), *C. reba* (60%), *L. bata* (20%), *Chela* sp. (15%), and others (5%).

Sub-Project D: **Impact of environmental changes on the biotic communities.**

Studies were undertaken to evaluate the environmental factors responsible for decline in fisheries of Rivers Ganga and Yamuna around Kanpur, Allahabad, Varanasi, Patna and Bhagalpur.

Characterization of sewage/domestic wastes

Characterization of city sewage wastes (Allahabad, Kanpur and Varanasi) and industrial wastes at Allahabad and Kanpur was done. It was observed that untreated sewage discharged into these two rivers created nutrient loading problem with respect to nitrate (0·25-21·50 mg/l) and phosphate (0·45-11·5 mg/l), especially during summer months. The presence of free ammonia (0·5-18·5 mg/l), free carbon-dioxide (1·5-26·5 mg/l) and dissolved oxygen (0·5-1·5 mg/l) at all the sewage discharge point (OF) with minor variations indicated eutrophication. Effluents from industries, municipal and domestic wastes contained biodegradable organic materials. This results in high oxygen demand (BOD-5 days at 20°C 290 to 410 mg/l) as against (BOD 1·5-8·2 mg/l in fresh-waters of the Ganga and the Yamuna. The situation further worsens particularly during summer when poisonous gases like carbon-dioxide, methane and hydrogen sulphide are also released at the outfall points of sewage and domestic waste discharge points of Rivers Ganga and Yamuna.

Primary productivity

The primary productivity near the outfall of sewage discharge points at Allahabad, Kanpur and Varanasi was found to enhance organic carbon production probably due to enriched minerals and nutrients in the sewage, whereas community respiration was very high (Table 3). Energy dynamics of River Yamuna was studied at two places—Kakaraha ghat and Sujawan. The rate of energy fixation by producers ranged from 1,211 to 8,194

Table 3: Showing characterization of different sewage and industrial waste of Allahabad/Kanpur/Varanasi

Parameter/Station	Sewage waste Allahabab/ Kanpur/ Varanasi	IFFCO Waste Allahabad	Combined waste of ITI/BPCL/ Cotton Mill/ Sewage (Naini)	Tannery Kanpur	Elgin Mill Kanpur	Fresh Zone R. Ganga Allahabad/Kanpur/ Varanasi	Fresh Zone R. Yamuna Allahabad
Temp (0°C)	20·5-31·5	20·5-31·5	20·6-31·5	24-30·5	24·5-30·5	20·5-31·5	20·4-31·5
pH	6·40-9·64	0·20-8·64	8·20-9·20	7·6-9·8	6·2-9·4	7·8-8·2	7·8-8·0
Alkalinity (mg/1)	130-914	340-870	210-410	240-600	130-914	210-310	290-410
Dissolved O_2 (mg/1)	0·5-1·5	nil	2·5-5·8	0-1·0	0-5·05	6·8-7·6	7·7-7·8
Sp. Cond. (micro mhos/cm)	342-1,640	840-1,156	218-836	1,040-1,750	418-1,550	66·12-92	310-518
Transparency (cm)	0·5-18·5	8·5-21·5	9·5-29·5	0·5-4·5	0·5-14·5	8·5-31·5	9·5-42·0
Hardness (mg/1)	68-148	110-126	—	—	74-148	68-84	62-78
Calcium (mg/1)	25·25-62·5	—	—	—	24·25-62·5	—	—
Nitrate (mg/1)	0·20-25·00	—	—	—	0·20-25·0	—	—
Phosphate (mg/1)	0·18-11·5	—	—	—	0·18-4·5	—	—
TDS (mg/1)	173-822	421-578	109-419	521-880	210-780	34-46	155-259
Free CO_2 (mg/l)	1·5-26·5	nil	0·5-3·5	nil	3·5-1·8	0·5-1·5	0·5-1·0
Silicate (mg/1)	8·5-22·5	—	—	—	10-20·5	8-10·5	7·8-8·5
Chloride (mg/1)	82·44-242·07	12·8-36·5	—	126-231	85-148	10·4-12·8	28-42
Free NH_3 (mg/1)	0·5-18·5	1·5-21·5	0·5-6·5	nil	1·8-11·5	nil	nil
Mg (mg/1)	0·085-0·150	—	—	—	0·085-0·150	—	—
Chromium (mg/1)	—	0·25-0·5	—	—28-118	—	—	—
Magnesium (mg/1)	—	—	—	—	9·5-21·5	—	—
Cyanide (mg/1)	—	—	—0·535-0·619	—	—	—	—
Sulphate (mg/1)	—	—	—60-110	—	—	—	—
BOD 5 days at 20°C	—	—	—	—	—	2·2-8·2	1·5-7·2
	190-410 (Yamuna, Baluaghat) 58-118 (Ganga, Mahdauri) 290-410 (Jagmau, Kanpur) 90-210 (Elgin Mill, Kanpur) 110-250 (Basantanala, Varanasi)						
Grass Carbon mg/c/m^8/hr.	52·37-125·12						
Net carbon mg/c/m^8/hr	31·25-78·56	—	—	—	—	—	—

cal m^{-2} day^{-1} at Kakaraha ghat (0 098 to 0·480% of light) and 511 to 7,345 cal m^{-r} day^{-2} (0 025 to 0·437%) at Sujawan. Average solar energy falling at the surface of the river was 15,80,000 cal m^{-2} day^{-1} of which only 0·240% was fixed by producers in Kakaraha ghat and 0·162% at Sujawan. The average for the whole river was 0·195% of light. The productivity potential of the river in terms of fish was 106·7 kg/ha/yr.

Effect of sewage on the biotic communities

At Kanpur, where the industrial effluents are mixed with the sewage effluents, average plankton population represented by Chlorophyceae, Bacillariophyceae, Myxophyceae, Desmidaceae, rotifers and copepods was found to be 475 μ/l, nil, 1675 μ/l and 1550 μ/l at AOF, OF, BOF and the fresh water zone.

Under the impact of tannery wastes, the benthic population recorded high rate of abundance from 660 μ/m^2 (monsoon) to 3564 μ/m^2 (winter). It was mainly represented by insect larvae 74·1%, annelids, 19·8%, molluscs, 2·5% and others 3·7% at outfall and below outfall.

The OF point of Jagmau sewage waste indicated a substantial increase (5772 μ/l) in plankton population compared to the AOF (4131 μ/l) and BOF (2774 μ/l). The benthic population at AOF varied from 220 μ/m^2 to 7920 μ/m^2 (December) whereas the same at BOF ranged from 352 μ/m^2 to 15,400 μ/m^2 in the respective months.

The combined industrial and sewage effluents discharged from Elgin mill resulted in decline of plankton and benthic populations.

Chemical characterisation of the sewage waste at Mehdauri (Ganga at Allahabad) was done. At the outfall, the total average plankton ranged from 800 μ/l in July to 22,233 μ/l in December, 1987 compared to 1,048 μ/l (April) to 33,333 μ/l (October) at BOF. In the freshwater zone, plankton density ranged from 357 μ/l to 37,000 μ/l. Average benthic population in sewage polluted areas of River Ganga was of a very high order at OF (528 μ/m^2 —29,400 μ/m^2) and BOF (748 μ/m^2 —8,800 μ/m^2) compared to the AOF (352 μ/m^2 —4,180 μ/m^2) and the FW zones (264 μ/m^2 —1,012 μ/m^2).

Similar studies were conducted on River Yamuna at Baluaghat point where the plankton population decreased from 436-1312 μ/m^3 to 186-627 μ/m^3 from AOF to OF. Figures for BOF and FW zones were 617-2136 μ/m^3 and 58-352 μ/m^3 respectively. There has been a tremendous increase in the benthic fauna due to sewage. The density of benthic organisms increased from 176-1716 μ/m^2 in the FW zone to 1,540-7,524 μ/m^2 in the polluted stretch.

Industrial Pollution in River Ganga

The studies indicated lesser concentration of chemical constituents in the effluents than in the previous year. The ammonia content of the waste water (1·5-21·5 mg/l) was diluted before its release at Dum Duma OF. No cases of fish mortality were recorded.

At the OF, the average plankton population was found to be 936 μ/l. At BOF the average plankton was 1,497 μ/l. The benthic population at the OF was very high (5,216 μ/m^2) in winter whereas it was very low (176 μ/m^2) in monsoon. At AOF (Mugarson tank), the benthic population varied from 440 μ/m^2-1,100 μ/m^2. At the BOF (riverine zone) the population ranged from 176 μ/m^2-396 μ/m^2.

At Mavaiya, where ITI, BPCL and Swadeshi Cotton Mill wastes were discharged, presence of cyanide (0·535-0·619 mg/l) was noticed. The average plankton population was 625 μ/l to 3,766 μ/l. At the OF, BOF and FW zones, the plankton

quantity was recorded as 900 to 3,340 μ/l, 255-1,243 μ/l and 326-4,728 μ/l respectively.

Average benthic population was very high at the OF in the month of May (26,400 μ/m^2) while it was very low in September (176 μ/m^2). At BOF oligochaetes and chironomids were very high (39,600 μ/m^2) whereas in FW zone the benthic population ranged from 132-1,540 μ/m^2 only.

At Basanta Nala in Varanasi, where untreated sewage wastes are discharged, the impact was felt upto 3½ km down-stream of Ganga. Several corpses were floating and pungent odour of H_2S pervaded this area. During monsoon, the degree of pollution was less. Average plankton population at AOF, OF and BOF was recorded at 1,225, 28,821 and 520 μ/l respectively. Quantitative abundance of zooplankton was very low (4·8%) at OF area. At Asighat, a sewage polluted area, the plankton population was 6,300, 15,214 and 6,300 μ/l at AOF, OF and BOF respectively.

The benthic population of OF, BOF and AOF at Assinala was estimated at 63,360, 748 and 308 μ/m^2 respectively; while at Basantanala OF region it was 220 μ/m^2. At BOF it was 352 μ/m^2 and at AOF 5,060 μ/m^2.

Micro-analysis of heavy metals

At Jagmau, solid sewage wastes contained zinc to the tune of 0·05-3·9 mg/l whereas the sewage water contained 0·085-0·150 mg/l of zinc. The chromium levels in tannery waste were 0·25-1·5 mg/l and the same as sludge were 28-118 mg/l. IFFCO wastes had 0·25-0·5 mg/l of chromium, traces of which were present in the soil sediments at Dum Duma on River Ganga.

Two centres *viz.*, Digha where leather wastes from Bata Shoe Factory are discharged and Rajapur where city sewage effluents are discharged, were studied to evaluate the impact of pollutants on aquatic biota. The total plankton density at Rajapur varied from 30 3,150 μ/l, 19 2,950 μ/l and 22 4,250 μ/l of at OF, BOF and AOF regions respectively while at Digha Bata, the total plankton density ranged from 18 76 μ/l, 15 104 μ/l, and 17 142 μ/l at OF, BOF and AOF regions respectively.

Maximum densities of benthic fauna at AOF and BOF in sewage effluent zone at Rajapur were 6,383 μ/m^2 and 5,000 μ/m^2 respectively. At the leather factory effluent area (Digha), the minimum density was recorded at 38 μ/m^2. In the Punpun River at Fatuha, the range was 57-266 μ/m^2. Benthic fauna was nil from August-December at Hajipur.

At Bhagalpur, in the OF zone of the sewage-fed channel, the range of primary productivity was 16·68-68·63 mg C/m^3/hr. The macro-invertebrates of the littoral zone were molluscs (1,600 nos/sq. m) and damselfly (80-100 nos/sq m.).

Energy dynamics of riverine ecosystem

The limnological investigations conducted at different stretches of the Rivers Ganga and Yamuna brought to relief some significant variations in transformation of incident solar energy into chemical energy at the primary producer level. The photosynthetic organisms (primary producers) fixed 0·02-0·37% of solar energy at Kanpur, compared to 0·06-1·10% at Allahabad and 0·083 to 0·53% at Patna (Table 4). Based on the level of energy stored at the primary producer level, the fish yield potentials at Kanpur, Allahabad and Patna were estimated to be 74, 249 and 192 kg/ha/year. Similar studies were conducted at two places in River Yamuna near Allahabad where the energy transfer from sunlight to primary producers ranged within 0·025 and 0·480%. The harvestable fish production from Yamuna at Allahabad was

Table 4: Light energy available, energy fixed by producers (Net) & photosynthetic efficiency at various places in River Ganga (Productivity Potential)

Months	Kanpur			Allahabad				Patna				
	Light energy Cal m^{-2} day^{-1}	Energy fixed by producers Cal m^{-2} day^{-1}		Light energy available Cal m^{-2} day^{-1}	Energy fixed by producers Cal m^{-2} day^{-1}			Light energy Cal m^{-2} day^{-1}	Energy fixed by producers Cal m^{-2} day^{-1}			
		Jagmau	Mag Zine Ghat		Mehdauri	Begam Sarai	Manaiya		Dighabata	Rajaur	Fatuha	Hajipur
September	19,90,000	B 588 (0·03) / A 1,066 (0·053)	3,821 (0·20) / 860 (0·043)	20,10,000	—	—	1,257 (0·062)	20,10,000	1,673 (0·083)	3,533 (0·17)	—	—
October	16,50,000	—	—	16,80,000	55,813 (3·32)	14,813 (0·88)	6,150 (0·360)	16,80,000	4,163 (0·247)	2,248 (0·146)	—	—
November	13,55,000	—	—	14,00,000	4,743 (0·34)	4,562 (0·33)	4,514 (0·32)	13,90,000	2,210 (0·159)	2,024 (0·146)	—	—
December	11,20,000	B 221 (0·02) / A 3,913 (0·349)	— / 4,159 (0·371)	12,30,000	13,539 (0·10)	9,121 (0·74)	5,987 (0·487)	12,10,000	6,354 (0·525)	5,624 (0·465)	6,389 (0·528)	3,388 (0·447)
Average	15,28,750	1,447 (0·095)	2,947 (0·193)	15,80,000	24,698 (11·56)	9,499 (0·601)	4,477 (0·283)	15,72,000	3,600 (0·223)	3,357 (0·212)	6,389 (0·528)	5,388 (0·497)

Figures in brackets represents photosynthetic efficiency in % B = Below the discharge point
A = Above discharge point

	Kanpur	Allahabad	Patna
Average Energy Transferation Efficiency	0·144%	0·814%	0·352%

estimated at 107 kg/ha/year. Average solar energy falling at the surface of the river was 15,80,000 Cal m^{-2} day^{-1} of which only 0·240% was fixed by producers in Kakaraha Ghat and 0·162% at Sujawan. The average for the whole river was 0·195% of light. The studies clearly indicate that the anthropogenic changes in the habitat variables have impaired the biological production processes and the basic productivity levels leading to poor fish harvest.

Primary productivity studies in River Ganga using Carbon-14 isotope technique are made at three different places—Kanpur, Allahabad and Patna. The results are presented in *Table* 5. In River Yamuna also the studies were conducted and the results are portrayed in *Table* 6.

Sub-Project E: **Economics of riverine capture risheries operations.**

The data regarding price and market arrival of landings were collected from Sadiapur wholesale and Daraganj retail fish markets.

C. catla turned out to be the costliest fish, fetching wholesale and retail prices at Rs. 21·04 and Rs. 24·67 respectively. *W. attu* was the lowest priced fish at Rs. 14·47 and Rs. 18·92 for wholesale and retail.

These prices are significantly higher than the previous year's.

The size of fish had significant effect on price which accounted for 2·86-36·80 per cent difference in prices of different size groups of fish species. No regular price trend was observed.

Price spread depicted a larger share (75·31%) of producer in consumer's rupee than the last year as revealed by the Table 7.

Table 6: Primary production (Net) in River Yamuna using Carbon-14 isotope technique (mgC m^{-2} hr^{-1})

Months	Kakaraha ghat	Sujawan *yamuna*
September	—	4·34
October	69·54	51·00
November	16·85	8·78
December	10·28	11·32
Average	32·22	18·86

Table 5: Primary production (Net) in River Ganga using Carbon-14 isotope technique (mgC$m^{-2}hr^{-1}$)

	Kanpur				Allahabad			Patna			
Months	Jag-mau (Below outfall)	Jag-mau (Above outfall)	Mag Zinc ghat (BOF)	Mag Zinc ghat (fresh water)	Meha-dauri	Begam Sarai	Mana-iya	Digha bata	Raja-pur	Fatua at the confluence	Haji-pur at the confluence
September	4·99	9·05	32·45	7·30	—	—	10·67	14·20	29·98	—	—
October	—	—	—	—	473·58	125·70	52·19	35·32	19·08	—	—
November	—	—	—	—	40·25	38·67	38·31	18·75	17·18	—	—
December	1·88	33·21	—	35·29	114·89	77·40	50·81	53·92	47·72	54·22	45·72
Average	3·43	21·13	32·45	21·29	209·57	80·59	38·0	30·55	28·49	54·22	45·72

Regarding relationship between market arrival of fish landings and price, regression results revealed that 4-55 per cent of variation in price was explained by it. It further indicated that one unit increase in fish landing decreased price in a range $0{\cdot}0457 \pm 0{\cdot}0309$ to $0{\cdot}099 \pm 0{\cdot}371$ units and vice versa for significant cases only.

Table 7

Sl. No.	Item	Percentage share in 1987	Consumer's rupee 1986
1.	Producer	75·31	69·09
2.	Wholesaler's cost	3·25	3·18
3.	Wholesaler's margin	3·26	3·18
4.	Retailer's cost	3·50	6·36
5.	Retailer's margin	14·68	18·19
	Total	100·00	100·00

Species-wise fish landing in tonnes at different centres during January 86 to March 87

Centre/Species	Sadiapur	Daraganj *	Naini (T.S.L.) *	Gaughat *	Talliar-ganj *	Buxar	Bhagal-Pur	Lalgola
C. mrigala	6·72 (4·10)	1·59 (7·6)	1·90 (8·7)	1·50 (7·2)	1·45 (8·4)	0·44 (1·0)	0·47 (0·7)	0·15 (0·2)
C. catla	3·34 (2·1)	0·41 (2·0)	0·16 (0·7)	0·86 (4·1)	0·52 (3·0)	0·12 (0·3)	1·92 (2·9)	0·48 (0·7)
L. rohita	3·55 (2·2)	0·30 (1·4)	0·45 (2·1)	0·62 (3·0)	0·36 (2·1)	0·20 (0·4)	0·77 (1·2)	0·26 (0·4)
L. calbasu	39·20 (24·1)	1·22 (15·8)	3·21 (14·8)	2·50 (12·0)	2·32 (13·4)	2·83 (6·2)	0·11 (0·2)	0·24 (0·4)
Major carps Total:	52·81	3·52	5·72	5·48	4·65	3·59	3·27	1·13
M. aor	12·86 (7·9)	2·22 (10·7)	2·65 (12·1)	1·86 (8·9)	2·29 (13·1)	5·74 (12·6)	7·32 (11·0)	3·24 (4·9)
M. seenghala	11·04 (6·8)	1·76 (8·5)	3·46 (15·9)	2·14 (10·2)	2·36 (13·6)	1·96 (4·3)	3·69 (5·5)	(0·94) (1·4)
W. attu	5·29 (3·3)	1·41 (6·8)	1·52 (7·0)	1·63 (7·8)	1·15 (6·6)	6·10 (13·4)	12·36 (18·5)	2·23 (3·4)
Large cat fishes Total:	29·19	5·39	7·63	5·63	5·80	13·80	23·37	6·41
H. ilisha	1·88 (1·2)	0·24 (1·2)	0·01 (0·1)	0·50 (2·4)	0·00 —	1·67 (3·7)	0·41 (0·5)	18·31 (27·6)
Miscellaneous	78·49 (48·3)	11·64 (56·0)	8·40 (38·6)	9·27 (44·4)	6·90 (39·8)	26·56 (58·1)	39·72 (59·5)	40·43 (61·0)
Total:	162·37	20·79	21·76	20·88	17·05	45·62	66·77	66·28

(Figure in parenthesis indicate percentage)
*Period August 86 to March '87.
NB. This Table shows the landing for the previous year which was not printed in the Annual Report for the year 1986-87.

PROJECT FC/B/9: INVESTIGATION ON FACTORS RALATING TO DECLINE IN FISHERY OF THE RIVER BRAHMAPUTRA AND ITS MAJOR TRIBUTARIES.

Personnel:

S. N. Mehrotra (W.E.F. 7.5.87), D. N. Singh, (upto 28.8.87), Y. S. Yadava, M. Choudhury and B. K. Biswas

Location:

Guwahati and Jorhat

Catch Statistics: Estimation of fish landings was done at 11 centres, *viz.*, Sibsagar, Jorhat, Nowgong, Dhing, Uzanbazar, Fancybazar and Goalpara on the south bank and Biswanath Charali, Tezpur, Dhekiajuli and Dhubri on the north bank. Enumeration was done daily at Uzanbazar, Fancybazar and Jorhat from April to July and six days in a month from August onwards. A six-day schedule was followed at all other centres also. Groupwise fish landings at these centres are presented in Table 18.

The centre-wise monthly distribution of the total catch in 1987 is given in Table 19.

Compared to the corresponding period in 1986, there was an increase in catch in 1987 at Uzanbazar and Fancybazar. Miscell-

Table 8: Groupwise fish landing (kg) at various landing centres on Brahmaputra river during April-December, 1987

	Major carps	Minor carps	Cat fishes	Hilsa	Feather-back	Miscella-neous	Total
Uzanbazar (Apr-Dec)	31,366 (32·65)	10,292 (10·71)	9,985 (10·39)	5,264 (5·48)	1,720 (1·79)	37,444 (38·98)	96,071
Fancybazar (Apr-Dec)	18,052 (30·41)	3,837 (6·46)	6,906 (11·63)	5,501 (9·27)	1,652 (2·78)	23,415 (39·44)	59,363
Jorhat (Apr-Dec)	22,979 (12·83)	45,551 (25·43)	54,527 (30·44)	—	10,650 (5·95)	44,389 (24·78)	1,79,114
Sibsagar (Sept-Dec)	4,244 (13·85)	4,785 (15·61)	7,840 (25·58)	—	1,906 (6·22)	10,048 (32·78)	30,651
Goalpara (Aug & Dec)	1,546 (26·32)	673 (11·68)	388 (6·74)	424 (7·36)	253 (4·39)	2,506 (43·51)	5,760
Dhubri (Aug & Dec)	2,562 (39·14)	320 (4·89)	852 (13·02)	646 (9·87)	186 (2·84)	1,980 (30·24)	6,546
Nowgong (Aug, Oct & Nov)	10,452 (22·54)	6,190 (13·35)	5,132 (11·07)	310 (0·67)	2,354 (5·07)	21,931 (47·30)	46,369
Dhing (Aug, Oct & Nov)	2,460 (14·05)	2,473 (14·13)	1,836 (10·49)	—	949 (5·42)	9,788 (55·91)	17,506
(Tejpur (Sept)	420 (32·56)	25 (1·9)	395 (30·62)	—	30 (2·32)	420 (32·56)	1,290
Dhekiajuli (Sept)	125 (10·68)	30 (2·56)	270 (23·08)	—	15 (1·28)	730 (62·39)	1,170
Biswanath Chariali (Sept)	750 (41·55)	190 (10·52)	385 (21·33)	15 (0·83)	145 (8·03)	320 (17·73)	1,805

Table 9: Monthly distribution of total catch (in kg)

	Uzanbazar 1986-87		Fancybazar 1986-87		Jorhat 1987	Sibsagar 1987	Goalpara 1987	Nowgong 1987	Dhing 1987
April	—	7,235	—	9,082	7,534	—	—	—	—
May	—	6,542	—	7,380	10,572	—	—	—	—
June	—	5,892	—	5,838	16,334	—	—	—	—
July	7,031	9,793	3,458	5,453	4,088	—	—	—	—
August	4,127	13,417	3,494	6,120	57,380	—	3,470	5,642	12,194
September	13,766	16,515	4,015	6,616	10,908	5,450	—	—	—
October	4,064	21,241	2,971	7,111	10,758	2,429	—	37,792	3,447
November	11,538	12,222	5,615	9,348	20,430	9,670	—	2,935	1,865
December	4,568	3,214	4,544	2,415	41,110	13,102	2,290	—	—

aneous fishes dominated in the landings followed by major carps at both the centres.

Environment Impact Studies: With a view to assessing the impact of upcoming industries on the water resources of Brahmaputra drainage, a comprehensive monitoring of effluent discharge in the Elanga group of beels by the Hindustan Paper Mill, Jagi Road was initiated in October 1987. The paper mill located at a distance of *c.* 60 km from Guwahati on N.H. 37 discharges its effluents into the Elanga beel which subsequently meets the river Kolong, a tributary of River Brahmaputra. The mill discharges highly alkaline (containing cellulose fibres) effluents @ *c.* 72,000 m^3 day^{-1} adopting the sulphate process.

The effluent is characterised by high alkalinity (286-480 ppm), near neutral pH (6·8-7·09), high concentrations of free CO_2 (44-68·2 ppm) and BOD (46·2-49·6 ppm) with low oxygen (0·35-1·6 ppm) values. Conductivity (892-1,527 micro mhos cm^{-1}) and TDS (447-768 ppm) values were also on the higher side.

Abiotic and Biotic Parameters of Elanga Beel

Water quality: Sector I (outfall) and II of Elanga beel showed dilution of the effluents indicating marked decline in BOD load (26·8-310 ppm), alkalinity (100-130 ppm), conductivity (304-654 micro mhos cm^{-1}) and TDS (152-327 ppm), whereas pH (7·6-9·9) and DO (4·8 ppm) registered a rising trend.

Plankton: A poor plankton population was recorded in the beel. While sector I had nil population, the count in sector II was recorded as 300 units l^{-1}. The plankton were represented by *Navicula* sp. and *Coelosphaerium* sp.

Macrobenthos: Qualitative analysis of benthos revealed a very poor benthic fauna (87 nos. m^{-2}) in the outfall zone (Sector I) as compared to sector II where it indicated a buildup (520 nos. m^{-2}) in numbers. The fauna constituted of only molluscs except the presence of water bug (14 nos. m^{-2}) in sector I. The species dominance was in the order: *Digoniostoma cerameopoma*, *Gyraulus*

convexiusculus and *Pisidium* (*Neopisidium*) *clarckeanum.*

Macrovegetation: Dense aquatic weeds choked sector I of the beel. Besides dense strands of *Eichhornia crassipes*, there was a heavy infestation of other free-floating weeds in some portions. *Pistia stratiotes*, *Wolffia* sp. and *Lemna* sp. dominated such patches. The infestation was quantified as 980 g m^{-2} (wet weight) and 90 g m^{-2} (dry weight).

Fishery biology: In order to study biological parameters like length-weight relationship, age and growth and food studies of commercially important species of River Brahmaputra. *Labeo gonius* and *Mystus aor* were selected for the purpose.

Labeo gonius: Specimens ranging from 144 0—277·0 mm in length and 35·0-230·0 g in weight were studied for dietary composition. The feed components were in the order, detritus (29·44%) algae (25·0%) plant matter (22 79%) and sand particles (15·0%) besides semidigested matter (5·55%) and unidentified matter (2 22%).

Mystus aor: Dietary composition of *M. aor* specimens revealed digested to undigested fishes as the main feed constituents besides sand particles (60%) and algal matter (10%).

PROJECT FC/A/2: ECOLOGY AND FISHERY MANAGEMENT IN SMALL RESERVOIRS GANGA BASIN (BACHHRA RESERVOIR)

Personnel:

M. A. Khan, Balbir Singh, R. K. Dwivedi, R. K. Tyagi, K. Chandra, P. K. Katiha, Ram Chandra, B. D. Saroj, J. P. Mishra, Bhai Lal

Duration:

1986-1988

Location:

Allahabad

Chemical characteristics of the water

Physico-chemical parameters of the water indicated medium productive potential. Alkalinity, dissolved oxygen and specific conductivity ranged from 46-180 mg/l, 6·00 to 8·65 mg/l and 92-246 micromhos/cm respectively. The water temperature fluctuated between 17° and 31·5°C, being minimum in January and maximum in May/June. It also remained clear throughout the year and transparency ranged from 36-130 cm. The values for other parameters were pH, 7·2 to 8·4; hardness, 18·5 to 52·00 mg/l; calcium, 21 to 28 mg/l; total dissolved oxygen 46 to 124 mg/l; nitrate, 0·1 to 0·16 mg/l and phosphate 0·07 to 0·12 mg/l. The value of gross carbon production ranged from 52 to 110 $mgC/m^3/hr$ being maximum in May and minimum in August and respiration varied from 16·5 to 26·5 $mgC/m^3/hr$. On an average, the former was estimated at 59·5 $mgC/m^3/hr$ and the latter at 8 $mgC/m^3/hr$.

Maximum plankton concentration was observed at 18 hrs in monsoon (1,800 u/l) followed by 24 hrs in summer (1,000 u/l) and winter (40 u/l).

Studies indicated declining trends in respect of temperature and oxygen with depth whereas, pH, specific conductivity, alkalinity and TDS indicated increasing trends upto 5 m depth with decreasing trend thereafter. An increase in pH (0·15), sp. conductivity (26 micromhos/cm), alkalinity (19 mg/l) and TDS (15 mg/l) was recorded upto 5 m depth and, thereafter (upto 10 m), declining trends were observed for the above parameters. A weak chemical stratification was observed but thermal stratification was totally absent.

Planktonic studies corroborated the above findings as maximum concentrations of plankton were at 1 m followed by 3 m, 6 m, 9 m and 10 m being 2,000, 1928, 333, 270 and 257 u/l. Phytoplankton was more

or less uniformly distributed at all depths while copepods and cladocerans were concentrated around 10 m depth.

Soil

Soil indicated sandy-loamy texture. The percentage of sand was 67·5-74·5%, clay 10·5 to 14·5% and silt 14 to 21% respectively. The pH of soil was alkaline (7·30-7·55), organic carbon was fairly rich (0·75-1·00%), calcium carbonate was inadequate (2·5-2·75%), available nitrogen (20·20-24·5 mg/100 g) was moderate and available phosphorus (2·25-2·59 mg/100 g) indicated optimal range. No significant seasonal variations were observed in respect of the above parameters.

Plankton

The plankton population of Bachhra Reservoir, on an average, ranged from 175 u/l in February to 1,199 u/l in July. Two peaks *viz.*, a higher one in monsoon and another of lesser magnitude in post-monsoon were observed in planktonic distribution.

Among phytoplankters, Bacillariophyceae (28·66%) dominated over Chlorophyceae (11·11%) and Myxophyceae (9·99%). This year Bacillariophyceae increased its population at the expense of Myxophyceae.

Periphyton

It ranged from 746 u/cm^2 in February to 1,20,000 u/cm^2 in May. Rich crop of periphyton was produced in summer followed by winter and monsoon. Myxophyceae dominated (37·50%) over Bacillariophyceae (36·10%) and Chlorophyceae (26·40%).

Macrobenthic fauna

The macrobenthic fauna of the reservoir ranged between 1,144 to 4,620 u/m^2 being minimum in September and maximum in November. The benthos were dominated by insect larvae (67·8%), annelids (23·5%) and molluscs (8·7%). The insect larvae were mainly represented by *Chironomus*, *Chaoborus*, *Culicoides* and *Phylopotamus* species. The insect larvae contributed two peaks, one in July and other in November.

Annelids were mostly represented by Oligochaetes which formed a peak in the month of May. The species commonly found were *Aulodrilus pluriseta* and *Branchiura sowerbui*. The maximum concentration of gastropods was in the month of March. They were mainly constituted by *Melanoides tubuculata*, *Viviparus bengalensis*, *Gyraulus* sp. and the bivalves were represented by *Pisidium clarckeanum*, *Parreysia fevidens*, *Indonaia caeruled* and *Lamellidens corrianus*.

The primary productivity studies using radioisotope carbon-14 were conducted and the results are given in Table 10. Studies on the energy transformation by nannoplankton and its contribution to the total energy fixation process were made by using isotope ^{14}C during September to December. The light energy falling on the reservoir ranged from 12,30,000 to 20,10,000 cal m^{-2} day^{-1} (Av. 15,80,000 cal m^{-2} day^{-1}). The rate of energy transformation by producer ranged from 1,507 to 2,277 cal m^{-2} day^{-1} (av. 2,032 cal m^{-2} day^{-1}) while that by nannoplankton

Table 10: Primary production (Net) in Bachhra reservoir using carbon-14 isotope technique (mgC m^{-2} hr^{-1})

Months	Bachhra reservoir	
	Total plankton	Nannoplankton
September	17·60	11·53
October	19·32	11·60
November	19·26	18·27
December	12·79	9·69
Average	17·24	12·77

ranged from 1,142 to 2,153 cal m^{-2} day^{-1} (av. 1,514 cal m^{-2} day^{-1}). The efficiency of transformation ranged from 0·103 to 0·160% by total plankton and 0 069 to 0·15% by nannoplankton. Almost 60 to 94% (av. 74·2%) of the energy fixed through primary production in the reservoir was contributed by nannoplankton. The potential yield of the reservoir estimated from energy flow studies worked out to be 75 kg/ha/yr.

Pre-recruitment studies

Studies to assess recruitment of spawn/fry in Bachhra reservoir were conducted for a period of 46 days during July and August 1987. Neither spawn/fry nor eggs could be collected due to failure of breeding in major carps on account of drought.

Stocking

A total number of 87,250 fingerlings (35 mm-100 mm TL)of major carps *viz.*, *C. mrigala* (47·80%), *L. rohita* (40·76%) and *C. catla* (11·50%) were stocked in the reservoir in the first week of September, 1987. The stocking policy for the reservoir was arrived at by using thermodynamic model.

Experimental fishing

A total number of 11,500 kg fishes were caught through experimental fishing by employing various gill nets of sizes 30 mm to 100 mm. *C. mrigala*, *L. rohita*, *Mystus seenghala*, *Puntius sarana* and *Notopterus notopterus* (Pallas) formed 45·64%, 6 38%, 19·27%, 15·95% and 12·76% by weight and 40·74%, 7·14%, 10·28%, 21·42% and 21·42% by numbers. 76 g of fishes were caught for every 100 metre of net-length.

Weed fish population

The weed fishes were dominated by *Ambassis* spp. (60%) followed by *Oxygaster bacaila*, (15%), *Amblypharyngodon mola* (12·00%), *Puntius* spp. (7·00%) and others (6·00%).

Economics of stocking and fishing

The various cost and return aspects of fish production in Bachhra Reservoir were examined. A profit of 133·48% was gained on investment.

PROJECT FC/A/3: ECOLOGY AND FISHERIES OF DHIR BEEL IN ASSAM

Problem:

Studies on some population parameters of Indian major carps in Dhir beel

Personnel:

Y. S. Yadava & M. Choudhury

Duration: 1986-87

Location: Guwahati, Assam

Study on the fish population dynamics was initiated in Dhir beel during 1987. The beel is oblong shaped and is a single basin with a water spread area ranging between 350-689 ha, consequent to the incursion of water from River Brahmaputra.

A total of 322 fingerlings of Indian major carps *Labeo rohita* (217 no; 112-250 mm/ 10-170 g), *Catla catla* (100 no; 120-190 mm/ 22-105 g) and *Cirrhinus mrigala* (5 no; 130-210 mm/15-70 g) were tagged with Dennison tagging gun using ash-grey internal anchor dart tags. These fingerlings were obtained from Ulubari Fish Farm (Govt. of Assam, Guwahati) on 20.8.87 and were transported to Dhir beel, a distance of about 230 km under oxygen packing. They were conditioned for a day and released in the beel. Only one specimen of *L. rohita* was recovered on 22.11.87, showing an increment of 30 mm/ 50 g in 90 days.

PROJECT FC / A / 4: ECOLOGY AND FISHERIES MANAGEMENT OF BEELS IN WEST BENGAL

Sub-Project:

(*i*) Ecology of an open and a closed beel
(*ii*) Development of management measures for optimum sustained yield
(*iii*) Studies on energy flow in beel ecosystem

Personnel:

A. G. Jhingran, M. Sinha, M. J. Bhagat, V. V. Sugunan, G. N. Chattopadhyay and Mrs. K. Mitra

Duration: 1980-1990

Location: Barrackpore, West Bengal

Studies were initiated (August, 1987) in two new beels *viz.*, Garapata and Mogra to evaluate their production potential and to develop suitable management norms for obtaining maximum fish production. Garapata is an 'open type' beel having a water spread of 122 ha. It gets connected with the River Ichamati during floods. Mogra is a 'closed type' beel having waterspread of 60 ha. Both are horse-shoe shaped beels.

Productivity studies

Abiotic parameters exhibited similar trends in both the beels but the gross production of Garapata beel was of higher order (Table 11). The macrophytes dominated zones yielded in general, lower productivity values possibly owing to the presence of lesser amount of nutrient element (mainly N) in watersoluble form. In open type beel, the productivity values were in higher order.

Macrophytes

Mogra beel was totally choked with aquatic vegetation which is dominated by submerged hydrophytes. They include: *Ceratophyllum demersum* L., *Hydrilla verticillata* (L.F.) Royle, *Najas* sp., *Potamogeton nodosus* Poir, *Alternanthera philoxeroides* (Mart) Griseb, *Nymphoides cristatum* (Raxb) O. ktze, *Nymphaea nouchali* Burm. F., *N. pubescens* Wild, *Nelumbo nucifera* Gaertn., *Phyla modifltora* (L.) Greene, *Vallisnaria spiralis* L., *Eleocharis* sp., *Monochoria hastata* (L.) Solms, *Eichhornia crassipes* (Mart.) Solms; and *Azolla pinnata* wild etc. The biomas of the predominant macrophytes like *Ceratophyllum*, *Hydrilla*, *Najas potamogeton* and *Eichhornia* was 10·7 kg/m² to 16·8 kg/m². The associated fauna were molluscs, insects, and annelids contributing 37-93·6%, 6-60% and 0·18-1·69% respectively to the total population.

Table 11: Physico-chemical parameters of surface water of Garapata and Mogra beels

Parameter	Garapata	Morga
	range	range
Dissolved oxygen (ppm)	6·8-9·6	6·4-19.6
pH	7·5-8·5	7·4-8·3
Total alkalinity (ppm)	84-186	50-106
Phosphate (ppm)	Trace-0·1	Trace-0·2
Inorganic nitrogen (ppm)	Trace-2·6	0·34-4·5
Gross primary productivity (mg C/m³/h)	124·8-416·0	41·6-249·6

The Garapata beel was comparatively less infested though a few hydrophytes were recorded at the low water level area. The total biomass of macrophytes ranged from 5·4 kg/m² to 7·70 kg/m².

The associated fauna represented by molluscs (89-93%), arthropods (4·6-10%) and annelids (0-3%) of the total population.

The lists of the species present in both the beels are given in Tables 12, 13 14 and 15.

Table 12: Molluscan fauna of Garapata and Mogra beels

Order	(14) Taxa
(1) Meogastropoda	*Bellamya bengalensis* f· *doliaris* *B. bengalensis* *Pila globosa* *Digoniostoma eerameopoma* *Thiara tuberculata* *Gabia orcula*
(2) Basommatophora	*Lymnea acuminata* *L. a. f. rufescens* *L. a· luteola* f. *typica* *Lna.l.f. ovalis* *Idoplanorbis exustus* *Segmentina calatha* *Camptoceras terebra* *Gyaulus convexiusculus*

Table 13: other fauna of Garapata and Mogra beels

Annelids	Oligocheata	*Branchiura sowerbji*
	Hirudinea	*Hellobdella* sp.
	Crustacea	Ostracoda, *Cypris* spp.
		Malacostraca, Shrimps
		Isopoda

Plankton

The open beel (Garapata) was very rich in plankton population the biomass being 85-12,025 u/l. The representative species were: Phytoplankton:—*Microcystis, Anabaena, Pediastrum, Botryococcus, Amphora, Synedra, Nitzchia*; *6ooplankton :—Keratella, Brachionus,*

Table 14: Insect fauna of Garapata and Mogra beels

Order	Taxa (29)	
Ephemeroptera	(GM)	*Cloeon* sp.
	(GM)	*Ceanis* sp.
Odonata	(GM) (Anisoptera)	dragonfly numphs
	(GM) (Zygoptera)	demselfly nymphs
Hemiptera	(GM) *Diplonychus annulatum*	
	(M) *Spherodema rusticusm*	
	(M) *Lithocerus indicus*	
	(GM) *Ranatra filiformes*	
	(GM) *Laccotrephes ruber*	
	(M) *L· maculatus*	
	(GM) *Micronecta proba*	
	(GM) *M. merope*	
	(GM) *M. striata*	
	(G) *Micronecta sp.*	
	(GM) *Plea sp.*	
	(GM) *Gerris spinolae*	
Coleoptera	(M) *Hydrovatus bonvoloiri*	
	(GM) *Hydrocoptus subvittulus*	
	(M) *H. confertus*	
	(GM) *Canthydrus laetabilis*	
	(M) *C. morsbachi*	
	(GM) *Berosus indicus*	
	(GM) *Sternolophus rufipes*	
Diptera	(M) *Tanypus sp.*	
	(GM) *Chyronomus sp.*	
	(GM) *Culex sp.*	
	(GM) *Ceratopogon sp.*	
Lepidoptera	(GM) *Nymphula sp.*	
Trichoptera	(GM) *Leptocera sp.*	

G=Garapata
M=Mogra

Filina, *Trichocerca*, *Moina*, *Ceriodaphnia* and *Chydorus*.

The closed beel (Mogra) recorded a plankton biomass of 2 u/l to 90 u/l. The representative species were similar to that at the open beel.

Biology

Food study of the commercial fishes indicated that the carps feed mainly on detritus.

Fish and fishery

Both the beels were leased out to the Fishermen cooperatives. About 313 fishermen were engaged in Garapata beel and 375 in the Mogra beel. The gear mainly used were cast net, gill net, scoop net, hook & line and traps. 'Katal' fishing also was practised and the total catch by this method ranged from 600 to 1,000 kg/katal/season. The total carp landings were estimated at 38,835·65 kg for the year 1986-87 recording the maximum (10,883·6 kg) during August, 1986. The total fishing days were 298. The Mogra beel recorded a catch of 29,400 89 kg for 335 fishing days. The maximum catch was recorded in May, 1987 (7,194·35 kg).

The estimated fish landing from both the beels are showed in the Table 15.

Stocking

Stocking was done by the cooperative society and the details are given in the Table 16.

Table 15: Estimated fish landings from Garapata and Mogra beells

Species	Garapata beel		Mogra beel	
	kg/ha	%	kg/ha	%
C. mrigala	135·76	40·88	199·23	38·70
L. rohita	111·52	33·58	147·50	28·65
Catla catla	44·16	13·30	73·11	14·20
Cyprinus carpio	14·61	4·40	20·38	3·96
Ctenopharyngodon idella	12·28	3·70	26·10	5·07
Hypophthalmichthys molitrix	—	—	23·68	4·60
Miscellaneous	13·73	4·14	24·83	4·82
	332·06		514·83	

Table 16: Fish stocking of Garapata and Mogra beels during July 1986—June 1987

Species	Garapata			Mogra		
	Av. wt.	(no./ha)	(%)	Av. wt.	(no/ha)	(%)
C. mrigala	4	1,062	11·6	4	1,755	12·1
Catla catla	6	4,887	53·0	6	7,172	49·2
L. rohita	5	2,788	30·0	5	4,188	28·7
C. carpio	4	233	2·6	4	326	2·2
C. idella	5	246	2·8	5	420	2·9
H. molitrix	—	—	—	5	710	4·9
		9,216			14,571	

Table 17: Ecological characteristics of Kanti Ox-bow lake

	Segment A	Segment B	Pen area
Net plankton (per m^3)	2,07,350-19,26,500	1,78,035-1,83,600	21,785-21,12,600
Phytoplankton (%)	95·55	24·04	79·72
Bacillariophyceae	53·05	8·82	62·63
Myxophyceae	40·08	0·99	12·73
Chlorophyceae	2·42	4·77	12·73
Dinophyceae	—	9·46	4·36
Zooplankton (%)	4·45	75·96	20·28
Copepoda	2·87	69·11	14·29
Cladocera	0·30	0·59	0·21
Rotifera	1·20	2·78	5·21
Protozoa	0·08	3·48	0·57
Nannoplankton (u/l)	10,125-29,327	18,683-26,734	12,305-26,775
Filamentous (%), bacteria	90·23-94·56	73·14	72·13-84·67
Bacillariophyceae	few	20·08	8·12-12·37
Myxophyceae	few	—	2·57-4·87
Chlorophyceae	few	3·52	2·37-5·16
Chysophyceae	—	—	0·53-1·27
Miscellaneous	—	3·26	—
Weeds (kg/m^2)	8·37-11·37	8·5-9·6	Nil
Periphyton (u/cm^2)	972-4,897	2,368-5,673	—
Bacillariophyceae (%)	72·83-87·56	73·68-91·25	—
Myxophyceae (%)	8·67-16·53	19·93-23·29	—
Chlorophyceae (%)	11·56-20.13	7·39-15·16	—
Animalcules (%)	3·29-5·67	—	—
Macrobenthos (m^2)	995	563-1,63,644	2,016
Mollusca (%)	52·16		94·79
Diptera (%)	45.73		3·97

PROJECT FC/A/5: ECOLOGY AND FISHERIES MANAGEMENT OF OX-BOW LAKE (*MAUN*) IN GANDAK BASIN (NORTH BIHAR)

Problem:

(*a*) Ecology and productivity of Kanti beel (*maun*)

(*b*) Pen culture in beel (*maun*)

Personnel:

K. P. Srivastava, V. Pathak, B. C. Jha, S. N. Singh and C. Lakra

Duration: 1984-89

Location: Muzaffarpur

Ecology

The Kanti ox-bow lake is divided by an earthen bundh into 2 segments, A and B. Segment B receives the thermal slurry from the thermal plant. Pens were erected in the marginal area of the Segment A enclosing a total area of 0·24 ha. The broad ecological characteristics of both the segments and the pen area are given in Table 17.

Fish landing and estimated production

The landing was largely dominated by the miscellaneous fishes like *Notopterus notopterus*, *Channa punctatus*, *Channa marulius*, *Nandus nandus* followed by catfishes specially *Wallago attu*. Details are given in Table 18.

Pen culture experiment

Two stocking pens of 0·1 ha each and a small nursery pen of 0·04 ha were installed at segment A which is connected with the

Table 18: Data on fish landing from Kanti Ox-bow lake, Muzaffarpur

Month	Estimated total landing in kg	Constituent groups of fishes			
		Major carp	Minor carp	Cat fishes	misc.
April	Nil	Nil	Nil	Nil	Nil
May	675·50	Nil	50·00 (7·4)	37·50 (5·5)	588·00 (87·1)
June	853·24	118·94 (13·94)	56·80 (6·66)	21·50 (2·52)	656·00 (76.88)
July	860·30	34·38 (5·00)	35·53 (4·13)	3·23 (0·37)	787·16 (91·50)
August	—	—	—	—	—
September	1,364·60	67·00 (4·91)	105·00 (7·69)	387·60 (28·40)	805·00 (59·00)
October	1,201·55	199·40 (16·60)	24·05 (2·00)	255·00 (21·22)	723·10 (60·18)
November	753·93	156·73 (20·79)	2·60 (0·34)	159·70 (21·18)	434·90 (57·69)
December	1,019·25	171·75 (16·85)	45·00 (4·42)	465·00 (45·62)	337·50 (33·11)
Total:	6,728·37	748·20 (11·12)	318·98 (4·74)	1,329·53 (19·70)	4,331·66 (64·38)

(Number in parenthesis indicate % abundance).

River Burhi Gandak through a sluice. One pen was stocked @ 5,000 advanced fingerlings/ha of catla, rohu and mrigal at a ratio 3:1·65:0·35. Catla, rohu and mrigal attained an average size of 450·50 g/322·6 mm, 329 g/291·4 mm, 396·67 g/328 mm respectively. The experiment was abandoned due to severe floods.

PROJECT FC/A/6: ECONOMICS OF FISHING—A CASE STUDY OF SELECTED RESERVOIRS

Personnel:

S. Paul, V. V. Sugunan and H. K. Sen

Duration: 1983-88 (Extended by two years)

Location: Barrackpore

More number of reservoirs were added and relevent data were collected, processed and tabulated. The work has been initiated in respect of States of Maharashtra and Madhya Pradesh also. On the basis of available information/data, reservoir fisheries are characterised by low labour productivity (0·26 tonnes per unit of labour per year), income below poverty line, unimaginative exploitation policy, erratic stock management, weak post-harvest infrastructure and lesser involvement of cooperatives/corporation in marketing management. The detailed analysis shall be made only after data gaps are filled.

PROJECT FC/A/7: ECOLOGY AND FISHERIES MANAGEMENT OF FRESHWATER RESERVOIRS

Personnel:

B. V. Govind, P. K. Sukumaran & M. F. Rahman (Bangalore)
P. L. N. Rao
B. K. Singh, V. Kolekar (Pune)
V. R. Desai, N. P. Srivastava, K. K. Agarwal, H. C. Banik (Raipur)
G. K. Bhatnagar, H. P. Singh, D. K. Kaushal, V. K. Sharma (Bilaspur)

Duration: 1987-1992

Location:

Bangalore, Pune, Raipur and Bilaspur

KRISHNARAJASAGAR, BANGALORE

Studies on the ecology and fisheries of 13,200 ha Krishnarajasagar reservoir situated latitude/longitude 12°33′ 20″ E/76°37′ 50″ N near Mysore in Mandya District were initiated in 1987. The reservoir has been constructed on the River Cauvery in the year 1931 with the prime objective of meeting the irrigation demands.

The water level during the period fluctuated from 24·4 to 33·5 (80·00 to 109·59 feet) and the mean fluctuation was (90·19 feet) 27·4 m. The maximum outflow was 7,976 million cubic feet and minimum outflow 3,517 m.cft. ($\bar{x}$: 5,086 m.cft.). The maximum inflow of the reservoir was 12,749 m.cft. and the minimum nil with a mean inflow of 6,434 m.cft. The annual rain fall ranged from 4·4 mm to 244·7 mm with a mean of 72·7 mm.

Chemical features of water

The water was clear. The water temperature ranged from 26·0° to 27·0° celcius. pH ranged from 7·9 to 8·3. The dissolved oxygen varied from 5·0 to 6·5 mg l^{-1}, free carbon dioxide from 84·0 to 88·0 mg l^{-1} and bicarbonate alkalinity from 100·0 to 124·0 mg l^{-1}. The specific conductivity was very low and ranged from 46·0 to 48·0 umhos cm l^{-1}.

Plankton

Plankton samples were collected along with water samples. Zooplankton dominated over phytoplankton. The plankton ranged from 0·001 to 0·002 ml l^{-1} and the total counts from 80 to 240 units l^{-1}. Generally the plankton population was very poor. The qualitative dominance of plankters was *Ulothrix* spp., *Cosmarium* spp., *Brachionus* spp.,

Diaptomus spp. and *Cyclops* spp. in order of preponderance.

Benthic and littoral fauna

The density of littoral fauna in the reservoir ranged from 1-6 $u.m^{-2}$ (0·01-2·37 gm^{-2} by weight). The forms encountered were — Insects: *Cybister limbatus*, *Diplonychus rusticum*, dragonfly, damselfly and mayfly nymphs; molluscs *Melania* (*Plotia*) *scabra*, *Melania striatella tuberculata*, *Vivipara bengalensis* and *Planorbis exustus;* Fish—fry of *Glossogobius giuris;* and prawn—*Macrobrachium* spp.

Fish production

Fish yield was computed from available records. Data on specimens of *Cyprinus carpio* var. *communis* (range—2,000-4,500 g), *Wallago attu* (range—1,000-1,500 g), *Oreochromis mossambicus* (range—0·250-0·400 g), *Glossogobius giuris* and *Salmostoma* spp. were observed at the fish market at Mysore and K. R. Sagar. The total fisherman population dependent on the reservoir is around 1,400. The gears operated for catching the fish are gillnets, castnets, dragnets and long lines.

Cage culture of carps in K. R. Sagar

One of the bays near the dam has been identified wherein cage culture of indigenous and exotic carps will be undertaken.

BHATGHAR RESERVOIR, PUNE

A dam on the river 'Yalwandi', a tributary of Mula-Mutha river which ultimately joins the river Bhima, has caused the formation of Bhatgar reservoir. At the time of inception this dam named as 'Lloyd Dam' and is at present referred to as 'Yesaji Kank Jalashay. The river Yalwandi traverses through the Sahyadri range of Western Ghats and has a length of 45 km upto the dam site. The following are the morphometric details of the dam.

1.	Type of dam	: Soil masonary dam in lime-mortar 1 : 2
2.	Period of construction	: 1912 to 1928
3.	Cost	: Rs. 17·2 million
4.	Length of dam	: 1,625 meters
5.	Max. height of dam	: 58 m
6.	Max. width	: 38 m
7.	Max. height of water	: 43 m
8.	Catchment area	: 336 sq. km.
9.	Rain fall in catchment area	: 625-1,000 mm
10.	Gross storage capacity	: 672·50 MCUM.
11.	Top of dam level	: 626-637 m
12.	F.S.L.	: 623·285 m

Water Wier

1.	Automatic gates	: 45 Nos 2·43 m × 3·04m
2.	Non-automatic gates	: 36 Nos 2·43 m × 3·04 m
3.	Length of spillway	: 325·5 m
4.	Discharge capacity	: 1,600 Cu.m. cs.
5.	Area of reservoir	: 2,800 ha
6.	Minimum area	: 500 ha
7.	Average area	: 1,050 ha

The reservoir has been leased out for its fishing rights once in two years. Gajanan Fishermen Co-operative Society, Bhor, has taken lease of this reservoir since 1987.

The reservoir was arbitrarily divided into three transeverse sectors, *viz.*, lentic, intermediate and lotic. The lotic sector extended from the origin of Yalwandi River upstream to its confluence with the tributary *Pangari* near the village Rajgar—a distance of 10 km. The intermediate zone extends between Rajgar and Brahmanagar 25 km downstream and the lentic zone below Brahmanagar to the dam site. The lotic zone comprises thick adjoining forests with rocky substratum while the intermediate and the lentic zones are considerably deeper with rocky substratum.

Productivity studies

Plankton: Fortnightly samples from the littoral, sub-littoral and the profundal zones were collected and analysed qualitatively. Phytoplankton consisted of Myxophyceae represented by *Microcystis*, *Oscillatoria* and *Spirulina;* Chlorophyceae by *Spirogyra*, *Monogeolia*, *Tribonema*, *Botryoccoccus*, *Ulothrix* and

Oedogonium; Bacillariophyceae by *Synedra, Navicula, Tabellaria, Diploneis, Denticula, Nitzschia, Centronella, Gyrosigma* and *Meridion.* Zooplankton consisted of rotifers, *Asplanchna;* copepods by nauplius, *Cyclops, Diaptomus* and *Canthocamptus* and cladocerans by *Camptocercus, Chydorus, Sinicephalus, Daphnia, Diaphnosoma, Alonella, Bosminopsis* and *Bosmina.*

Fish Fauna

The indigenous fauna of the reservoir comprised 36 species belonging to 9 families. The following species were encountered.

Catla catla, Labeo rohita, Cirrhinus mrigala, C. reba, Labeo calbasu, L. fimbriatus, Tor khudree, Puntius kolus, P. dobsoni, P. sarana, P. sophore, P. ticto, Chela bacaila, Chela sp., *Rohtee cotio, R. vigorsii, Rohtee* sp., *Rasbora daniconius, Aspidoparia morar, Lporcellus, Cyprinus carpio, Barilius bendelisis, Ompok bimaculatus, Ompok* sp., *Mugil corsula, Mastocembelus armatus, Ambassis nama, A. ranga, Mystus aor, M. seenghala, M. cavasius, M. bleekeri, Glossogobius giuris, Notopterus notopterus, Channa marulius* and *C. gachua.*

Fishing gears

The exploitation of fishery in this reservoir is mainly through gill nets and drag nets. The gill nets have a mesh range of 1/2″ to 5″ and are stacked along the width of the reservoir. Drag nets with a mesh range of 1/2″ to 2″ either with or without pocket are operated as shore seines. Cast nets account only for a very minor percentage of the catches.

Fish yield estimates

A total of 23·32 tons of fish were landed from the reservoir (Data collected from the records of the Fishermen Co-operative Society, Bhor). The species-wise catches in order of their abundance are as follows:

Chela sp.: 43·21%; *P. kolus:* 39·89%; *A. morar:* 10·44%; *C. mrigala:* 1·53%; *T. khudree:* 1·48%; *W. attu:* 1·29%; *Ompok* spp.: 0·64%; *P. dobsoni:* 0·62%; *C. catla:* 0·60%; *Mastocembelus* sp.: 0·18%; *Channa* spp.: 0·05%; *M. seenghala:* 0·03%; *L. rohita:* 0·04%.

C. catla, L. rohita, C. mrigala, Tor khudree and *Puntius kolus* together formed 43·54% of the total catches.

A total of 47·1 kg fish caught from 59 gill nets each operating for a period of 12 hours. The catch per unit of effort was worked out to be 0·798 kg.

Reservoir stocking

The State Fisheries Department has stocked the reservoir with major carp fry brought from Calcutta from 1979 onwards. The records on year-wise stocking figures are as follows:

1979-80: 1 lakh; 1980-81: 4·82 lakhs; 1981-82: nil; 1982-83: nil; 1983-84: 1,000 fingerlings; 1984-85: 5,000; 1985-86: 10,000; 1986-87: 25,000.

Fry of *Tor khudree* (5,000 nos.; 35-50 mm) obtained from Lonavala were stocked during the month of September, 1987.

Food & Feeding Habits

Gut content analysis of the most abundant species *viz., P. kolus* and *Chela* were carried out. The former mainly subsisted on organic detritus and the latter thrived *Microcystis* and zooplankters.

RAVISHANKAR RESERVOIR, M.P.

Investigations on the 9,540 ha, Ravishankar Sagar Reservoir built across the river Mahanadi in Madhya Pradesh were initiated since November, 1986.

The reservoir water level during 1987-88 varied between 341·25 m and 343·52 m, the capacity 362·56 m and 495·78 m cu m and rainfall 133·35 and 143 0 mm in October and September '87 respectively.

Fish yield estimation

In October 1987 the fishing of Ravishankar Sagar reservoir was executed only for 17 days, when a total number of 90 gill nets were operated each day by 28 fishermen using 17 boats. During the course of this fishing, a total fish catch of 1,774·30 kg was landed from the reservoir. As compared to the fish catch of September 1987 (1,690 kg), the yield slightly increased in October.

The group-wise fish catch alongwith the respective species shows that among carps, *C. mrigala* (6 97%) was the most dominating followed by *C. catla* (3·31%) and *L. rohita* (0·66%). The carp group as a whole accounted for 11·68% in the total landings. Among catfishes, *M. aor* (30·27%) was represented very significantly with *W. attu* (1·16%) being the only other catfish. The catfish group accounted 31·51% in the total landings. Among 'others' *Channa* sp. (55·23%) was the most predominant and this species alongwith *N. notopterus* also formed a major bulk (56·81%) of the total fish catch of the month. These species were caught by the gears other than the gill nets such as scoop-nets and mosquito netting drag nets. It is, therefore, suggested that the fishermen should be encouraged to resort to the operation of these types of gears also to weed out the undesirable fish species from the reservoir.

GOVINDSAGAR RESERVOIR, H. P.

Water level, inflow and outflow

The water level of the reservoir during the period April to December 1987 fluctuated by 42·98 m from a minimum of 464·5 m (May 1987) to a maximum of 507·48 m (September 1987). The monthly inflow ranged between 3,88,553 ha.m in the month of July to 40,607 ha.m in the month of December. The total inflow during the period was 16,13,868 ha.m. The minimum outflow was in December (1,25,206 ha.m) whereas maximum was in August (1,89,502 ha.m).

Meteorological observation

The water temperature at tail race fluctuated between 17 00°C (April) and 23·10°C (July). The total rain fall during the period was 867·2 mm, maximum being during August (297·0 mm) and minimum being during June (9 2 mm). Maximum atmospheric temperature varied from 38·68°C (June) to 22·86°C (December) to 27·0°C (July).

Physico-chemical characteristics of soil and water

Soil samples from different zones of the Gobindsagar Reservoir had pH towards the alkaline side (7·4); and a poor nutrient level.

The water temperature, transparency, pH, dissolved oxygen, free CO_2, total alkalinity, calcium, magnesium, nitrate, phosphate, silicate and specific conductivity fluctuated between 15·0 and 29·0°C, 39·0 and 456·0 cm, 4·8 and 11·2 ppm, nil and 6·0 ppm, 68·0 and 86·0 ppm, 21·9 and 24·6 ppm, 2·2 and 2·8 ppm, 0·06 and 0·10 ppm, 0·05 and 0·08 ppm, 2·3 and 2·6 ppm and 169·4 and 331·0/umhos/cm respectively. Low temperature and higher values of dissolved oxygen were recorded at Slapper as compared to other observed centres. Generally, free CO_2 was absent at surface or sub-surface and it was observed at higher depths. The lowest transparency was recorded in June due to mixing of snow melt water coming from upper zone alongwith heavy silt. The higher values of nitrate and phosphate were observed in monsoon months.

Thermal and chemical stratifications were observed in Lunkhar khad and lentic zone (Bhakra). In Lunkhar khad, it was observed in April, September and October 1987. In the month of April water temperature dropped from 26 0°C at 4 m and 23·5°C at 6 m depth

showing a fall @ 1·25°C/m. pH and dissolved oxygen were also reduced from 8·2 at 4 m to 7·8 at 8 m and 8·32 ppm to 6·4 ppm respectively. In September, water temperature suddenly dropped from 29·0°C at 6 m to 23·0°C at 8 m depth indicating a fall @ 3·0°C/m. pH and dissolved oxygen also fell from 8·2 to 7·6 and 7·36 ppm to 4·8 ppm respectively at the same depth. In the month of October, water temperature dropped from 29·0°C at 4 m to 24 0°C at 6 m depth. It further went down to 21·0°C at 8 m depth. Dissolved oxygen and pH also fell down substantially.

In lentic zone (Bhakra) in June, water temperature decreased from 25·5°C at 4 m to 23·0°C at 6 m showing a decline @ 1·25°C/m. It went further down to 21·0°C at 8 m depth. pH also dropped from 8·1 at 4 m to 7·7 at 8 m depth. Dissolved oxygen decreased from 7·68 ppm at 6 m to 6·72 ppm at 8 m depth. In August, water temperature fell down from 28·0°C at 8 m to 25·0°C at 10 m depth showing a decrease of 1·5°C/m. pH reduced from 8·1 to 7·9 and dissolved oxygen from 8·64 ppm to 8·0 ppm at the same depth.

Primary organic carbon production

Gross and net organic carbon fluctuated between 300·0 and 750·0 mg C/m³/day and 200·0 and 450·0 mg C/m³/day respectively. The respiration value also fluctuated between 150·0 and 500·0 mg C/m³/day. Depthwise observation reveals that the highest organic carbon production was observed at 1·5 m depth as compared to 0·5 m and 2·5 m depth of incubation.

Plankton

Plankton population of the reservoir during the period showed that its abundance declined from 3,494 units/litre in April to reach a minimum of 430 units/litre in August. Plankton population increased from September onwards to attain a peak in December (2,901 units/litre). Similar was the trend for planktonic biomass which fluctuated from 3·66 ml/m³ in April to 0·92 ml/m³ in August. Lentic zone had comparatively rich plankton population except in April and August when the abundance of plankton was recorded in Lunkhar khad. Plankton population in Lentic zone was estimated to be 1,634 units/litre with 2·24 ml/m³. Lunkhar khad had 1,396 units/litre with 2·43 ml/m³ whereas in lotic zone plankton population was 1,193 units/litre with 0·56 ml/m³.

Qualitatively, phytoplankton were recorded to be dominant over zooplankton *Ceratium* and *Peridinium* dominated during the period April-June while *Ceratium* and *Synedra* were abundant during the period July-September. Other common forms encountered were *Rhizocolonium*, *Staurastrum*, *Cladophora*, *Pediastrum*, *Cyclotella* and *Botryococcus*. Nauplii and *Cyclops* dominated the zooplankton followed by *Keratella*, *Brachionus* and *Hexarthra*.

Plankton samples collected at Slapper (upper reaches of the reservoir) showed distinct difference in qualitative and quantitative composition. The standing crop varied from 262 u/l in May to 100 u/l in July. *Ceratium*, *Mastogloia*, *Pediastrum*, *Cyclotella* and *Cymbella* were the common forms observed.

Macrobenthos

The average standing crop of macrobenthos was maximum in May, 1,379 nos/m² and represented the summer peak. It declined to 99 nos/m² in July and again formed a winter peak in December with 605 nos/m². Thus, it showed a bimodal pattern of distribution. Lunkhar khad was richer in macrobenthos with 715 nos/4·3 g/m² followed by Lentic zone with 509 nos/28·03 g/m² of macrobenthos. Lotic zone was poor in macrobenthos abundance with 227 nos/0·16 g/m². The fauna encountered were *Chironomus*,

Chaoborus, Nais, Limnodrilus, Branchiura, Tubifex, Sphaerium, Pissidium and *Baetis*. Bathymetric distribution of macrofauna showed the greater abundance of fauna at higher depth.

Periphyton

Studies of periphytic communities showed that Bacillariophyceae remained dominant flora both qualitatively and quantitatively (58·0-90·5%). The abundance of Bacillariophyceae followed by Chlorophyceae (4·0-20·5%), Myxophyceae (3·0-20·5%) and animalcules (0·5-11·5%,). The common forms observed were *Melosira, Cymbella, Navicula, Diaptoma, Chaetophora, Ulothrix, Synedra, Vorticella, Chara* and *Difflugia.*

Fish yield

The fish landing records showed that a total of 369·8 tonnes of fish was landed during the period April to December 1987. Thus, a gross yield of 407·0 tonnes was estimated at the rate of 36·02 kg/ha/9 months of fish production, after considering 10% of the total landings as poaching and spoilage. The area of the reservoir was taken to be 11,300 ha. *H. molitrix* dominated the catch forming 61·53%. The catch of silver carp increased during the year as compared to 40·05% in the year 1986. *C. carpio* constituted 17·25% of the total catch followed by *C. catla* (6·76%), *T. putitora* (5.67%), *L. dero* (5·27%), *L. rohita* (1·59%), *C. mrigala* (0·77%), *M. seenghala* (0·50%) and *L. calbasu* (0·46%).

The period from 16.6.1987 to 15.8.1987 was observed as closed season for fishing. Seasonal variations in the catch was evident during the period of May-June, with highest landing of 162·5 tonnes (43·9%).

Zone wise landings showed that maximum fish were landed at Bhakra Centre (lentic zone), forming 64·41% of the total catch from the reservoir. Fish landings at Bilaspur Centre amounted to 20·15% of the total catch while at Lunkhar khad it formed 15·44% of the total catch.

Experimental fishing

Experimental fishing was done by employing eight numbers of gill nets of different mesh bar ranging from 40-150 mm, at Lunkhar khad and lentic zone. At Lathiani an average of 0·212 kg/net/day of fish catch was recorded while at Bhakra 0·109 kg/net/day of fish catch was recorded. Catch of H. *molitrix* dominated in the experiment. Small mesh bar of 45-75 mm were more effective for fishing *L. dero, T. putitora, C. carpio* and *H. molitrix.*

Forecast

The above studies, except experimental fishing, shall be continued in the remaining three months of the year 1987-88. A total of 470 tonnes of fish is expected to be landed during the year 1987-88.

PROJECT FC/A/10: ECOLOGY AND FISHERIES OF THE SMALL RESERVOIR IN ALIYAR BASIN

Personnel:
C. Selvaraj, V. K. Murugesan

Duration: 1985-1990

Location: Pollachi (Tamil Nadu)

The water level varied between 6·51 m (April) and 30·73 m (December) at the minimum level and 10·85 m to 33·96 at the maximum level. The average wind speed was minimum in October (4·35 km/hr) and maximum in August (14·32 km/hr). The total rainfall ranged from 13·0 (October) to 3,549 mm during the period.

The surface water temperature of the reservoir during April, varied from 28·1 to 31·0°C. The D.O. and pH ranged from 6·8

to 8·0 ppm and from 6·5 to 6·7 respectively. While the specific conductivity ranged from 94·0 to 101·0 mmhos cm, the total alkalinity was in the range of 40 to 52 ppm. The free carbondioxide varied between 2·0 and 4·2 ppm. The Ca and Mg were in the range of 8·0 to 10·0 ppm and 5·0 to 6·0 ppm respectively.

The bottom soil was slightly acidic in reaction (pH ranging from 6·0 to 6·3) low in available P_2O_5 (4·2 to 4·8 mh/100 g soil) and medium in organic carbon (1·2 to 1·4%).

The periphytic organisms varied from 7 to 14 units/mm² in the intermediate zone and from 7 to 24 units/mm² in the lentic zone.

The recruitment studies indicated that there was no recruitment of commercially important carps in the reservoir. However, specimens of *Oreochromis mossambicus* and *Tor khudree* made entry into the reservoir along with the inflow water from Parambikulam.

Fish yield

The appropriate management measures taken by the project centre helped to achieve an yield of 16·513 tonnes of fish during the period from April to December, 1987. The average catch per unit of effort per day was 8·42 kg as against 8·02 kg during 1986-87, indicating a good standing crop of fish in the reservoir. With the present trend in high fish landings, it will be possible to harvest another 11·5 tonnes of fish, taking the total fish yield to around 28 tonnes.

Seed raising

The problem of maturation of major carps hitherto faced at Aliyar fish farm was overcome by improving the quality of water in ponds. Periodic manuring and liming of ponds holding brood fish helped to improve the quality of water in terms of high total dissolved salts, pH and alkalinity which in turn helped the brood fish of all the species to attain sexual maturity. In spite of heavy mortality and damage of spawn due to catfishes, 5·75, 14·5 and 1·4 lakhs of spawn of *C. catla*, *L. rohita* and *C. mrigala* respectively were produced. After meeting the spawn requirements of the centre for raising fingerlings for stocking the reservoir, a balance of 3·25 lakh spawn of *C. catla* and 13·2 lakhs spawn of *L. rohita* were handed over to the Tamil Nadu Fisheries Development Corporation Ltd. In addition to major carps, 14 sets of *C. carpio* were also utilized for spawning, resulting in a production of 2·45 lakhs of spawn.

Fry of *C. catla*, *L. rohita*, *C. mrigala*, *H. molitrix* and *C. carpio* were reared in 17 nurseries with a total water spread area of 0·44 ha for raising fingerlings for stocking the reservoir.

Tagging experiments and growth studies

Left pelvic fins in 50 advanced fingerlings each of *C. calta*, *L. rohita*, *C. mrigala* and *C. carpio* were clipped and stocked in the ponds after treating the wound with hydrogen peroxide and furacin to study the percentage survival of fish, the rate of regeneration of clipped fins, the effect of clipping on the growth, etc.

In order to assess the rate of growth of different species in the reservoir, 500 nos. of *L. rohita* fingerlings were also stocked, with their left pelvic fins clipped. The wound was treated with hydrogen peroxide and furacin ointment. It is proposed to stock 500 nos. of *C. catla*, 600 nos. of *C. carpio* and 500 nos. of *C. mrigala*, with their left pelvic fins clipped, during January 1988.

Stocking

A total of 1,71,533 fingerlings consisting of 54,734 catla, 29,842 rohu, 44,973 mrigal, 5,031 silver carp, 36,573 common carp and 380 fimbriatus were stocked in the reservoir.

Biological investigations

Observations on the biology of commercially important carps and trash fishes were made in May-June 1987. The observations are given below: (Table 19).

PROJECT FC/A/12: ECOLOGY AND FISHERIES MANAGEMENT OF PENINSULAR TANKS, NALLIGUDA RESERVOIR

Personnel:

B. V. Govind and P. K. Sukumaran

Duration: 1987-1990

Location: Bangalore

Studies on the ecology and fisheries of Nelligudda reservoir (area: 132 ha) in Bangalore district was initiated in 1987 (August). The impoundment has been formed across River Bidadihalla with the prime objective of meeting the irrigation needs. The details of the reservoir are as follows:

Year of construction	..	1940
River across which constructed	..	Bidadihalla
Catchment area—total	..	28·875 sq. miles
Catchment area—water spread area		11·87 sq. miles
Rainfall	..	30
Rainfall per unit sq. miles assessed		32 units
Total yield from the catchment	..	828 units
Capacity of the reservoir	..	768 units
Submerged area	..	326 acres
Height of the bund deepest portion		55½ ft.
Length of the bund	..	2,140 ft.
Top level of the bund	..	142 ft.
R.L. of river bed	..	86 ft.
Sill of sluice	..	112 ft.
R.L. of waste weir	..	125 ft.
Length of the waste weir	..	150 ft.
Discharge	..	4,140 cusecs
Spillage	..	3 ft.
No. of channals and length	..	1 no. 4 miles
Area proposed to be irrigated	..	1,000 acres
Compensation amount	..	Rs. 64,700·00
No. of acres	..	1. Dry — 202 2. Wet — Nil
No. of villages submerged	..	Nil
Rate of contribution	..	Rs. 125·00/acre
Water rate	..	Rs. 8·00/acre
Estimated cost	..	Rs. 9,14,000/-

Physico-chemical parameters

The water was clear. Water temperature was 27·5-33·0°C; pH 7·5-8·3; dissolved oxygen 4·6-4·8 mg/l^{-1}; Carbon dioxide 88-108; bicarbonate alkalinity 88-140·0 mg-l^{-1}

Table 19: Biology of fishes from Aligar

Species	Nos. observed	Size range (mm)	Sex ratio (Male: Female)	Maturity stage (May-June)	Food composition
Catla catla	5	530-628	3 : 2	II	*
Labeo rohita	18	450-554	1 : 1	IV	*
Cirrhina mrigala	36	505-664	1 : 1	III to IV	*
Puntius filamentosus	63	*	— O +	III to IV	Debris, diatoms and algae
P. mahecola	18	105-140	-do-	-do-	-do-
Mystus malabaricus	57	144-195	O +	II to V	Insect larvae, aquatic insects and debris
P. jerdoni	10	143-192	— O +	II to V	Filamentous algae and debris

*Not recorded.

and the specific conductivity ranged from 98·0-44·0 umhos/cm^{-2}.

Plankton

Surface plankton samples were collected from the reservoir for the analysis. Zooplankton dominated over the phytoplankton. The volume of plankton ranged from 0·1 to 0·3 ml^{-1} and the total counts were between 180 and 590 ul^{-1}. The dominant species encountered were *Microcystis aeruginosa*, *Ulothrix* sp., *Pediastrum* sp., *Ankistrodesmus* sp., *Arcella* spp., *Keratella* spp., *Brachionus* spp., *Filinia* spp., *Diaphnosoma* spp., *Bosmina* spp., *Diaptomus* spp. and *Cyclops* spp.

Littoral fauna

The density of littoral fauna in the impoundment ranged from 1-41 um^{-2} (0·01-5·13 gm^{-2} by wt.). The forms encountered were: Insects — *Laccotraphes maculatus Corixa* sp. and mayfly nymphs; molluscs — *Melania striatella tuberculata*, *M.* (*Plotia*) *scabra* var. *elegana*, *M.* (*Plotia*) *scabra* and *Lamellidens marginalis;* Fish — *Oreochromis mossambicus*, and Prawn — *Macrobrachium* spp.

Benthic fauna

The benthic fauna was represented by *Melania* (*Plotia*) *scabra*. Their number was 133 um^{-2} and the weight being 19·11 g m^{-2}.

Stocking

15,000 fry of exotic *Cyprinus carpio* var. *communis* have been stocked during the period.

PROJECT FC/A/13: A COMPARATIVE STUDY OF PRE-HARVEST AND POST-HARVEST MANAGEMENT PRACTICES OF SELECTED BEELS OF THE COUNTRY

Personnel:

S. Paul and M. Sinha (up to 29.12.87)

Duration: 1987-90

Location: Barrackpore

The work was initiated during middle of 1987. On the basis of preliminary information, fisheries activity emerges as a subsidiary occupation in beels due to overall low productivity and this fact is well reflected in annual income levels of around Rs. 3,901 and Rs. 4,222 per fisherman in case of Mogra and Garapata beels respectively.

PROJECT BF/B/2: ECOLOGY AND FISHERIES MANAGEMENT OF ESTUARINE WETLANDS (BHERIES)

Personnel:

Apurba Ghosh, G. N. Saha, K. M. Das (up to 9.10.87), P. K. Chakraborty, G. N. Chattopadhyay, Amitabha Ghosh, K. R. Naskar, S. K. Mandal, A. Hajra, R. K. Das, A. C. Nandy, S. C. Thakurta, G. C. Laha, P. K. Ghosh, N. N. Mazumder, P. B. Das, S. K. Chatterjee and L. K. Parbat

Duration: 1986-1990

Location: Barrackpore

Conditions of sewage-fed wetlands were simulated in a 0·17 ha impoundment by feeding with sewage effluents at 50% dilution rate and stocking with tilapia and common carp. The impoundment was completely cleaned of carnivorous fishes and was stocked with tilapia @1000/ha in September 1987 and then with *Cyprinus carpio* @240/ha in December. Tilapia is being allowed to multiply so as to obtain various size groups for experimentation on the predatory efficiency of *Lates calcarifer* to be introduced later. *Eichhornia* infestation was only partially

cleared so as to facilitate the breeding of *C. carpio*. Another impoundment of 0·08 ha is also being prepared on similar lines in order to ascertain the predatory preference of bhetki in the usual polyculture operations adopted in sewage-fed wetlands around Calcutta.

Studies on the biotic communities in these impoundments revealed the dominance of *Cyclops* sp., *Moina* sp. and *Brachionus* sp. amongst zooplankters and *Oscillatoria* sp. *Spirogyra* sp., *Synedra* sp., *Closterium* sp. and *Coelestrum* sp. amongst phytoplankters. The average density of plankton was 0·3 ml/ 50·1 of water. The ratio between zooplankton and phytoplankton varied from 4: 1 to 1: 4 approximately during the year.

Chironomid larvae, tubificid worms and odonate nymphs were abundant among bottom fauna. Other forms encountered were *Lamellidens* sp. and *Vivipara* sp. *Spirogyra* and *Lyngbya* were the principal bottom algae.

The Titagarh impoundment was characterised by pH ranging between 7·4 and 8·8, moderately high alkalinity values (118·0 to 218·0 ppm), D.O. range of 0·8-10·4 ppm., high water soluble P (between 1·5 and 2·2 ppm) and 0·8 and 4·5 ppm nitrogen.

Gut analysis of *Scatophagus argus* collected from Minakhan-Malancha wetlands exhibited predominance of *Phormidium* sp. and *Oscillatoria* sp. among the food items.

Besides Minakhan-Malancha wetlands (sewage influenced saline wetlands under rice-based aquasystem) investigations were continued at three ecologically distinct wetland non-saline areas, *viz.*, Salt Lake (adjacent to Calcutta receiving raw sewage), Bantala (5 km from Calcutta, receiving sewage of moderate concentration) and Handipata (10 km from Calcutta receiving sewage of low concentration).

Studies on the biotic communities of these wetlands showed dominance of *Lyngbya* sp., *Amphora* sp., *Brachionus* sp., *Keratella* sp. *Oscillatoria* sp. was the common alga of the entire wetland except the Handipota region. Average plankton concentration was 0·27 cc and 0·41 cc per 50 litres of water in non-saline and saline wetlands respectively.

Among the benthic forms the dominance of *Lyngbya* sp., *Closterium* sp., *Amphora* sp. and *Vivipara* sp. were observed in all the zones.

Dominance of *Oscillatoria* sp. *Merismopedia* sp. and to some extent of *Lymnaea* sp. and *Indoplanorbis* sp. were observed in the strong and moderate sewage influenced wetlands of the non-saline areas. *Anabaena* sp. *Nostoc* sp., *Enteromorpha* sp., *Gyrosigma* sp., *Pinnularia* sp. and *Cocconeis* sp. among phytoforms and *Gammarus* sp., teneids, nematodes among zooforms mainly occurred in the saline wetlands.

Due to intensive fishing activity at Salt Lake and Bantala wetlands, the weed infestations were scanty. Handipata wetlands were heavily infested with *Vallisneria spiralis* that even grass carp stocked at 500/ha failed to control the weed. However, this was checked through secondary infestation of *Eichhornia* sp.

In Minakhan-Malancha wetlands following denudation some halophytes and other flora only remained. Common halophytic grasses and sedges of the area comprised *Apluda mutica, Diplachna fusca, Eragrostis tenella, Myriostachya wightiana, Paspalum disticlum, Pragmites kakra, Sporobolus diander, Cyperus exaltalus, Fimbristylis complanato.*

Chemical properties of different wetlands rceiving Calcutta sewage at various states of concentrations have been studied. The values D.O. and pH for the year were 4·0-20·0 ppm, 7·5-8·8 respectively. In the Minakhan plot where water-diluted sewage effluent was utilised for rice-fish culture, pH was as high as 11·9 during the end of October, when the main plot was almost dry and total alkalinity 58·0-270·0 ppm. N values were

generally higher in the impoundments receiving Calcutta sewage directly than that in the impoundments receiving estuarine water mixed with sewage effluents. Water soluble P, during the summer months, has observed to occur in higher amounts in the rice-fish culture plots. During the monsoon period, the amount of P in river water declined and more amount of water soluble P was observed in the raw sewage-fed impoundments. The P existed in very low level in the water. In the wetlands receiving estuarine water-mixed sewage effluents, a salinity cycle assuming EC_e values as high as 27·0 mmhos/cm during summer and as low as 3·8 mmhos/cm during monsoon was observed. A standard rice production of 3 t/ha was achieved in the same plot after brackishwater phase.

Microbiological investigations

During April, 1987, microbiological investigations have been carried out in various sewage-fed non-saline and saline wetlands in respect of heterotrophic bacteria, phosphate solubilizing bacteria and actinomycetes. The results indicate that bacterial density of these groups is a function of the sewage concentration in water while in the sediment it varies also with the soil texture. Thus, Captains Bheri showed lesser bacterial density than that of Bantala in the bottom sediment.

The results obtained in October indicate that these wetlands are having both oxygen and nutrients insufficient quantity to support a high rate of production of fish food organisms.

SUB-PROJECT: **Ecology and fishery management of estuarine bheries**

Duration: 1982-1989

Location and site of the Sub-Project:
Calcutta

Ecological studies of bheri ecosystems under different saline regimes have been made to assess the effect of important chemical parameters on fin and shell-fish production. Monthly observations were made on six selected bheries of sizes 7·0-33·0 ha, two in each saline zone, namely low saline (Kharibari and Deyganga), medium saline (Hashnabad and Kulti) and high saline (Golabari and Nazat).

The data on physico-chemical parameters of water and soil samples are presented in Table 20 and on plankton, benthic fauna and fish and prawn production in Table 21.

BIOLOGICAL PRODUCTION

Plankton

The plankton density varied to a great extent in bheries under three saline regimes. Total plankton was recorded maximum (4236 u/l) in October in high saline bheri at Nazat while minimum (12 u/l) in May in medium saline bheri at Hasnabad.

Benthic fauna

The benthic fauna was encountered richer in low saline bheri at Kharibari as 400-1110 u/m^2, but poorer in medium saline bheri (170-370 u/m^2) at Hasnabad.

Fish and prawn production

Total fish and prawn production was recorded much higher in high saline bheries. The poorest production of both fish and prawn was recorded in Kulti bheri which is subjected more to sewage pollution. Both freshwater fishes (*Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio* and *Tilapia mossambicus*) and brackishwater fishes (*Liza parsia* mainly) along with *Penaeus monodon* and other prawns were countered in medium and low saline bheries while in high saline bheries brackishwater fishes (*Liza parsia,*

Table 20: Water and soil qualities of estuarine bheries under different saline zones

WATER—

Saline zone	Location of bheries	pH	CO_2 ppm	DO ppm	Total alkalinity	Phosphate (P_2O_5) ppm	Nitrate (NO_3-N) ppm	Salinity ppt.
Water	Kharibari	7·4-8·3	7·8-16·3	4·6-6·2	96·0-148·0	Tr.-·16	·08-·38	0·9-5·4
Low	Deyganga	7·4-7·6	5·2-10·8	4·2-5·2	78·0-148·0	0·2-·40	·07-·25	0·3-6·8
Medium	Kulti	7·4-8·0	7·8-17·3	3·0-4·2	84·0-134·0	0·2-·06	·09-·43	1·6-10·8
	Hashnabad	7·3-7·7	4·6-12·1	4·5-5·6	86·0-152·0	0·10-·32	·06-·21	0·9-11·6
High	Nazat	7·4-7·8	1·6-5·6	4·2-5·6	74·0-130·0	Tr.-·20	·06-·19	1·4-20·1
	Golabari	7·4-7·8	Tr.-1·8	4·4-6·2	72·0-148·0	Tr-14	04·13	11·7-28·9

SOIL—

		pH	E. C. m.mhos²/cm	Organic carbon (%)	Av. Phosphorus mg/100 g	Av. Nitrogen mg/100 g
Low	Kharibari	7·4-7·5	0·71-3·6	·3-·5	3·2-4·6	9·2-14·2
	Dehganga	7·4-7·5	0·05-3·3	0·26-0·48	3·2-4·8	8·4-11·3
Medium	Kulti	6·8-7·4	0·81-6·1	0·32-0·49	3·4-5·2	11·2-14·8
	Hashnabad	7·5-7·6	0·9-6·1	0·21-0·32	1·41-2·68	7·7-9·8
High	Nazat	7·4-7·5	1·0-11·1	0·32-0·34	3·2-4·8	8·3-9·2
	Golabari	7·0-7·5	10·3-16·4	0·21-0·26	4·8-5·6	6·8-7·3

Table 21: Plnkton, bottom fauna, Fish and prawn production in estuarine bheries

Saline zones	Location of Bheries	Plankton		Bottom fauna (Units/m²)	Fish and prawn production (kg/ha/yr.)	
		Volume (cc/50 1)	(Units/m²)		Total	*P. monodon*
Low	Kharibari	Tr. -2cc	156-1,046	400-1,110	425·00	247·00
	Deyganga	Tr. -0·2cc	78-260	170-370	386·00	32·00
Medium	Kulti	Tr. 0·6cc	84-348	240-440	101·00	17·00
	Hashnabad	Tr. -0·2cc	12-318	50-590	344·00	96·00
High	Golabari	Tr. -0·1cc	98-418	140-730	1,180·00	585·00
	Nasat	Tr. -6cc	168-4,236	90-900	835·00	294·00

Liza tade, *Lates calcarifer* and *Tilapia mossambicus* along with *Penneus mondon* and others were recorded.

Maximum survival of *P. monodon* post larvae was recorded in high saline bheri (87%) and minimum in low saline bheri (48%) at salinity range of 10·0-13·5 ppt and 2·8-4 8 ppt respectively.

Qualities of ingress tidal water

Studies on tidal water drawn into bheri for fish raising revealed that the water source (Bidyadhari Khal, Kulti River System) feeding low and medium saline zones are contaminated with sewage effluents. As a result, the B.O.D. level and free NH_3 concentration were recorded higher in the above zone, maximum values being as 42·0 ppm and 4·5 ppm respectively on ingress water of Kulti bheri. These values were minimum (6·0 ppm and 0·06 ppm) in ingress water (Matla River) of high saline bheri at Golabari at lower stretch.

Seed abundance

The availability of commercial and non-commercial species of seed in ingress water bheries was monitored by operating shooting nets at different centres. *P. monodon* post larvae were recorded at Malancha and Hasnabad (medium saline zone) and Golabari and Nazat (high saline zone), but not at Kharibari and Deyganga (low saline zone) and Kulti.

The abundance of *P. monodon* post larvae was low (1-11/net/hr). Other commercial prawns such as *Palaemon styliferus*, *Metapenaeus monoceros* and *Metapenaeus brevicornis* were encountered in all centres. Commercial fishes like *Liza parsia* and *L. tade* were recorded in high and medium saline centres excepting Kulti. Non-commercial fish and prawn seed were recorded maximum at Nazat (502/net/hr.) and minimum at Golabari (35/net/hr.).

PROJECT BF/B/3: ECOLOGY AND FISHERIES OF HOOGHLY-MATLAH AND KULTI ESTUARINE SYSTEMS

Personnel:

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Duration: 1983-90

Location:

Barrackpore, Canning, Diamond Harbour, Digha and Uluberia

Sub-Project-I: **Assement of fishery resources biological investigations and stock recruitment studies and monitoring of ecological paramenters of the estuarine systems**

SAMPLE SURVEY FOR ESTIMATION OF CATCH AND EFFORT

Total Fish Landings

Estimated total landings for the period November 1987 to January 1988 from the Hooghly estuary amounted to 25,900·4 t. The major share of these landings (92%) came from the winter migratory bag net fishery during November 1987 to January 1988 with an average CPUE of 156·47 kg. Winter bag net fishery during 1987-88 was

much higher as compared to 1986-87 (a lean year for winter fishery) and about 22% higher compared to average catch reported during 1984-85 to 1985-86. Dominant fish species *viz.*, *H. nehereus*, *Setipinna* spp., *P. pama*, *Trichiurus* spp., *Coilia* spp. and the miscellaneous varieties of prawns accounted for 65% of the total bag net winter landings.

Zone-wise and month-wise Catch structure

The lower estuarine zone alone accounted for almost 87% of the total fish landings. Upper estuarine (Zone I), middle estuarine (Zone II) and the Rupnarayan tributary (Zone IV) accounted for 5, 4 and 4% of the total catch respectively. Zone-wise monthly catch distribution is presented in Table 22.

Species composition

In order of abundance, *Harpodon nehereus*, *Hilsa ilisha*, *Trichiurus* spp., *Setipinna* spp., *Pama pama* and various species of prawns constituted the dominant fishery of the estuary accounting for nearly 10,833·7 t (55%) of the total catch. Fish and prawn species which contributed the bulk catches in 1985-86 and 1986-87 are presented in Table 23.

Hilsa fishery

Without taking into account the winter bag net fishery, *H. ilisha* formed the mainstay of the estuarine fishery contributing 1,935·3 t (16·6% of the total catch) compared to 2,252·7 t during 1985-86 exhibiting thereby a slight decrease of 317·4 t. However, the hilsa catch in 1986-87 was well above (35%) the average annual hilsa catch reported during 1982-85. Dominance of large-sized fishes in the length range of 23 to 52 cm representing 3rd, 4th and 5th year age-groups with a mean length of 38·5 cm was the striking feature of monsoon hilsa fishery. This indicates that there was no significant

TABLE 22 Zone-wise total catch (in t) in different months

Months / Zones	Nov. 86	Dec. 87	Jan. 82	Feb. 87	Mar. 87	Apr. 87	May 87	June 87	July 87	Aug. 87	Sept. 87	Oct. 87	Total	%
I (Upper estuary-Nabadwip to Calcutta)	48·5	45·2	43·9	46·3	66·2	51·8	43·4	52·9	65·3	153·5	117·7	164·8	899·5	4·54; 7·71*
II (Mid estuary-Calcutta to Diamond-Harbour)	69·8	27·5	30·6	108·1	89·3	77·7	102·4	58·2	109·3	103·2	68·3	20·4	864·8	4·32; 7·41*
III (Lower estuary)	6,324.1 (2,064·3)*	3,588·6 [(1,762·6)*	4,388·9 (2,348·9e*	1,095·5	378·2	60·0	79·1	127·4	111·8	302·0	448·5	422·6	17,326·7 (9,200·9)*	87·52; 78·83*
IV (Rupnarayan)	103·8	63·6	67·1	81·6	49·8	31·6	61·1	45·4	51·6	30·9	23·2	97·2	706·9	3·57; 6·06*
Total	6,546·2 (2286·4)*	3,724·9 (1,898·9)*	4,530·5 (2,490·5)*	1,331·5	583·5	221·1	286·0	283·9	338·0	589·6	657·7	705·0	19·797·9 (11,672·1)*	100·00; 100·01
%	33·06; 19·58*	18·81; 16·27*	22·88; 21·34*	6·73; 11·41*	2·95; 5·00*	1·12; 1·89*	1·44; 2·45*	1·43; 2·43*	1·/7/1; 2·90*	2·98; 5·05*	3·38; 5·63*	3·33; 6·04*	3·6;	100·00, 99·99

*Excluding winter fishery.

Table 23: Contribution of dominant fish species and prawns (in t) to the total estuarine fish catch

Name of the species	Contributio to total catch		% in the total catch		Contribution to total catch excluding winter fishery		% of Col. 6	% of Col. 7
	Nov. 86-Oct. 87	Nov. 85-Oct. 86	Nov. 86-Oct. 87	Nov. 85-Oct. 86	Nov. 86-Oct. 87	Nov. 85-Oct. 86		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Hilsa ilisha	1,935·3	2,252·7	9·8	8·5	1,934·9	2,252·7	16·6	25·4
Pama pama	1,090·8	3,908·4	5·5	14·8	805·1	354·4	6·9	4·0
Setipinna spp.	1,196·5	2,055·8	6·0	7·8	356·1	192·3	3·0	2·2
Trichiurus spp.	1,451·3	1,473·0	7·3	5·6	139·1	64·4	1·2	0·7
Harpodon nehereus	2,596·5	5,197·7	13·1	19·7	316·7	261·7	2·7	3·0
Tachysurus jella	366·6	702·3	1·9	2·7	345·2	479·1	3·0	5·4
Stromateus cinereus	351·8	344·4	1·8	1·3	225·1	236·3	1·9	2·7
Polynemus paradiseus	141·4	106·5	0·7	0·4	134·9	93·9	1·2	1·1
Coilia spp.	536·7	479·1	2·7	1·8	349·5	86·6	3·0	1·0
Ilisha elongata	288·3	315·7	1·5	1·2	176·8	115·6	1·5	1·3
Sciaena biaduritus	92·6	602·3	0·5	2·3	20·4	32·9	0·2	0·4
Polynemus indicus	147·2	31·0	0·7	0·1	147·2	28·8	1·2	0·3
Prawns	2,563·5	1,892·4	12·9	7·2	1,421·9	675·8	12·2	7·6
Others	7,039·4	7,074·3	35·6	26·8	5,299·3	3,979·7	45·5	44·9
Total:	19,797·9	26,435·6	100·0	100·2	11,672·2	8,854·2	100·1	100·0

variation in the stock structure of hilsa catches from the Hooghly estuary. Zone-wise total hilsa catch, effort, CPUE by different hilsa gears in 1986-87 and 1985-86 are presented in Table 24.

Winter migratory bag net fishery

The total estimated winter migratory bag net fish landings during mid-October 1986 to early February 1987 were recorded to be 8,125·8 t, forming about 41% of the total estuarine catch with an average CPUE of 83·37 kg as against 17,581·4 t with an average CPUE of 151·8 kg during the last winter. Severe cyclonic storm and heavy rainfalls in early winter of 1986 resulting in the closure of a number of fishing camps, loss of nets, boats and fishermen in Jamboodwip complex mainly accounted for the drastic fall (over 100%) in the winter bag net catches. The appearance of jelly fish shoals in the coastal waters also restricted the operation of bagnets resulting in lesser effort compared to 1985-86. Dominant species *viz.*, *H. nehereus*,

Table 24: Zone-wise total hilsa catch, effort, CPUE by different hilsa gears in 1986-87 and 1985-86

Zone	Gear	Catch (kg)		Effort (net tides)		CPUE (kg)	
		1986-87 (Nov.-Oct.)	1985-86 (Nov.-Oct.)	1986-87 (Nov.-Oct.)	1985-86 (Nov.-Oct.)	1986-87 (Nov.-Oct.)	1985-86 (Nov.-Oct.)
I	Purse seine	32,581	13,945	67,794	43,227	0·48	0·32
	Drift gill net	2,06,186	78,539	3,21,432	2,62,297	0·64	0·30
	Set gill net	41,982	20,062	26,438	17,588	1·59	1·14
	Bag net	16,943	7,710	—	—	—	—
	Small seine	435	1,076	—	—	—	—
	Total:	2,98,127	1,21,332	—	—	—	—
II	Drift gill net	5,10,635	2,09,529	3,20,277	2,19,351	1·59	0·96
	Bag net	3,931	1,039	—	—	—	—
	Others	441	—	—	—	—	—
	Total:	5,15,007	2,10,568	—	—	—	—
III	Drift gill net	6,41,191	16,39,558	—	—	—	—
	Large seine	3,01,367	87,922	—	—	—	—
	Others	14,370	40,500	—	—	—	—
	Total:	9,56,928	17,67,980	—	—	—	—
IV	Drift gill net	1,43,052	1,50,732	1,43,358	1,52,005	1·00	0·99
	Bag net	21,918	2,121	—	—	—	—
	Others	257	—	—	—	—	—
	Total:	1,65,227	1,52,853	—	—	—	—
	Grand Total:	19,35,289	22,52,733	—	—	—	—

P. pama, *Setipinna* spp., *Trichiurus* spp. and prawns accounted for about 74% of total bagnet winter landings (Table 25). Centre-wise catch, effort and CPUE in respect of winter migratory fishery during 1986-87 are shown in Table 26.

Gear-wise composition of catch

Bag nets and drift gill nets constituted the most dominant gears in the entire estuary accounting for 76% of the total catch (Bag nets 49%, gill net 27%). Gear-wise composition of catch for different zones is presented in Table 27.

Bag net fishery

Zone-wise bag net catches, effort, CPUE other than winter migratory bag net fishery are shown in Table 28 indicating an increase in catch and CPUE than in the preceding year.

Table 25: Contribution of dominant fish species and prawns (in t) in winter migratory bag net fishery in lower estuary during mid October 1986 to early February 1987 and mid October '85 to early February '86

Name of the species	Contribution to total catch		% in the total catch	
	1985-86	1986-87	1985-86	1986-87
Harpodon nehereus	4,936·0	2,279·8	28·1	28·1
Pama pama	3,554·0	285·8	20·2	3·5
Setipinna spp.	1,863·5	840·4	10·6	10·3
Trichiurus spp.	1,408·6	1,312·1	8·0	16·1
Sciaena biauritus	569·4	72·3	3·2	0·9
Coilia spp.	392·5	187·3	2·2	2·3
Tachysurus jella	223·2	21·4	1·3	0·3
Ilisha elongata	200·1	111·5	1·1	1·4
Stromateus cinereus	108·1	126·6	0·6	1·6
Polynemus paradiseus	12·6	6·6	0·1	0·1
Prawns	1,216·5	1,141·6	6·9	14·0
Others	3,096·9	1,740·4	17·7	21·4
Total:	17,581·4	8,125·8	100·0	100·0

Significant findings

(*a*) Analysis of variance for percentage contributions of catch from different zones over the years (1981-82 to 1986-87) was taken up after introducing *arc sine* transformation. Although ANOVA has indicated highly significant differences between zones, no significant differences were observed between Zones I, II and IV. The variations so far encountered in the total landings over the years excluding winter fishery catch do not show significant differences.

(*b*) Estimated variances for an assembly centre (Canning) in lower estuary were calculated for different sample sizes. Optimum sample size was worked out as 6 days in a month considering both costs and variances.

Estuarine fish and prawn seed prospecting

Investigations on the estuarine prawn and fish seed abundance from Frazerganj Centre of Hooghly estuarine system have been made during 1987. It is revealed from the analysis of shooting net collections from this centre that important cultivable species of prawn and fish seed like *Penaeus monodon*, *P. indicus*, *Metapenaeus brevicornis*, *M. monoceros*, *Liza parsia* and *Eleutheronema tetradactylum* were available. The maximum numbers of seed collected per net per hour were as follows: 514, 105 and 280 of *P. indicus* in March, April and November; 75 and 184 of *P. monodon* in April and May; 127, 41 and 155 of *M. brevicornis* in April, May and June; 29, 33 and 25 of

Table 26: Centre-wise catch, effort and CPUE in winter migratory bag net fishery in lower estuary during 1986-87

Centre	Estimated catch (t)				Estimated effort (net-tides)				CPUE (Kg)		
	Mid. Oct. & Nov. 86	Dec. 86	Jan. early Feb. 86	Total	Mid. Oct. & Nov. 86	Dec. 86	Jan. & early Feb. 87	Total	Mid. Oct. & Nov. 86	Dec. 87	Jan. & early Feb. 87
Frazergunj	166·5	130·5	104·5	401·5	2,770	2,807	3,338	8,915	60·11	46·49	31·31
Bokkhali	191·0	322·5	281·8	795·3	2,384	2,774	3,129	8,287	80·12	116·26	90·06
Upper Jamboo	2,025·3	417·6	570·3	3,013·2	9,771	6,537	5,959	22,267	207·28	63·88	95·70
Lower Jamboo	735·3	499·3	448·8	1,683·4	5,476	4,996	5,780	16,252	134·28	99·94	77·65
Kalisthan	662·4	280·4	590·0	1,532·8	3,903	2,595	5,932	12,430	169·72	108·05	99·46
Sagardwip	479·2	175·7	44·7	699·6	15,319	10,109	3,886	29,314	31·28	17·38	11·50
Total	4,259·7	1,826·0	2,040·1	8,125·8	39,623	29,818	28,024	97,465	107·51	61·24	72·80
									Av. CPUE:	83·37	

Table 27: Gearwise zonal catch (in t) during November '86 to October '87

Gear	Zone I	Zone II	Zone III		Zone IV	Total		% in the total catch	
			Including winter fishery	Excluding winter fishery		Including winter fishery	Excluding winter fishery	Including winter fishery	Excluding winter fishery
Drift-gillnet	296·1	561·1	4,272·8	4,272·8	143·0	5,273·0	5,273·0	26·63	45·18
Bag net	185·4	298·2	8,721·6	595·8	558·8	9,764·1	1,638·3	49·32	14·04
Trawl net	66·2	—	—	—	—	66·2	66·2	0·33	0·57
Small Seine	2·3	0·2	380·6	380·6	—	383·1	383·1	1·94	3·28
Large Seine	—	—	3,211·3	3,211·3	—	3,211·3	3,211·3	16·22	27·51
Purse Seine	32·6	—	—	—	—	32·6	32·6	0·17	0·28
Set-gill net	42·0	—	—	—	—	42·0	42·0	0·21	0·36
Set-berrier	75·0	2·9	42·0	42·0	4·7	124·6	124·6	0·63	1·07
Lift	105·5	0·2	—	—	—	105·7	105·7	0·53	0·90
Hooks & Lines	—	1·5	16·8	16·8	0·4	18·7	18·7	0·09	0·16
Cast net	45·7	—	—	—	—	45·7	45·7	0·23	0·39
Trap net	48·7	—	—	—	—	48·7	48·7	0·25	0·42
Unclassified & unknown	—	0·6	681·6	681·6	—	682·2	682·2	3·45	5·84
Total	899·5	864·8	17,326·7	9,200·9	706·9	19,797·9	11,672·1	100·00	100·00

Table 28: Zonewise total bag net catch, effort and average CPUE in 1986-87 and 1985-86 excluding winter fishery

Zone	1986-87			1985-86		
	Catch (kg)	Effort (net tides)	Average CUPE (kg)	Catch (kg)	Effort (net tides)	Average CPUE (kg)
I	1,85,432	32,270	5·75	1,51,843	32,607	4·66
II	2,98,267	86,904	3·43	2,80,826	1,27,997	2·19
III	5,95,783	—	—	3,57,819	—	—
IV	5,58,778	1,10,586	5·05	4,52,872	1,10,957	4·08
Total	16,38,260	—	—	12,43,360	—	—

M. monoceros in March, April and May respectively, 25 of *E. tetradactylum* in March. The seeds of *P. indicus*, *P. monodon*, *M. brevicornis*, *M. monoceros* and *E. tetradactylum* were available during the period of higher salinity (15·9-22·7 ppt) and moderately higher water temperature (27·0°-30·0°C).

Biological studies on *Hilsa ilisha*

The age and growth studies of hilsa indicated that the species attained an average length of 173·9 mm, 275·5 mm, 357·1 mm, 422·6 mm, 475·1 mm and 517·3 mm during the 1st, 2nd, 3rd, 4th, 5th and 6th years of age respectively. The different growth parameters were found as under:

L_∞ =688 61 mm, K=0·220, t_0= —0·323

The von Bertalanffy's growth equation was estimated to be $L_t=688{\cdot}61\ [_{1-e}-0{\cdot}220\ (t+0{\cdot}323)]$.

The instantaneous mortality rate, Z, pooled for all age groups above one year was estimated to be 1·117. The annual mortality and survival rates were estimated as 0·673 and 0·327 respectively.

Specimens of *Polynemus paradiseus* from the Hooghly estuary and Rupnarayan river were examined in detail for various biological parameters. The species has shown a distinct carnivorous feeding behaviour, with a preference to prawns, particularly *Metapenaeus* group. The young *P. paradiseus* (20-65 mm), available upstream upto Khasbati in Hooghly estuary and around Kolaghat in river Rupnarayan were found to be mainly planktophagous (zooplankton). Occasionally, they were observed to feed upon prawn post-larvae. Abundance of juveniles of *P. paradiseus* in both Hooghly estuary and Rupnarayan river were observed to have direct relation with lunar periodicity indicating their maximum availability during fullmoon and newmoon phases of monsoon months. Fecundity ranged between 16,821 and 22,206 for the fishes in the size range of 170-181 mm TL and 40-44 g wt. The number of ova varied from 2,649 to 3,862 per gram of ovary weight.

Plankton population in Hooghly—Matlah estuarine system

The population density and distribution of plankton species indicated their maximum

abundance in marine zone (av. 464 nos./l), followed by the gradient zone of Rupnarayan River (av. 138 nos./l), Matlah estuary (av. 93 nos./l) and Hooghly estuarine stretch (av. 69 nos./l). Qualitatively plankton population in marine zone was characteristically different from the rest of the estuarine stretches and mainly comprised herpacticoid copepods like *Longipeda* sp. and *Enterpina* sp. and the diatoms represented by *Melosira* sp. and *Coscinodiscus granii*. Both Rupnarayan and gradient stretch of Hooghly estuary had a mixed population of freshwater and estuarine plankton forms while Matlah estuary maintained an estuarine population of plankton throughout the year.

Bottom biota

Benthic population in upper zone (Nurpur to Hajinagar) of the Hooghly estuary and Rupnarayan River ranged between 3,556 nos./m^2 and 12-132 nos./m^2 respectively. The dominant organisms in both the stretches were gastropods (*Pleurocerca* sp.), oligochaete and polychaete worms and dragonfly nymphs. The maximum density of the bottom biota was observed around the pulp and paper waste discharge point.

Hydrological investigations

Freshwater zone in the Hooghly estuary extended upto Uluberia (max. 0·034 ppt salinity). A gradual increase in salinity was reflected thereafter at Nurpur (max. 2·709 ppt) and gradient salinities were observed at Kakdwip (max. 17·662 ppt) which was found to be slightly lesser than that of last year (max. 18 604 ppt). Highest salinity values were observed at Digha (max. 27·530 ppt).

The pH values ranged from 7·6-8·5, DO from 4·5-8·8 ppm, turbidity from 85-1,000 units, total alkalinity from 51-169 ppm, salinity from 0·014-27·530 ppt, sp. conductivity from 132-26,954 micromhos/cm, hardness from 49-4,737 ppm, nitrate from Tr-0·1 ppm, phosphate from Tr·0·4 ppm & silicate from 323 ppm in the Hooghly-Matlah-Rupnarayan estuarine ecosystem.

Primary productivity studies indicated lower organic production in the mid-stretch of the Hooghly estuary between Kuntighat and Nawabgunj lying in the industrial belt (max. GP: 46·87 mg C/m^3/hr; max. NP: 31·25 mg C/m^3/hr) and comparatively higher production was observed both in the upper non-industrial stretch (max. GP: 110·94 mg C/m^3/hr; max. NP: 97·65 mg C/m^3/hr) between Nabadwip and Medgachi and also in the lower non-industrial stretch (max. GP: 89·84 mg C/m^3/hr; max. NP: 54·68 mg C/m^3/hr) between Uluberia and Kakdwip. Highest values were recorded in the marine zone at Digha (max. GP: 166·7 mg C/m^3/hr and max. NP: 125·0 mg C/m^3/hr) and Sagar (max. GP: 171·87 mg C/m^3/hr; max. NP: 137·50 mg C/m^3/hr). At Port Canning (Matlah estuary, max. GP: 156·25 mg C/m^3/hr; max. NP: 125·0 mg C/m^3/hr) and at Kolaghat (Rupnarayan estuary, max. GP: 132·8 mg C/m^3/hr & max. NP: 78·12 mg C/m^3/hr) were also recorded.

Soil characteristics in the entire stretch studied indicated a variation of pH from 7·1-8 0, organic carbon (%) from 0·024-0·52, total nitrogen (%) from 0 025-0·054 and C/N ratio from 3·9-15·3 respectively.

Hydrological studies were conducted at lower Sunderbans during winter at six sampling centres, namely, Frazergunj, Bokkhali, Kalisthan, Sagar, upper & lower Jamboo in the lower Sunderbans and the results are given below.

The pH values ranged from 7·5-8·5, DO from 6·0-10·0 ppm, turbidity from 85-1,000 units, total alkalinity from 86-132 ppm, salinity from 10·552-25·635 ppt, specific conductivity from 3,999-24,662 micromhos/cm, hardness from 1,199-4,437 ppm, nitrate from

Tr-0·1 ppm, phosphate from 0·04-0·4 ppm and silicate from 3-16 ppm in the entire stretch under study.

Sub-Project-II: **Studies on the impact of industrial, agricultural and metropolitan wastes on estuarine environment in West Bengal.**

Water quality studies

The effluents from IPP, Hajinagar showed much higher values of chloride (max. 133 mg/l), hardness (max. 500 mg/l), alkalinity (max. 224 mg/l) and BOD (max. 230 mg/l) as compared to their ambient levels in the estuary. The stretch within 1 km below the IPP outfall indicated pronounced organic pollution (BOD: 40-130 mg/l). Effluents drained from Bandel Thermal Plant showed higher chloride (max. 40 mg/l) and alkalinity (max. 260 mg/l) compared to estuarine water. Rise of 6·5°C in water temperature was noted at Bandel Thermal Power Plant outfall during summer and rise of 5·5-6·0°C during winter above the ambient temperature of the estuarine water. The marginal stretch above the outfall was affected by the drainage of pulp & paper mill effluent as reflected by comparatively higher pH, absence of DO and faint brownish colour of the water.

Gross organic production within 1 km stretch, above and below the outfall of BTP and IPP ranged between nil-41·68 (av. 20·1 mg C/m³/hr) and nil-62·5 (av. 28·12 mg C/m³/hr) and net organic production varied between nil-20·84 (av. 9·9 mg C/m³/hr) and nil-31·25 (av. 14·58 mg C/m³/hr), respectively. These production figures are relatively lower than the normal primary production in the upper and lower non-industrial stretch of the Hooghly estuary.

Heavy metal and pesticide residue monitoring

Monitoring of heavy metals was conducted at 10 points in the industrial zone between Kuntighat and Batanagar, one point in the upper non-industrial zone at Nabadwip and two points, Nurpur and Kakdwip in the lower non-industrial zone. Metal content in water and sediments in the different zones is shown below:

Metal	Upper non-industrial zone		Industrial zone		Lower non-industrial zone	
	Water	Sediment	Water	Sediment	Water	Sediment
Zinc μg/l	47·9-84·0	22·2-48·6	37·0-1,248	46·75-132·1	41·0-63·3	43·8-63·4
Copper μg/l	6·2-21·0	3·4-9·25	12·6-38·1	10·4-21·15	8·4-26·3	4·8-12·6
Chromium μg/l	ND-1·02	3·67-9·12	ND-10·3	8·9-16·35	ND-3·9	5·6-9·2
Cadmium μg/l	ND-3·1	2·6-3·95	ND-6·43	8·0-12·64	ND-2·3	2·5-5·4
Lead μg/l	ND-1·8	4·2-14·8	ND-124·7	8·1-83·05	ND-4·38	7·3-23·8
Mercury μg/l	ND	—	ND-0·23	Upto 1·24	ND	—

Out of the 10 locations in the industrial zone, metal concentration, particularly of Cr, Cd, Pb and Hg was considerably higher in the Garden Reach-Batanagar stretch. Zn was maximum near the outfall of Rayon factory at Kuntighat. Mercury up to the maximum of 1·24/μg/l was also detected in the sedi-

ments from the Garden Reach area in the industrial zone.

Out of 44 sediment samples analysed for pesticide residues, 14 showed presence of DDT residues and 3 showed BHC-Y residues. Methylene blue active substances were found in sewage discharge points near Hajinagar and their value ranged between 2·8-3·0 mg/l.

Toxicological studies

Metals: Acute toxicity of copper (LC_{50} 96 h: 0·065 ppm) was much higher than zinc (5·1 ppm) to estuarine prawn *M. rude*. Salinity suppressed the toxicity of both the metals, the LC_{50} values at 2 ppt salinity being 0·6 and 11·2 ppm for Cu & Zn. Gravid females were more susceptible to these metals than the male prawns. Moulting frequency was increased under sublethal Zn (0·2 ppm) exposure.

Pesticides: Four insecticides *viz.*, monocrotophos, Carbaryl, quinalphos and DDT were screened to evaluate their toxicity to different life stages of estuarine prawn *M. rude*. The LC_{50} 24 and 48 h values are given below:

Pesticides	LC_{50} values in ppm for *M. rude*					
	Size 30-40 mm		Size 15-25 mm		Size 5-10 mm	
	24 hrs.	48 hrs.	24 hrs.	48 hrs.	24 hrs.	48 hrs.
monocrotophos	13·4	12·1	7·5	6·3	1·72	1·45
carbaryl	$5·2 \times 10^{-2}$	$3·2 \times 10^{-2}$	$2·6 \times 10^{-2}$	$2·1 \times 10^{-2}$	$1·5 \times 10^{-2}$	$0·7 \times 10^{-2}$
quinalphos	$1·1 \times 10^{-3}$	$0·7 \times 10^{-3}$	$0·5 \times 10^{-3}$	$0·3 \times 10^{-3}$	$2·5 \times 10^{-4}$	—
DDT	4×10^{-3}	$1·5 \times 10^{-3}$	$2·7 \times 10^{-3}$	$1·3 \times 10^{-3}$	$0·8 \times 10^{-3}$	$0·7 \times 10^{-3}$

The LC_{50} values indicate that DDT, quinalphos and carbaryl are highly toxic to *M. rude*, while monocrotophos is comparatively less toxic.

In situ Toxicity studies

Pulp & paper mill effluent (sulphite process) was found to be harmful to fish, *Rita rita* during summer months causing 50% mortality of the caged fishes within 48 h near the confluence of estuarine water and effluent. The temperature of the extruded water (30-32°C) from Bandel Thermal Plant was not harmful for the prawns and other aquatic organisms during winter months.

Biomonitoring in the Hooghly estuary

The population density in the industrial zone ranged between 11 to 54 no./l and the dominant species were *Spirogyra* sp., *Oscillatoria* sp., *Nostoc* sp., *Spirulina* sp., *Brachionus* sp., *Keratella* sp., *Cyclops* sp. and *Diaptomus* sp.

Effluent discharge from the pulp & paper industry at Hajinagar (IPP) was found to affect heterotrophic bacteria, phosphate solubilizing bacteria and aerobic nitrogen fixing bacteria; which are involved in the self-purification process and nutrient enrichment, more adversely than the thermal discharges from the BTP. Regeneration of these groups of bacteria even at a distance of 200 m in the downstream from the outfall region was found to be extremely low.

Studies in Kulti estuary

Heavy metals, *viz.*, Zn, Cu, Cr, Cd, Pb and Hg in water were found to be 980, 300, 380, 110, 256 and 0·31 μg/l at Tapsia, the

starting point of the storm-water channel draining Calcutta metropolitan effluents into the Kulti estuary. These levels came down to 410, 80, 22, 7, 22 and 0·03 μg/l at Ghusighata, the point of confluence with Kulti estuary. The metal content in water within the 3 km stretch of the Kulti estuary from this point, ranged between Zn, 52-320; Cu, 8-30; Cr, Tr-16; Cd, 2-6; Pb, 4-10 and Hg, Tr-0·02 μg/l. Metals in the sediment in the SWC ranged between Zn, 93·7-1,239·8; Cu, 31·1-117·8; Cr, 10·2-1,328·5; Cd, 3·8-19·8; Pb, 10·8-87·8 and Hg, 0·24-3.39 μg/g.

The synthetic detergents in the SWC water were detected as methylene blue active substance (MBAS) to the extent of 20 mg/l. The MBAS content varied between 1·8 and 7·5 mg/l near the confluence of SWC and Kulti estuary.

Sub-Project III: **Isolation and identification of fish pathogens**

During 1987-88, 560 numbers of estuarine fishes were examined. The fishes were collected both from their natural environment and from bheries and the man-made impoundments on estuarine mud-flats, in order to make a comparative study on their parasitic afflictions. 40 permanent slides were made to study the parasites as well as histopathological manifestations due to their actions. Some new animal parasites have also been preserved properly for further taxonomical studies. The salient findings are:

(*i*) Two new species of *Myxobolus* have been recorded from gills of *Liza parsia* and from muscles of *Mystus gulio*.

(*ii*) *Trichodina tenuidens* and *T. domerguei* have been encountered for the first time from the gills of *L. parsia* and *M. gulio* respectively.

(*iii*) Comparative studies on the parasitic afflictions of estuarine fishes collected both from their natural abode and bheries reveal that

(*a*) *L. parsia* is never affected by myxozoan parasites in bheries where the fish is often attacked by *Trichodina* sp. and parasitic copepods.

(*b*) Estuarine fishes of commercial importance are often parasitized by myxozoans and rarely by copepod parasites.

(*c*) *M. gulio* of bheri waters is generally infected with helminth parasites.

(*d*) Intensity of infection of *Myxobolus* sp. reaches the peak during December to April within the muscles of adult *M. gulio*.

(*e*) Intensity of infestation of an unidentified parasitic copepod attains the peak during November to March in the gills and branchial chamber of *L. parsia*.

(*iv*) A survey was made on ecological condition of freshwater sewage-fed fish-culture ecosystems, in relation to the diseases of fishes encountered therein. Sizes of these bheries varied between 6 and 35 ha. Diseases of fishes reported from such waters are: dropsy, fin-rot and haemorrhagic septicemia. Environmental conditions of fishes of these bheries are quite conducive excepting high bacterial load in water. Preliminary investigations suggest that fishes are affected due to lacunae in managerial practices such as: overstocking (10,000-12,000/ha) non-supply of any compounded feed and avoidance of using any disinfectant (particularly lime). Accumulation of organic load at the bottom was another constraint.

(*v*) Data collected from Kolleru lake (A.P.) are analysed and it is found that infestation of *Argulus* on carps is directly proportional to the presence of aquatic macrovegetation providing suitable substratum for egg-laying by the branchiurans.

(*vi*) Data collected on the bacterial load of sewage-fed ponds of Titagarh municipality

reveal that usage of treated sewage in fish ponds for recycling is better than using raw sewage. MPN/100 ml (faecal coliform index) in ponds manured with treated sewage as well as control ponds varied between 0 and 350 colonies though on an average, the counts were 90 and 20 respectively.

(*vii*) Fish mortality in Bethuadahari deer park (Nadia) was investigated and it was found that deposition of organic load at the bottom restricted release of nutrients from soil phase to water phase. This was further retarded due to lack of calcium in water. An unhygienic environment and want of food caused the mortality.

(*viii*) A preliminary survey on fisheries was made in relation to the construction of dam across the river Narmada; this was done in view of the hilsa migration as well as from capture fisheries point of view.

(*ix*) Identifications of myxozoans, urceolariids, helminths, copepods and branchiuran parasites are in progress.

Sub-Project IV: **Studies on the productivity of estuaries and connected impoundments using Radioisotope, Carbon-14**

Primary productivity studies were made in the Hooghly-Matlah estuarine system. From Farakka to Frazerganj 12 places (Farakka, Nabadwip, Barrackpore, Uluberia, Diamond Harbour, Kolaghat, Canning, Frazerganj, Bokkhali, Jamboodwip, Kalisthan and Digha) were covered for *in situ* experiments. Radioisotope C^{14} technique was used for productivity studies.

During the monsoon months, the rate of carbon assimilation was very low (22·62 mg Cm^{-3} day^{-1} to 44·51 mg Cm^{-3} day^{-1}). Low production during the monsoon period is attributable to silt laden water and heavy current which reduce the penetration of solar radiation and destabilization of chlorophyll-bearing organisms coupled with low alkalinity (60×10^{-6}). During post-monsoor period, primary production rate was found to increase considerably when almost three times more carbon was assimilated as compared to monsoon months (53·0 mg Cm^{-3} day^{-1} to 95·16 mg Cm^{-3} day^{-1}). This increase in the rate of primary production coincided well with the increase in the half-bound carbon and chlorophyll concentration.

Abrupt increase in bicarbonate alkalinity (120·5 to $200·0 \times 10^{-6}$), penetration of solar radiation and stabilization of chlorophyll-bearing organisms with moderately rich nutrients perhaps resulted in very high rate of carbon assimilation in almost all the zones of estuary during the pre-monsoon period. Rate of primary production during pre-monsoon months varied from 212·55 mg Cm^{-3} day^{-1} to 225·75 mg Cm^{-3} day^{-1}.

Appearance of periodical algae around marine zones in the month of November probably resulted in tremendous increase in the rate of carbon assimilation (maximum 1·586 g Cm^{-3} day^{-1}). High rate of carbon assimilation is well substantiated with high value of electrical conductivity (22·5 m mhos Cm^{-1}, total dissolved solids about $11·2 \times 10^{-3}$ and higher content of half bound carbon, max. 300×10^{-6}). Depth of water at and around Jamboodwip, where maximum productivity was recorded, is also very shallow. Shallow depth and muddy bottom helped in the nutrient regeneration from the bottom mud and ready penetration of sunshine.

In order to know the relative contribution of nannoplankton and netplankton towards the productivity in the running water, organisms were separated by using GF/C Glass microfibre filters (pore size $0·45 \times 10^{-6}$ m) and plankton net (25 mesh bolting silk). During monsoon months, the contribution of nannoplankton was almost similar to that of netplankton (51·45/48·95), whereas during the post-monsoon and pre-monsoon periods,

the relative contribution towards the primary production and energy transformation was observed to be from 59·67/39·45 and 69·75/30·15 respectively. Thus, out of total energy fixed in the estuary, about two-thirds of the solar energy was fixed by the nannoplankton only.

PROJECT BF/B/8
ECOLOGICAL STUDIES ON TROPICAL MANGROVE VEGETATION ON WESTERN FRINGE AREA OF THE SUNDARBANS

Personnel:
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Duration: 1986-1989

Location: Gosaba-Sajinakhali, Minakhan-Malancha, Kakdwip and Bakkhali

Phytotelmates and tidepools amidst mangrove vegetation are considered to be the natural nurseries for the estuarine shrimps and fishes. To conserve such areas for the benefits of estuarine fisheries and as a prerequisite for mangrove management, investigations on the ecology of such an environment were initiated in 1985 and continued during the year under report.

Macrophytes of the mangrove thickets were identified zonewise. These zones were Gosaba, with sanitary influence and deforestation effect; core areas *viz.*, Sajinakhali and Sudhannyakhali; semi-core area *viz.*, Durgaduania; low saline Minakhan-Malancha area with sewage influence; moderately saline Kakdwip char, with human interference; and Bakkhali at the seaface. The species-wise dominance of macrophytes at these zones were different due to changes in the salinity pattern and in the nature of interferences.

The halophytes *viz.*, *Sonneratia apetala*, *Clerodendrum inerme*, *Porterasia coarctata*, *Phragmites kakra*, *Hemarthria compressa*, *Fimbristylis halophila*, etc. though occurred at the fringe area, Gosaba, the dominant species were *Avicennia marina*, *A. alba*, *Excoecaria agallocha*, *Suaeda nudiflora* and *Acanthus ilicifolius*.

The composition of dominant plant species totally differed at the semi-core area, Durgaduania and they were *Ceriops tagal*, *C. decandra*, *Derris* spp. and *Xylocarpus granatum*. Stray occurrence of some halophytes *viz.*, *E. agallocha*, *Avicennia officinalis*, *A. alba*, *S. apetala*, *Bruguiera gymnorhiza*, *Phoenix paludosa*, *Tamarix gallica*, *Aegiceras carniculatum*, *Aegiolitis rotundifolia*, *Suaeda maritima*, *S. nudiflora*, and *Salicornia brachiata* rather brought in species diversity than improving the floral density much for the region.

Core areas showed dominance of *Avicennia* spp., *Bruguiera parviflora*, *B. gymnorhiza*, *A. corniculatum*, *A. rotundifolia*, *Suaeda* spp., *X. granatum*, *P. coaretata*, and *A. ilicifolius*. *S. apetala*, *S. brachiata*, *Amoora culculata*, *Heritiera fomes*, etc. were also recorded but infrequently. In guano-rich Sajinakhali, *C. tagal*, *Rhizophora apiculata*, and *P. coarctata* were more abundant as *E. agallocha* and *P. paludosa* were at Sudhannyakhali.

But almost denuded and sewage-influenced mud flats of Minakhan-Malancha area had remnants of a few halophytes *viz.*, *C. inerme*, *Sonnerasia caeseolaris*, *A. alba*, *Crinum defixum*, *E. agallocha*, and *A. ilicifolius*.

Similarly, cattle grazing and human interferences being at their heights, Kakdwip char has lost almost completely the once dominated *A. ilicifolius* along with *P. paludosa*, *C. inerme*, *C. defixum*, *T. gallica*, *C. tagal*, *Derris* spp., *Sarcobolus carinatus* and other

occasionally existing plant species. Presently, there are very scanty representation of *Exocecaria* sp., *Avicennia* spp., and *Aegiceras* sp. which tried in vain to establish them in the vacant niche. Among grasses *Porteresia* sp., *Panicum* sp. and *Leersia* sp. also exhibited their existence in the area.

Diversity of plant species was found to be much less at Bakkhali, only *P. paludosa*, *C. tagal*, *A. rotundifolia* and *Avicennia* spp. were dominant. A single stock of the rare mangal, *Nypa fruticans* was also recorded from the region.

The abundance of *Thalacina* sp. and *Acetes* spp. among the associated fauna were the maximum at Sudhannyakhali and the minimum at Durgaduania where tree-crabs were more. The core areas were found to be infested more with *Nerita* sp. and *Onchidium* sp. than in other areas.

In the high saline zones, excluding *Acetes* spp. from the associated faunal community, the abundance of molluscs (*Pugilina* sp., *Littorina* spp., *Nassarius* spp., *Telescopium* sp., *Cymia* sp., *Onchidium* sp., *Teredo* sp., etc.) varied from 2·5 to 20%; fish fry (*Boleophthalmus* spp., *Glassogobius* sp., *Liza* spp., *Sciaena* spp., etc.) from 5 5 to 12·5%; shrimp juveniles (*P. indicus*, *M. monoceros*, *M. brevicornis*, *P. styliferus*, *P. monodon*, *M. rude*, etc.) from 60 to 90% and other fauna (crabs, hermitcrabs, polychaetes, etc.) from 1 to 10% only.

Kakdwip char and Minakhan-Malancha area had allied type of associated fauna such as *Vivipara* sp., *Lymnaea* spp., *Thiara* sp., *Littorina* spp., etc. among molluscs; *Scylla* sp., *Uca* spp., etc. among crabs; different shrimps found in high saline zones including *M. rosenbergii* and *M. mirabile;* and mullets, gobiids, *Mystus gulio*, sciaenids, *Lates calcarifer*, etc. among fish fry. *Gammarus* spp., herpecticoids, *Mesopodopsis orientalis*, *Chironomus barbatitarsis*, soil nematodes, polychaetes, etc. were also found to contribute substantially to the faunal biomass of the two regions.

But the faunal composition was somewhat different at Bakkhali where they were represented mainly by *Telescopium* sp., *Littorina* spp., *Assiminea* sp. among molluscs; *Parapneopsis sculptilis* among estuarine shrimps; chanos fry among fishes; and *Dotilla* sp., *Ocypoda* spp. etc. among crabs.

The average benthos density was the highest at Minakhan-Malancha (*c.* 76 thousand u/m^2) followed by Durgaduania (*c.* 5·5 thousand u/m^2), Sajinakhali (*c.* 4 thousand u/m^2), Gosaba (*c.* 1·1 thousand u/m^2), Sudhannyakhali (*c.* 0·9 thousand u/m^2), Bakkhali (*c.* 0·6 thousand u/m^2) and Kakdwip char (*c.* 0·38 thousand u/m^2).

Among phytobenthos usually *Lyngbya* sp. and *Anabaena* sp. dominated at Malancha; *Phormidium* sp. at the high saline zones and *Oscillatoria* sp. in the core areas. Characteristic benthic algae were *Closterium* sp., *Pleurosigma* sp., *Pinnularia* sp. for Malancha area; *Nitzschia* sp. for Gosaba; *Amphora* sp., *Gomphonema* sp., *Cocconeis* sp., *Pinnularia* sp., *Closterium* sp. for the core areas; *Oscillatoria* sp., *Anabaena* sp. for Kakdwip char; and *Lyngbya* sp., *Nostoc* sp. for Bakkhali region. Among zoobenthos, *Gammarus* sp., chironomids, harpecticoids dominated low saline sewage-influenced areas; dipterans, tenaeids in Kakdwip char area; and *Diopetra* sp., *Fascolosoma* sp., *Nereis* sp. in Bakkhali region.

Plankton density was the highest at Gosaba (2·7 thousand u/l) followed by Sajinakhali (1·6 thousand u/l), Sudhannyakhali (1·5 thousand u/l), Durgaduania (1·4 thousand u/l), Malancha (1·3 thousand u/l), Kakdwip char (0·7 thousand u/l) and Bakkhali (0 5 thousand u/l). These seven zones showed dominance of *Cyclops* sp. and *Brachionus* sp. But other dominant zooplankters like *Euglena* sp. and *Diaptomus* sp. were noticed mainly at low and high saline zones respectively.

Likewise *Lyngbya semiplana, Closterium setaecum* and *Coscinodiscus concinnus* dominated among phytoplankters of the zones under study excepting Malancha area where *Amphora* sp., *Cladophora* sp. and *Spirulina* sp. however, dominated.

Besides this, typical phytoplankters for specific areas were also recognised. They were: *Phormidium* sp. of high saline zones; and *Enteromorpha tuberosa, E. prolifera* and *E. intestinalis* of sewage influenced low saline areas.

Among the plankters of high saline zones; the plankton of Bakkhali was rich in *Anabaena* sp.; and among the plankters of low saline zones *Biddulphia sinensis, Navicula* sp., *Pleurosigma elongatum, P. normanii* and *Nitzschia scriata* were well represented at Kakdwip.

High saline zones again could be demarcated by the abundance of *Nitzschia* sp. in the fringe area; *Oscillatoria* sp., *Cladophora* sp., *Anacystis* sp., *Pinnularia* sp., *Pleurosigma* spp. in the semi-core area; and *Pinnularia* sp., *Pleurosigma* spp. in the core areas. Among core areas, the guano-influenced niche had sufficient *Nitzschia* sp. whereas Sudhannyakhali, without any guano-effect had significant quantities of *Chaetomorpha aerea* and *Merismopedia* sp.

Seasonal studies on the chemical properties of mangrove swamps in the Gosaba-Sajinakhali and Kakdwip-Bakkhali stretches were carried out during the period under report. The water salinity of the entire stretch ranged between 3·6 and 29·4 ppt. Water pH varied between 7·1 and 8·3. Probably due to buffering action of sea in the vicinity of Kakdwip-Bakkhali stretch pH exhibited slightly higher values there than those at Gosaba-Sajinakhali stretch.

Total alkalinity values ranged between 50 and 170 ppm in both the stretches of which Kakdwip-Bakkhali stretch showed slightly higher values. DO values were rather high (7·2-23·2 ppm) in these stretches; but they were slightly higher in Gosaba-Sajinakhali stretch perhaps due to high photosynthetic activities.

Amount of water-soluble nitrogen varied between 0·9 and 2·6 ppm in Gosaba-Sajinakhali stretch, the maximum value being obtained at Pakhiralaya area where guano effect of bird sanctuary worked out as an additive factor for the nitrogen concentration of water. In the Kakdwip-Bakkhali stretch, the amount of water soluble N varied between 0·45 and 3·1 ppm. Higher values were obtained in waters of phytotelmates at Bakkhali during low tide period whereas values were lower in the high tide period. Amount of water-soluble P ranged between 0·004 and 0·6 ppm in the Gosaba-Sajinakhali stretch; and between trace and 0·1 ppm in Kakdwip-Bakkhali zone.

PROJECT BF/A/2
FISHERY AND BIOLOGY OF HOOGHLY HILSA WITH SPECIAL REFERENCE TO BREEDING AND RECRUITMENT

Personnel:

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Duration: 1986-90

Location: Estuarine Division, Barrackpore

Breeding of Hilsa

Artificial fecundation of hilsa was carried out in River Ganga, close to downstream of Farraka Barrage during October, 1987. Altogether five sets of experiments were

conducted, out of which ovulation took place in three sets. The percentage of fertilized eggs ranged between 70 and 90. Fertilized eggs were incubated under laboratory and natural conditions (water temperature 22·0°C-30·0°C). Percentage of hatching observed was between 60 and 75. Depending on the water temperature the hatching time varied between 16 and 20. Sixtyseven thousand hatchlings were obtained from three sets of successful experiments and fortyeight thousand hatchlings of one and two days old were transported to Barrackpore 300 km away, in open containers (without oxygenation) at a density of 1000 nos./l in settled river water for a duration of 14-16 hrs., with 10-20% mortality. Hatchlings stocked in cemented ponds survived for 11 days.

Hilsa farming

To conduct experiments on hilsa culture (0·1 ha.), about 500 numbers of hilsa fry (16-40 mm) were collected from the Hooghly River and stocked in the pond during March. During 4 months rearing, they attained an average size of 130 mm.

Seed prospecting

Studies on larval abundance of hilsa in the freshwater zone of the Hooghly estuary were carried out during September to February 1987. Maximum number of hilsa seed (post larvae and fry in the size range of 8-25 mm) collected were 37, 467, 16 and 23 nos/net/hr from the freshwater zone of the estuary near Medgachi, a distance of about 250 km upstream of sea during October, November, December 1987 and January 1988.

The availability of post-larvae and fry of hilsa during October to February indicates its prolonged spawning season from October to February with a peak in October. Young ones of hilsa form a substantial part of juvenile fishery in the freshwater zone during this period.

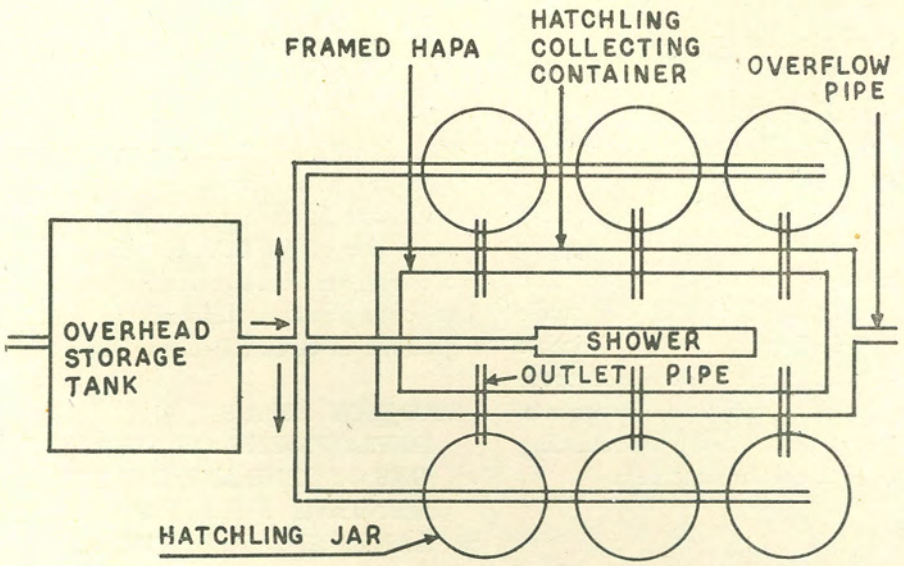
Studies on population dynamics

The stocks of the post-monsoon hilsa from the feeder canal and from the main Ganga-Padma system were compared for their mean sizes in the landings with a view to finding out if the stocks had any characteristic differences. Mean sizes of hilsa observed were 378·17 mm in the landings from feeder canal and 328·12 mm in the catches from the main system. Hilsa fishery was scarce in the upstream of the Farakka Barrage. But moderate catches of hilsa fry in the size range of 32-61 mm were also available in the upstream of the Barrage during later part of October. The presence of fry in the upstream of the Barrage might be due to spawning of the resident or migratory hilsa stock. The electrophoretic study of serum protein of various stocks of hilsa is being continued.

Studies on proximate composition

Samples of hilsa were collected from different localities of Hooghly River *viz.*, Nawabgunj, Frazergunj and downstream of Farakka Barrage of River Ganga. The Gonado Somatic Index (GSI) was recorded and the samples of muscle, liver and gonad were subjected to analyses for estimating the moisture, total protein and lipid content. The GSI values were found to be 0·7 (Nawabgunj; 22.7.88), 0·14 (Frazerganj; 12.8.87), 5·0 and 10·0 (Farakka; 17.8.87 and 18.10.87). The GSI value has been studied in order to see if there is any correlation with the proximate composition (moisture, fat and protein values in %) of the fish at various stages of maturity. The moisture values recorded for the fishes varied from 54·9 to 62·8% in gonad and 61·2 to 74·9% in muscles. The protein values varied from 11·3 to 14·2%

in muscles, 15·1 to 16·3% in liver and 12·0 to 15·0% in gonads. No definite conclusion could be derived from these data as almost similar moisture and protein values were observed for the fishes obtained from both the water bodies. However, a notable feature observed was in case of lipid values. The lipid values for the mature hilsa collected from Farakka showed high values of 9·2% in muscle and 20·9% in gonad.



SCHEMATIC DIAGRAM OF A MODEL HATCHERY

PROJECT AN/A/7
ECOLOGY AND PRODUCTION BIOLOGY OF EDIBLE INLAND MOLLUSCS

Personnel:
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Duration: 1984-88 (Extended by one year)

Location: CICFRI, Barrackpore

PRODUCTION BIOLOGY OF *Achatina Fulica*

Breeding of snails

Breeding of snails was done in specially prepared floor of the snail house. Altogether 9 snails were bred during the year. The fecundity varied from 126 to 336 for snails in the range of 36·5 g to 82·6 g. Suitable hatching conditions were ascertained from placing the eggs under various environments. Undisturbed eggs with moist surrounding were found to be ideal for hatching.

Feed trials

Apart from vegetables and kitchen refuse, plants like *Eichhornia* (tender leaves) and *Hydrilla* were tried as feed for the young ones. They showed a poor preference for both.

Snail house construction

A snail house ($5 \times 2 \times 0{\cdot}5$ m) was constructed in the CICFRI campus at an expenditure of about Rs. 5,300/-. The house has a capacity of rearing 3,000 snails at a time. In the house, successful breeding of snails was done and the young ones are being reared.

Studies on natural population

Above 450 snails were collected from nature from a plot of about 2 ha. in area. Observations on the habitat and the availability of snails in nature for exploitation were made. Snails were available immediately after the summer rains in April to September. The size composition of the natural population is being analysed.

Export promotion of snail meat

A consignment of 25 kg of live *Achatina fulica* was handed over to MPEDA for arranging their processing and exhibiting in the *Anuga fair* in Cologne, West Germany (10-15 October, 1987). The European traders evinced keen interest in the product and the order for several thousand tonnes of snail meat is already with MPEDA and the Indian traders. With the possibility of developing an overseas trade, arrangements are being made with the assistance of MPEDA for disseminating the breeding and culture techniques of the snails to enterpreneurs through a training programme at CICFRI during June 1988.

PROJECT AN/A/9
DEVLOPMENT OF SUITABLE DESIGNS OF PENS AND CAGES FOR AUGMENTING FISH PRODUCTION IN LAKES AND RESERVOIRS

Personnel:
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Duration: 1986-1991

Location: Barrackpore, Bangalore and Muzaffarpur

On the basis of hydrological studies undertaken at the KR Sagar Reservoir (Mysore), design of a low-cost net cage structure has been prepared for raising carps in cages installed in reservoirs. The rectangular cage measures $8 \times 4 \times 2{\cdot}25$ m with nylon netting. The cage is to be moored in a protective/sheltered area (shallow reservoir area) with

less exposed fetch length to prevent damages due to wave and wind action.

The float system (floats and mooring systems) of the cage structure is capable of dissipating and dampening the wave energy and preventing the floats as far as possible from being rocked by incident waves.

Pen enclosure

Construction of net pen enclosures covering an area of 0·345 ha. (3 stock ponds each of 0·1 ha. and one nursery pond of 0·045 ha.) at the Kanti oxbow lake, Muzaffarpur has been completed. Bamboo batter piles spaced at 1·5 m apart constitute the main supporting frames considering their capability to resist horizontal and inclined forces.

PROJECT AN/A/10: STUDIES ON FISH PASSAGE FACILITIES IN EXISTING HYDRAULIC STRUCTURES

Personnel:
A. B. Mukherjee and D. K. De

Duration: 1987-1992

Location: Barrackpore

Observations were made at the Farakka Barrage to ascertain the efficacy of fish locks provided in the barrage. Studies were made on flow mechanisms through the fish locks, physical factors in the flow, turbulence and migration of fishes past the barrage.

The major congregation of adult hilsa had been in the down-stream of the barrage during June to November. The fishing activities were at peak during this period and were mostly confined to about 5-6 sq.km. down the barrage. On the contrary, fishing activity was sparse in the upstream of the barrage as noticed in a survey of a stretch of about 6 km above the barrage. However, a sizeable catch of hilsa fingerlings in the size range of 129-152 mm (Av. size 139 mm/25 g) could be obtained in June by operating fine meshed drag net in relatively shallow still areas in the upstream of the barrage. Hilsa fry (25-50 mm) were also available in moderate quantities in the upstream of the barrage particularly in October.

Occurrence of fry and fingerlings of hilsa in the upstream of the barrage might be due to spawning of the resident or migratory hilsa stock.

Normally, water level differences at the Farakka Barrage range from 8-8·5 m round the year except in the monsoon months when all the gates are kept open for release of excess flood water which thus brings down the head difference to the minimum. Because of very low head difference and less formation of downstream eddies, a few shoals of hilsa might be migrating upstream past the barrage through the various opened bays only during the flood seasons.

Information on the location and details of different types of fishways provided in hydraulic structures in the country are being collected.

PROJECT CSS/1: DEVELOPMENT OF INLAND FISHERIES STATISTICS

Personnel:
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Duration: 1984-90

Location: CICFRI, Barrackpore

The entire freshwater aqua-biotope in the country was broadly classified into 8 hydrological regions. From each region, one state

was selected and from one state 3 randomly selected districts were taken for coverage. The survey work for resource estimation following stratified two stage cluster sampling has been completed. Two types of estimates, one based on average area per pond and the other based on average area per village have been worked out. District-wise estimates of total water bodies along with the coefficient of variation have been presented in Table 29.

In Assam, the important water resource is ox-bow lakes or beels. Three districts namely Sibsagar, Lakhimpur and Dhubri were selected for total enumeration. The total area under this class of resource is 1,146·5 ha. in Sibsagar, 1,322·0 ha. in Lakhimpur and 2,375·07 ha. in Dhubri district.

The work for catch estimation from ponds and tanks has been partially completed in selected districts of the chosen states.

Table 29: Showing district-wise estimates of total area

States	District	Av. area per pond (ha)	Coeff. of variation (%)	Total area (ha)	Av. area per village (ha)	Coeff. of variation (%)	Total area (ha)
West Bengal	24-Parganas	0·10	7·51	25,833	6·40	8·81	24,463
	Midnapore	0·17	16·97	84,544	4·99	30·97	58,755
	Murshidabad	0·16	4·54	11,420	5·11	19·54	11,433
Madhya Pradesh	Raipur	1·64	8·24	28,929	7·49	10·83	25,340
	Shahdol	0·81	8·26	7,288	4·93	20·20	7,707
	Seoni	1·27	6·81	1,675	2·85	24·22	1,736
Uttar Pradesh	Varanasi	1·21	21·03	1,968	1·36	25·01	2,060
	Baharaich	0·98	10·29	1,991	1·03	8·88	1,987
	Banda	2·80	12·78	4,819	3·57	11·79	4,641
	Meerut	1·61	6·03	2,486	2·35	5·19	2,406
Tamil Nadu	Pudukottai	0·91	1·70	5,209	7·73	25·01	5,857
	Ramanathapurum	0·67	10·54	6,141	4·33	10·00	6,440
	Tirunelveli	Complete information is not available.					
Andhra Pradesh	West Godavari	1·04	7·4	3,651	4·32	8·86	3,884
	Nellore	0·80	13·26	2,075	1·29	18·67	1,076
	Vizianagaram	Complete information is not available.					
Bihar	Ranchi	0·25	21·31	1,095	0·35	14·09	1,368
	East Champaran	1·64	21·61	2,133	1·82	20·35	2,247
	Madhubani	0·49	12·34	4,129	3·88	23·63	4,484

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PERSONNEL

The following scientists rendered their services to the Institute during the period.

Dr. Arun G. Jhingran, Director, Barrackpore

RIVERINE DIVISION

Allahabad Centre

Shri Ravish Chandra, S-3 (Head)
Shri R. K. Saxena, S-2
Shri G. N. Srivasthava, S-2
Dr. D. N. Singh, S-2
Dr. S. K. Wishard, S-2
Shri Balbir Singh, S-2
Dr. M. A. Khan, S-2
Dr. K. Chandra, S-1
Shri R. K. Dwivedi, S-1
Shri P. K. Katiha, S-1
Shri R. K. Tyagi, S-1

Bhagalpur Centre

Dr. A. K. Laal, S-2
Dr. B. L. Pandey, S-2
Shri S. K. Sarkar, S-1

Patna Centre

Shri Dhirendra Kumar, S-2
Shri V. R. Chitranshi, S-2
Dr. V. Pathak, S-1
Shri P. N. Jaitly, S-1

Lalgola Centre

Shri A. R. Chowdhury, S-1

Guwahati Centre

Shri S. P. Singh, S-3
Shri S. N. Mehrotra, S-2
Shri Y. S. Yadava, S-2
Shri M. Chowdhury, S-1

LACUSTRINE DIVISION

Bangalore Centre

Shri B. V. Govind, S-3 (Head)
Shri D. S. Krishna Rao, S-2 (12.1.88)
Shri P. K. Sukumaran, S-1

Bilaspur Centre

Shri G. K. Bhatnagar, S-3
Dr. D. K. Kaushal, S-2
Dr. H. P. Singh, S-2
Dr. V. K. Sharma, S-1

Eluru Centre

Shri Ch. Gopalakrishnayya, S-3
Dr. R. S. Panwar, S-2
Shri K. V. Rao, S-2
Dr. M. Ramakrishnaiah, S-2
Shri J. B. Rao, S-2

Muzaffarpur Centre

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Shri B. C. Jha, S-1
Dr. S. N. Singh, S-1

Pollachi Centre

Shri C. Selvaraj, S-3
Shri V. K. Murugesan, S-2

Pune Centre

Shri P. L. N. Rao, S-2
Dr. M. D. Pisolkar, S-2
Shri B. K. Singh, S-1
Shri V. Kolekar, S-1

Raipur Centre

Dr. V. R. Desai, S-3
Shri N. P. Srivastava, S-1

Srinagar Centre

Dr. K. K. Vass, S-3
Dr. (Smt.) Usha Moza, S-2

Karnal Centre

(Being shifted to Agra)
Shri K. L. Shah, S-2
Shri B. C. Tyagi, S-2
(Under transfer to CIFA)
Shri D. N. Mishra, S-2

ESTUARINE DIVISION

Barrackpore Centre

Dr. B. N. Saigal, S-3 (Head)
Shri R. N. Pal, S-3
Shri B. B. Ghosh, S-3
Dr. A. K. Ghosh, S-2
Dr. M. K. Mukhopadhyay, S-2
Dr. M. Sinha, S-2
(up to 29.12.87)
Dr. H. C. Joshi, S-2
Shri M. M. Bagchi, S-2
Shri R. K. Das, S-2
Shri P. M. Mitra, S-2
Dr. M. K. Das, S-2
Shri D. K. De, S-2
Shri H. C. Karmakar, S-2
Shri A. Mukherjee, S-2
(On study leave)
Dr. Babulal, S-1

BRACKISHWATER IMPOUNDMENTS SECTION

Barrackpore Centre

Shri Apurba Ghosh, S-3
Dr. S. K. Mukhopadhyay, S-3
Shri P. K. Chakraborty, S-2
Dr. Amitabha Ghosh, S-2
Dr. K. R. Naskar, S-2
Shri A. Hajra, S-1

Calcutta Centre

Shri G. N. Saha, S-3
Shri S. C. Thakurta, S-2
Shri A. C. Nandy, S-2
Dr. R. K. Banerjee, S-2
Shri G. C. Laha, S-1

Canning Centre

Shri S. N. Dutta, S-2
Shri D. Nath, S-2
(Under transfer to CIBA)

OTHER CENTRES/SECTIONS AT BARRACKPORE

Inland Molluscs Section

Shri V. V. Sugunan, S-2
Smt. G. K. Vinci, S-2
Dr. V. K. Unnithan, S-2

Beel Fisheries Section

Dr. G. N. Chattopadhyay, S-2
Dr. M. J. Bhagat, S-1
Dr. (Mrs.) Krishna Mitra, S-1

Extension Section

Shri D. D. Halder, S-3
Shri U. Bhowmick, S-2
Shri J. G. Chatterjee, S-2
Shri P. K. Pandit, S-2

Engineering Section

Shri A. B. Mukherjee, S-2

Economics Section

Shri S. Paul, S-2

Central Sector Scheme for Inland Fisheries Statistics

Shri R. A. Gupta, S-3
Shri S. K. Mondal, S-1

Scientists on deputation/lien

Dr. P. V. Dehadrai, S-5 (Per. Grade), ICAR, New Delhi
Dr. M. Y. Kamal, S-3, ICAR, New Delhi
Dr. P. Das, S-4 (Per. Grade), NBFGR, Allahabad
Shri D. V. Pahwa, S-3, ICAR, New Delhi
Dr. K. M. Rao, S-2, ICAR, New Delhi
Dr. Y. Rama Rao, S-3, North Eastern Council Secretariat at Shillong
Dr. Kuldip Kumar, S-2, State Fisheries Dept., Himachal Pradesh

The following members of staff (Technical/Auxiliary) rendered their services during the year.

Sr. R.A.

Shri S. N. Sar

T-6

Shri J. Ghosh

T-5

Shri A. R. Majumder
Shri P. K. Ghosh
Shri S. K. Das
Smt. Anjali De
Shri R. C. Satapati
Shri P. B. Das
Shri K. Subba Rao
Shri T. S. Rama Raju
Shri R. C. Singh
Shri N. K. Srivastava
Shri R. N. De
Smt. Sukla Das (up to 6.9.87)

T-4

Shri H. K. Sen
Shri P. Dasgupta (Adhoc)
Shri A. K. Roy
Shri N. N. Mazumdar
Shri N. C. Mondal
Shri S. P. Ghosh
Shri K. K. Agarwal
Shri P. S. C. Bose
Shri Md. F. Rahman
Shri Alok Kr. Sarkar
Shri D. N. Srivastava
Shri K. S. Banerjee
Shri B. D. Saroj
Shri Ram Chandra
Shri A. R. Paul
Shri N. D. Sarkar (up to 1.10.87)

T-II-3

Shri Camil Lakra
Shri M. P. Singh
Shri S. K. Srivastava
Shri Ramji Tiwari
Shri Dipak Kr. Biswas
Shri A. K. Banerjee
Shri Fatik Manna
Shri H. Chaklader
Shri T. Chatterjee
Shri Pintu Biswas
Miss. Keya Saha
Shri H. C. Banik
Shri B. K. Biswas

T-I-3

Shri M. M. Das
Shri S. C. Bhowmick
Shri S. Bhattacharjee
Shri Swapan Chatterjee
Shri S. N. Sadhukhan
Shri N. C. Roy
Shri K. L. Das
Shri Kanchan Datta
Shri R. L. Balmiki
Shri U. K. Chatterjee
Shri Suraj Bahadur
Shri N. C. Biswas
Shri Badal Lal Singh
Shri K. R. Dev
Shri K. P. Singh
Shri Kishan Deo
Shri S. K. Chatterjee
Shri B. B. Das
Shri Ranjit Singh
Shri Donald Singh
Shri R. M. Roy
Shri Ajit Kr. Banerjee
Shri D. P. Verma
Shri J. P. Mishra
Shri T. P. Ghosh

T-2

Shri Bhai Lal
Shri Debasis Sanfui
Shri K. Ganesan
Shri D. Borgoyary
Shri A. K. Majumder
Shri M. C. Pal
Shri R. K. Halder
Shri S. K. Deb
Shri S. K. Biswas
Shri C. R. Das
Shri Dipankar Chatterjee (From 10.3.88)
Miss Rina Basak (From 22.3.88)

T-1

Shri G. N. Burman
Shri K. L. Chakraborty
Shri Md. Sahmood
Shri J. L. Bose
Shri N. K. Saha
Shri Bholanath Das
Shri Ch. G. Rao
Shri S. Kotaiah
Shri L. K. Parbat
Shri S. K. Chakraborty
Shri Saradindu Chakraborty (From 10.3.88)
Shri S. N. Chaki (From 10.3.88)
Shri Hiralal Biswas (From 10.3.88)
Shri H. K. Routh (From 10.3.88 on Ad-hoc)
Shri K. K. Das (From 10.3.88 on Ad-hoc)
Shri A. K. Barui (From 10.3.88 on Ad-hoc)

Auxiliary

Shri P. Ramana Rao (Hindi Translator)
Shri Swapan Kr. Das (Time Keeper)

The following members of staff (Administrative) rendered their services during the year.

Senior Administrative Officer

Shri L. M. Nandy

Accounts Officer

Shri A. N. Mukherjee
(up to 29.2.1988)
Shri J. R. Verma
(From 1.3.1988)

Administrative Officer

Shri K. B. Rajani
(From 28.3.1987)

Assistant Administrative Officer

Shri M. L. Biswas
(up to 15.10.1987)
Shri A. K. Sengupta

P.A. to Director

Shri G. Lahiri

Senior Stenographer

Shri R. C. Srivastava

Superintendent

Shri B. C. Dutta
Shri M. R. Roy
Shri N. K. Sarkar
Shri S. C. Roy

Assistant

Shri N. H. Baidya
Shri B. C. Bhattacharjee
Shri M. M. Neogi
Shri D. C. Bose
Shri I. N. Kodandaraman
Smt. Bani Roy
Shri S. K. Bose (up to 17.3.87)
Smt. Namita Choudhury
Shri Arup Chatterjee
Shri S. Dasgupta
Smt. S. Majumder
Shri D. K. Banerjee
Shri S. K. Pramanick
(Ad-hoc from 23.8.86)
Shri S. P. Sastry (up to 7.12.87)
Shri Mahesh Prasad
Shri C. C. Das
Shri R. C. P. Singh

Stenographer

Shri U. K. Ghosh
Shri S. Bhattacherjee (Ad-hoc)
Shri T. K. Roy

Senior Clerk

Shri S. K. Kar
Shri Keshav Prasad
Shri J. N. Banerjee
Shri D. N. Baidya
Shri H. L. Sarkar
Shri B. C. Majumder
Shri J. C. Patra
Shri M. K. Das
Shri R. R. Mukherjee
Shri M. Kachhap
Shri Ranjit Kr. Ghosh
Shri S. N. Paramanick
Shri L. P. Mishra
Shri K. S. Verma
Shri N. K. Mitra
Shri H. K. Nath
Shri S. K. Sarkar
Shri S. R. Halder
Shri B. B. Mukherjee
Shri T. K. Majumder
Shri S. Bhowmick
Shri D. K. De Sarkar
Shri H. B. Sutar
Shri A. B. Biswas
Shri S. S. Sinha
Shri T. K. Sreedharan
Shri Baij Nath
Shri Jagdish Rai (up to 2.6.1987)
Shri Surendra Kumar
(From 20.2.1988)

Junior Stenographer

Miss G. Vinoda Lakshmi

Junior Clerk

Shri Dipanker Chatterjee
(up to 9.3.88)
Shri S. B. Ray
Shri Samir Kr. Ray
Shri P. K. Dutta
Shri P. Lahiri
Smt. Sikha Majumder
Smt. N. Banerjee
Smt. Anita Majumder
Shri Babul Kanti Das
Shri Samir Kr. Bose
Shri N. R. Kundu
Shri Jyotirmoy Roy
Shri Malay Kr. Joarder
Shri Sujit Kr. Ghosh
Shri Brahmapal Balmiki
Shri C. K. Pandey
Shri M. L. Biswas
Shri K. Manjhi
Shri Ramdeo Singh
Miss Shyamali Samanta
Shri S. K. Maranappan
Shri Chottey Lal
Shri R. R. Debnath
(up to 31.7.87)
Shri B. N. Sah
Miss Bulbul Mondal
Smt. Anjali Neogi
Shri S. P. Mondal
Shri U. Bhattacharjee
Smt. Mrinalini Banerjee
Smt. Amita Chakraborty
Shri S. Karmakar
Shri P. K. Ghosh
Smt. Jaysri Pal
Shri Sukumar Sarkar
Shri Achinta Kr. De
Miss Sefali Biswas
Shri Surendra Kumar
(up to 19.2.1988)
Shri C. K. N. Sahi
Shri D. Chowdhury
Shri K. Subba Rao
Shri S. K. Tikadar
Smt. Geeti Majumdar
Shri Kunja Behari
Shri Ambika Lal
Miss Swapna Talapatra
Shri Paras Ram
(from 28.11.1987)

The following members of staff of supporting grade rendered their services during the period.

Supporting Grade IV

Shri H. K. Routh (upto 9.3.88)
Shri H. K. Paramanick
Shri Mewalal
Shri H. B. Lama
Shri H. K. Das
Shri J. N. Biswas
Shri S. K. Das
Shri Sitaram Nishad (inter-Institutional transfer w.e.f. 2.6.1987)
Shri Moolchand Raikwar
Shri R. L. Raikwar
Shri P. V. Verghese
Shri Anti Ram Das
Shri T. K. Biswas

Supporting Grade III

Shri K. K. Das (up to 9.3.88)
Shri S. N. Burman
Shri S. K. Burman
Shri Prahlad Singh
Shri G. C. Mondal
Shri Ram Prasad
Shri Satyendra Burman
Shri Sita
Shri Rajdhari Mallah
Shri S. P. Yadav
Shri R. N. Tiar
Shri H. L. Biswas (up to 9.3.88)
Shri Nar Bahadur
Shri A. M. Patra
Shri Bhim Bahadur
Shri H. K. Burman
Shri Khem Chand Balmiki
Shri Balaram Bhanja
Shri Munshiram Balmiki
Smt. Hemlata Halder
Shri S. N. Nan
Shri U. Nayak
Shri A. K. Dey
Shri Iswarram Balmiki
Shri G. C. Paramanick
Shri S. K. Boral
Shri Tek Bahadur
Shri Jugal Kishore
Shri Jangali
Shri Gulab Shaw
Shri Karan Raj
Shri Lalta Prasad
Shri Munnilal Mallah
Shri P. Sayalu
Shri Biswanath Mandal
Shri Lalu Ram
Shri Sitaram Balmiki
Shri M. S. Burman
Shri N. L. Das
Shri S. N. Chaki (up to 9.3.88)

Supporting Grade III

Shri A. K. Biswas
Shri B. B. Das
Shri H. S. Burman
Shri S. G. Biswas
Shri Balkishan Balmiki
Shri M. Balmiki
Smt. Rupali Chatterjee
Shri A. K. Barui (up to 9.3.88
Shri M. L. Saha

Supporting Grade II

Shri S. Chakraborty (up to 9.3.88)
Shri A. C. Ghosh
Shri Durga Dutta Pandel
Shri Budh Prakash
Shri Bideshi Lal
Shri Ram Sundar
Shri K. Kalianan
Shri C. K. Bhava
Shri S. T. Gavate
Shri G. J. Roundali
Shri T. H. Ghume
Shri Bholanath Mondal
Shri K. D. Raju
Shri P. Seshanna
Shri Om Prakash
Shri Parasram
Shri M. Mahadeva
Shri M. Anyanappa
Shri B. Hazarika
Shri S. S. Burman
Shri A. Sahani
Shri J. M. Kujur
Shri Parameshwar
Shri J. Mukhia
Shri L. K. Halder
Shri K. L. Balmiki
Shri Chatter Singh
Shri Sukchand Biswas
Shri Maha Singh
Shri S. C. Balmiki
Shri M. V. Krishnan
Shri A. Ramaswamy
Shri S. S. Bondre
Shri M. S. Bhoi
Shri G. N. Mallah
Shri Suraj Bahadur
Shri L. Somulu
Shri M. B. Naik
Shri Kuldeep Singh
Shri Subramani
Shri K. Nagi Gowda
Shri B. N. Krishnappa
Shri B. C. Das
Shri C. P. Singh
Shri Rajendra Ram
Shri A. L. Yadav
Shri Jairam Prasad

Supporting Grade I

Shri C. P. Singh
Shri Bharat Halder
Shri S. K. Mansoor Ali
Shri N. K. Das
Shri Hiralal Bose (on long leave)
Shri S. K. Chakraborty
Smt. Mina Bahadur
Smt. Kaloshashi Mandal
Shri Sree Nath
Shri R. D. Chowdhury
Shri Yusuf Dar (joined on 9.12.1987)
Shri A. Murugesan
Shri Man Bahadur
Shri S. Govindarajan
Shri R. Palaniswamy
Shri Shitala Prasad
Smt. Lakshmiram
Shri Kawlpatiram
Shri H. P. Bhanja
Shri N. Rajak
Shri A. Gangaih
Shri V. Satyanarayana
Shri P. Atchaiah
Shri Mohan Ch. Das
Shri P. C. Bej
Shri P. C. Kachari
Shri N. Deka
Shri S. Guin
Shri S. Rajak
Shri R. V. Moochi
Smt. Anjali Dutta
Shri Ananda Biswas
Shri P. C. Paramanick
Shri Jaydev Patra
Shri Gunadhar Dhibar
Shri Sanker Bose
Shri Gopal Chand
Shri T. P. Ghosh
Shri Khorban Kumar
Shri G. Lal
Shri M. P. Das
Shri A. C. Biswas
Shri Lakhiram
Shri K. Subramanium
Shri K. K. Dhir
Shri V. Mariappan
Shri K. Subbiayan
Shri S. Mahendran
Shri Atiullah
Shri Karna Bahadur
Shri Dukharam Sahni
Shri U. Chowdhuri
Shri Mahadev Panikar
Smt. Godhuli Mondal
Shri P. N. Rao
Shri A. Krishtaih
Shri Syed Jaan
Smt. Kamala Devi
Shri D. C. Das

Supporting Grade I	Supporting Grade I	Supporting Grade I
Shri Bablu Boro	Shri Bhaskar Sardar	Shri R. K. Sardar
Shri Khagen Ch. Das	Shri P. Ghosh	Shri Lal Bahadur
Shri Anil Ch. Das	Shri J. Balmiki	Shri Mohan Lal Sarkar
Smt. Bimla Devi	Shri S. Banerjee	Smt. Mina Biswas
Shri Joseph Khalko	Shri S. C. Sadhukhan	Smt. Biramkala Devi
Shri M. P. Bind	Shri Sibulal Das	Shri Kartik Ch. Malakar
Shri Paramjeet Singh	Shri Dipak Chakraborty	Shri Dilip Kr. Das
Shri A. Bhattacharjee	Shri Biswanath Bose	Smt. B. Sakuntala
Shri G. L. Bairagi	Shri A. K. Bhanja	Shri M. Dutta

PROMOTION

On recommendation of the Agricultural Scientists Recruitment Board the following Scientists of this Institute were promoted as shown below:

Name	Designation	Promoted to	With effect from
Dr. P. V. Dehadrai	S-3	S-5 (Personal Grade)	1.1.1983
Dr. V. R. P. Sinha	S-3	S-5 (Personal Grade)	1.1.1984
Dr. K. K. Vass	S-2	S-3	1.1.1984
Shri D. K. De	S-1	S-2	1.1.1984
Shri A. Mukherjee	S-1	S-2	1.7.1982
Shri S. N. Dutta	S-1	S-2	1.7.1982
Shri A. C. Nandy	S-1	S-2	1.7.1980

The following members were promoted/granted advance increments as below on the recommendation of the Assessment Committee.

Name 1	Designation 2	Promoted to 3	With effect from 4
Shri N. K. Srivastava	T-4	T-5	1.1.1986
Smt. Sukla Das	T-4	T-5	1.1.1986
Shri A. K. Roy	T-II-3	T-4	1.7.1982
Shri M. F. Rahman	T-II-3	T-4	1.7.1982
Shri P. S. C. Bose	T-II-3	T-4	1.7.1982
Shri K. K. Agarwal	T-II-3	T-4	1.7.1982
Shri Ramchandra	T-II-3	T-4	1.7.1982
Shri D. N. Srivastava	T-II-3	T-4	1.1.1985
Shri N. D. Sarkar	T-II-3	T-4	1.1.1985
Shri A. R. Paul	T-II-3	T-4	1.1.1985
Shri N. C. Mondal	T-II-3	T-4	1.1.1985
Shri K. S. Banerjee	T-II-3	T-4	1.1.1985
Shri N. N. Majumder	T-II-3	T-4	1.1.1985
Shri S. P. Ghosh	T-II-3	T-4	1.1.1985
Shri Alok Sarkar	T-II-3	T-4	1.1.1985
Shri B. D. Saroj	T-II-3	T-4	1.1.1985
Shri H. K. Sen	T-II-3	T-4	1.1.1985
Shri P. Dasgupta	T-II-3	T-4 (Ad-hoc)	1.9.1987
Shri Ramji Tiwary	T-I-3	T-II-3	1.4.1987
Shri Swapan Kr. Chatterjee	T-2	T-I-3	1.1.1987
Shri B. B. Das	T-2	T-I-3	1.1.1987
Shri K. P. Singh	T-2	T-I-3	1.1.1986
Shri J. P. Mishra	T-2	T-I-3	1.1.1985
Shri Badal Lal Singh	T-2	T-I-3	1.1.1986
Shri K. R. Deb	T-2	T-I-3	1.1.1986
Shri R. L. Balmiki	T-2	T-I-3	1.1.1987
Shri Suraj Bahadur	T-2	T-I-3	1.1.1987
Shri N. C. Biswas	T-2	T-I-3	1.1.1987

Name	Designation	Promoted to	With effect from
Shri Kanchan Dutta	T-2	T-I-3	1.1.1987
Shri U. K. Chatterjee	T-2	T-I-3	1.1.1987
Shri T. P. Ghosh	T-2	T-I-3	1.1.1986
Shri K. Ganeshan	T-1	T-2	1.1.1986
Shri M. C. Pal	T-1	T-2	1.1.1986
Shri D. Borgoyary	T-1	T-2	1.1.1987
Shri S. K. Biswas	T-1	T-2	1.1.1986
Shri S. N. Sadhukhan	T-I-3	2 advance increments	1.1.1987
Shri Swapan Chatterjee	T-I-3	1 advance increment	1.1.1987

The following administrative/supporting members of staff were promoted as shown below on the recommendations of the Departmental Promotion Committee.

Name	Designation	Promoted to	With effect from
Shri K. B. Rajani	Asst. Adm. Officer	Adm. Officer	29.9.1987
Shri A. K. Sengupta	Superintendent	Asst. Adm. Officer	1.8.1987
Shri N. K. Sarkar	Assistant	Superintendent	1.8.1987
Shri I. N. Kodandaraman	Sr. Clerk	Assistant	1.8.1987
Shri S. K. Pramanick	Sr. Clerk	Assistant (Ad-hoc)	1.8.1987
Shri S. Bhattacharyya	Jr. Steno	Stenographer (Ad-hoc)	
Shri S. K. Das	SSG-III	SSG-IV	1.8.1987
Shri R. L. Raikwar	SSG-III	SSG-IV	1.8.1987
Shri H. K. Routh	SSG-III	SSG-IV	1.8.1987
Shri T. K. Biswas	SSG-III	SSG-IV	1.8.1987
Shri Harke Bahadur Lama	SSG-III	SSG-IV	1.8.1987
Shri H. K. Das	SSG-III	SSG-IV	1.8.1987
Shri Anti Ram Das	SSG-III	SSG-IV	1.8.1987
Shri J. M. Kujur	SSG-III	SSG-IV	1.8.1987
Shri S. K. Boral	SSG-II	SSG-III	1.8.1987
Shri Jugal Kishor	SSG-II	SSG-III	1.8.1987
Shri Jangli	SSG-II	SSG-III	1.8.1987
Shri Balaram Bhanja	SSG-II	SSG-III	1.8.1987
Shri S. P. Yadav	SSG-II	SSG-III	1.8.1987
Shri S. N. Chaki	SSG-II	SSG-III	1.8.1987
Shri B. B. Das	SSG-II	SSG-III	1.8.1987
Shri P. Sayalu	SSG-II	SSG-III	1.8.1987
Shri S. N. Burman	SSG-II	SSG-III	1.8.1987
Shri R. N. Tair	SSG-II	SSG-III	1.8.1987
Shri Tek Bahadur	SSG-II	SSG-III	1.8.1987
Shri P. Singh	SSG-II	SSG-III	1.8.1987
Shri S. K. Burman	SSG-II	SSG-III	1.8.1987
Shri B. N. Mondal	SSG-II	SSG-III	1.8.1987
Shri G. C. Mondal	SSG-II	SSG-III	1.8.1987
Shri S. T. Govate	SSG-I	SSG-II	1.8.1987
Shri Sita	SSG-I	SSG-II	1.8.1987
Shri Joseph Khalko	SSG-I	SSG-II	1.8.1987
Shri Om Prakash	SSG-I	SSG-II	1.8.1987
Shri M. Mallah	SSG-I	SSG-II	1.8.1987
Shri R. Mallah	SSG-I	SSG-II	1.8.1987
Shri Lalta Prasad	SSG-I	SSG-II	1.8.1987
Shri B. C. Das	SSG-I	SSG-II	1.8.1987
Shri A. C. Ghosh	SSG-I	SSG-II	1.8.1987
Shri Laxmi Ram	SSG-I	SSG-II	1.8.1987
Shri Dukhram	SSG-I	SSG-II	1.8.1987
Shri Subramani	SSG-I	SSG-II	1.8.1987
Shri M. Mahadeva	SSG-I	SSG-II	1.8.1987
Shri K. Niugegawda	SSG-I	SSG-II	1.8.1987
Shri H. K. Pramanik	SSG-III	SSG-IV	13.11.1987

Retirements during the period

Name	Designation	Place of posting	Date of Retirement
Shri N. P. Saha	T-I-3	Barrackpore	30.6.1987
Shri N. D. Sarkar	T-4	Raidighi	1.10.1987
Shri P. B. Das	T-5	Barrackpore	31.12.1987

Resignation

Name	Designation	Date of acceptance
Shri Radha Raman Debnath	Jr. Clerk	31.7.1987 (AN)

Appointments

Following appointments were made during the period April 1987 to March, 1988.

Name	Designation	Place of posting	Date of appointment
Shri Jyotirmoy Ghosh	T-6 Sr. Reprographic Officer	Barrackpore	11.8.1987 (AN)
Shri A. C. Biswas	SSG-I	Allahabad	8.9.1987
Shri N. Deka	SSG-I	Guwahati	9.9.1987
Shri Arup Chatterjee	Assistant	Barrackpore	21.9.1987
Shri Balbir Singh	SSG-I	Raipur	21.9.1987
Smt. Kamla Devi	SSG-I	Bilaspur	1.10.1987
Shri R. D. Chowdhury	SSG-I	Allahabad	3.10.1987
Smt. Bimla Devi	SSG-I	Patna	19.10.1987
Shri Mohan Lal Sarkar	SSG-I	Barrackpore	20.11.1987
Shri Paras Ram	Jr. Clerk	Bhagalpur	28.11.1987
Shri Paramjeet Singh	SSG-I	Raipur	7.12.1987
Miss. G. Vinoda Lakshmi	Jr. Steno	Bangalore	14.12.1987
Shri Dipankar Chatterjee	T-2	Barrackpore	10.3.1988
Miss. Rina Basak	T-2	Barrackpore	22.3.1988
Shri S. Chakraborty	T-I	Barrackpore	10.3.1988
Shri S. N. Chaki	T-I	Barrackpore	10.3.1988
Shri Hiralal Biswas	T-I	Barrackpore	10.3.1988

Transfers

The following members of CICFRI were transferred during the period April, 1987 to March, 1988.

Name	Designation	From	To
Dr. S. K. Mukhopadhyay	S-3	Rahara	Barrackpore
Shri S. P. Singh	S-3	Allahabad	Guwahati
Dr. K. R. Naskar	S-2	Rahara	Barrackpore
Dr. R. K. Banerjee	S-2	Rahara	Calcutta
Shri K. P. Srivastava	S-2	Allahabad	Muzaffarpur
Dr. R. S. Panwar	S-2	Allahabad	Eluru
Dr. D. N. Singh	S-2	Guwahati	Allahabad
Shri P. K. Chakraborty	S-2	Canning	Barrackpore
Shri B. C. Jha	S-2	Bilaspur	Muzaffarpur
Shri P. N. Jaitly	S-1	Ranchi	Patna
Shri N. C. Mandal	T-4	Diamond Harbour	Barrackpore
Shri K. R. Deb	T-I-3	Rahara	Barrackpore
Shri B. B. Das	T-I-3	Rahara	Calcutta
Shri M. C. Pal	T-2	Kakdwip	Barrackpore
Shri D. Safui	T-2	Kakdwip	Diamond Harbour
Smt. Geeti Majumdar	Jr. Clerk	Barrackpore	Calcutta
Shri S. K. Chakraborty	SSG-I	Kakdwip	Diamond Harbour

Relieved from the Institute to take up new assignment to other organisations during the period April 1987 to March, 1988.

Name	Designation	Relieved on	To join at
Shri Jagadish Rai	Sr. Clerk	2.6.1987	NBAGR & NIAG, NDRI Campus,Karnal
Smt. Sukla Das	T-5	16.9.1987	NBFGR, Allahabad
Shri M. R. Saha	SSG-I	6.10.1987	ICAR Lab. to Land Programme Zone-II, BCKVV, Mohanpur
Shri M. L. Biswas	Asst. Adm. Officer	15.10.1987	CIAE, Bhopal
Shri S. P. Sastry	Assistant	7.12.1987	NAARM, Hyderabad
Dr. M. Sinha	S-2	29.12.1987	NBFGR, Allahabad

APPENDIX I

Ministry/Department/Office of the Central Inland Capture Fisheries Research Institute (I.C.A.R.), Barrackpore, West Bengal. Statement showing the total number of I.C.A.R. servants and the number of Scheduled Castes and Scheduled Tribes among them as on 31st March, 1988.

Group/Class	Permanent/ Temporary	Total no. of employees	Scheduled castes	Percentage of total employees	Scheduled tribes	Percentage of total employees	Remarks
Gr. A (Cl. I)							
Permanent—							
(*i*) Other than lowest rung of Cl. I		76	5	6·57	—	—	
(*ii*) Lowest rung of Cl. I total		23	2	8·70	—	—	
Temporary—							
(*i*) Other than lowest rung of Cl. I		—	—	—	—	—	
(*ii*) Lowest rung of Cl. I		—	—	—	—	—	
Gr. B (Cl. II)	Permanent	33	8	24·24	2	6·06	
	Temporary	3	—	—	—	—	
Gr. C (Cl. III)	Permanent	107	22	20·56	2	1·87	
	Temporary	50	9	18	—	—	
Gr. D (Cl. IV)	Permanent	145	45	31·03	7	4·83	
Excluding sweepers	Temporary	33	4	12·12	2	6·06	
Gr. D (Cl. IV)	Permanent	12	12	100	—	—	
Sweepers	Temporary	1	1	100	—	—	

APPENDIX II

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
(ICAR) : BARRACKPORE : WEST BENGAL

Address List of Research/Survey Centres

	Research/Survey Centre	Telegram/Telephone
1.	**Central Inland Capture Fisheries Research Institute** Barrackpore-743 101 West Bengal	FISHSEARCH BARRACKPORE 53-161 53-322
2.	**Allahabad Research Centre** Central Inland Capture Fisheries Research Institute 24, Pannalal Road Allahabad-211 002, U.P	FISHSEARCH ALLAHABAD-2
3.	**Bangalore Research Centre** Central Inland Capture Fisheries Research Institute No. 51, 8th Cross Road 7th Main, Malleswaram Bangalore-560 003, (Karnataka)	FISHSEARCH BANGALORE-3 36-6610
4.	**Bhagalpur Research Centre** Central Inland Capture Fisheries Research Institute Khanjarpur, Beatson Road Bhagalpur-812 001, (Bihar)	1385
5.	**Bilaspur Research Centre** Central Inland Capture Fisheries Research Institute Roara Sector, Bilaspur-174 001 Himachal Pradesh	
6.	**Calcutta Research Centre** Central Inland Capture Fisheries Research Institute 39, Rabindra Sarani, (3rd Floor) Calcutta-700 073 West Bengal	
7.	**Canning Survey Centre** Central Inland Capture Fisheries Research Institute R. N. Tagore Road Canning-743 329 West Bengal	
8.	**Diamond Harbour Survey Centre** Central Inland Capture Fisheries Research Institute House of Bidhu Bhushan Bhuiya New Madhavpur, P.O. Diamond Harbour 24-Parganas (South), West Bengal	
9.	**Digha Survey Centre** Central Inland Capture Fisheries Research Institute Digha, Midnapur Dist West Bengal	
10.	**Eluru Research Centre** Central Inland Capture Fisheries Research Institute Sastry Bhavan D.M.C. Home Street, Kandukuruvarithota Patehbad, Eluru-2, West Godavari Dist Andhra Pradesh	

Research/Survey Centre	Telegram/Telephone
11. **Guwahati Research Centre** Central Inland Capture Fisheries Research Institute Natun Sarania Guwahati-781 003 Assam	23831
12. **Agra Research Centre** Central Inland Capture Fisheries Research Institute 221, Jaipur House Agra-282 010	
13. **Lalgola Survey Centre** Central Inland Capture Fisheries Research Institute Lalgola, Dist. Murshidabad, West Bengal Pin-742 148.	
14. **Muzaffarpur Research Centre** Central Inland Capture Fisheries Research Institute House No. 113, Ward No. 27 Damuchak, Muzaffarpur-842 001, Bihar	
15. **Patna Research Centre** Central Inland Capture Fisheries Research Institute 2-C(A), Peoples Cooperative (2nd Floor) Kankarbagh, Patna-800 020, Bihar	26285
16. **Pollachi Research Centre** Central Inland Capture Fisheries Research Institute 10, Chakrapani Iyer Street, Venkatesa Colony Pollachi-642 001, Tamil Nadu	
17. **Pune Research Centre** Central Inland Capture Fisheries Research Institute Flat No. 6, Indraprasta Housing Society Godital-Hadapsar P.O., Pune-411 028 Maharastra	
18. **Raidighi Survey Centre** Central Inland Capture Fisheries Research Institute Raidighi, 24-Parganas (South) West Bengal	
19. **Raipur Reservoir Fisheries Research Centre** Central Inland Capture Fisheries Research Institute 326, 'Ashirwad' Shankar Nagar, Near Bottle House Raipur-492 007, M.P.	CENTRAL FISHERIES 32, ASHIRWAD SHANKAR NAGAR NEAR BOTTLE HOUSE, RAIPUR
20. **Srinagar Research Centre** Central Inland Capture Fisheries Research Institute Harwan, Srinagar-191 123, Kashmir	FISHESARCH SRINAGAR
21. **Uluberia Survey Centre** Central Inland Capture Fisheries Research Institute Uluberia, Dist. Howrah, West Bengal	

APPENDIX III

ORGANIZATION CHART, 1987-88

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
BARRACKPORE-743 101, WEST BENGAL