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1. PREFACE

The fish germplasm resources of the country found in diverse agroclimatic regions contribute substantially to India's food and nutritional requirements. However these resources are declining rapidly due to several factors. The liberalisation of the Indian economy and the changing global scenario has led to newer threats to biodiversity as well as opportunities for equitable sharing of benefits from aquatic resources. As we move into the next millennium, we need to give greater emphasis on achieving the ultimate goal of sustainable utilisation of India's germplasm resources. During the year, NBFGR continued its efforts in developing techniques and formulating location specific strategies for conservation of fish germplasm. The new initiatives during the current year were building database of fish germplasm using modified software, formulation of NATP projects, fish germplasm inventorisation in the protected areas of North Eastern States as well as greater use of geographical information system and DNA fingerprinting. I thank the scientific and other staff of NBFGR for working hard to accomplish the targets set.

The NBFGR from its inception was housed in hired accommodation, but this year it stepped into its own permanent building complex at Canal Ring Road, Telibagh, Lucknow. I am pleased to highlight that the new building was inaugurated by Hon'ble Prime Minister Shri Atal Behari Vajpayee which indicates the commitment of Indian Government to conserving biodiversity. I would like to express my gratitude for Dr. R.S. Paroda, Director General, ICAR who has been a great source of encouragement and support which provided much needed strength in sustaining the development of the Bureau. I am grateful to Dr. K. Gopakumar, Deputy Director (Fisheries) for the time and effort he had given in helping our programme. I thank Dr. R.A. Selvakumar, Assistant Director General (Fisheries), ICAR for the continued support he had extended in implementing all the tasks. As we move into our building, I and the staff of NBFGR look back with gratitude for the support given by Dr. P.V. Dehadrai, former Deputy Director General (Fisheries), ICAR and Dr. P. Das, Ex-Director, NBFGR who had worked tirelessly in establishing NBFGR in its permanent building. I hope that the flurry of activities of the recent past will accelerate the pace of work in new millenium. It is hoped that the Annual Report will foster interest on issues of conserving aquatic biodiversity and their sustainable utilization in a holistic way. We solicit comments and suggestions for the expansion of our activities and for fostering greater linkages with stake holders.

(A.G. PONNIAH)
DIRECTOR

2. EXECUTIVE SUMMARY

The sustainable utilization of genetic resources, including fish, is imperative for the socio-economic status of a large country like India. Legitimate concern about declining harvests and obvious reduction in fish biodiversity brewed over the course of time, necessitated a more holistic approach to aquaculture and fisheries management and research in regard to exploitation and conservation. To address this apparent need, the Government of India in 1983 added to its chain of Fisheries Research Organization, the National Bureau of Fish Genetic Resources under ICAR. From its inception it was housed in hired accommodation. The laboratory buildings are in the final stages of completion. From April, 1999 it is functioning from its own building at Canal Ring Road, Telibagh, Lucknow.

Within a short span of years after its establishment, NBFGR has emerged as a pioneering research Institute in the country in the field of *in situ* and *ex situ* conservation of fish genetic resources.

During the current year, research was conducted in identified thrust areas of fish germplasm conservation through eight research projects. The significant achievements during the year are herewith summarized.

Database

The database of 220 aquarium fish found in India was prepared on the basis of published information. The available database on fish biodiversity of India was updated by incorporating 800 synonyms. List of sixty four potential ornamental and thirty five cultivable endemic to peninsular India was added to the main database and twenty two images of commercially important fishes were incorporated in the database. Fish biodiversity of two bird sanctuaries in Uttar Pradesh was studied and it was discovered that in these sanctuaries, those fish species were found that are threatened in other parts of the country.

Geographical Information Systems (GIS)

Microhabitat inventory along with sampling for periphyton, an important constituent of endangered mahseer diet, was conducted in Kosi river. The habitat conditions for fish was also assessed in Ramganga (West, East), Saryu, Gola and Kali rivers. A GIS map of the Kosi river was prepared showing road network, forest area, major places and the tributaries. This forms the base digital map for overlaying microhabitat details. Methodology was developed for arranging habitat inventory data at micro level on GIS using GPS and remote sensing techniques. Through microhabitat inventory it was possible to identify optimum habitat for different life stages of endangered Mahseer. Also the influence of Bisauria nala, a natural phenomenon on fish habitat inventory, was quantified. Information was also collected on macro level fish distribution data on digital map from Internet.

Conservation of endangered mahseer

Survey was conducted in the Kosi river in Kumaon region on the present status of fish biodiversity, abundance, distribution, angling success, local community involvement and socio-economic impact. Fish sampling in twelve selected stations in Kosi stream were done and the data on various aspects of fisheries conservation were quantified covering more than 150 km. stretch. The deep pools were identified where big sized mahseer inhabited. The fishing methods with particular reference to indigenous and destructive methods in the major and minor hill-streams of Kumaon region were documented. Of these, eight types were destructive of which use of dynamite, pesticides/ bleaching and electric current are most destructive. Various life history traits of endangered *Tor putitora* were studied. Attempts were also made to induce breed the mahseer under pond conditions at State Fisheries Farm, Dhakrani near Dehradun.

Socio economic survey of people residing on banks of Kosi river was carried out to determine the people's perception on fish biodiversity, threats and possible conservation measures that can be adopted. There is a strong support of the local people in favour of implementing conservation efforts. The potential area for angling mahseer was identified on the basis of anglers catch data in Kumaon region. A mass awareness programme was organised at Ramnagar on saving endangered mahseer in collaboration with local NGO, the Corbett Foundation. 'Mahseer Bachao Gosthis' were formed at Mohan village. A hoarding with conservation slogan was fixed near Kosi barrage. Under North East collaborative project, surveys on the fish germplasm in eight states have been completed. The germplasm inventory in three protected areas of Assam (Manas Wildlife sanctuary, Dibruchaikhowa, Loharband) was carried out. Peoples participatory programmes on the awareness of saving endangered fishes of North East were organized in the villages surrounding Jai-Bhorelli river, Fisheries College at Raha and Balipara fish market in Nagaon district.

Exotics

The spread of exotic fish *Clarias gariepinus* and *Aristichthys nobilis* in six districts of Uttar Pradesh was documented on the basis of survey undertaken in collaboration with U.P. State Fisheries Department. The reasons for culturing exotics by the farmers were identified. Evidences to indicate natural breeding of exotic magur from five districts of U.P. was collected. A workshop was also organized at Varanasi in collaboration with U.P. State Fisheries Department on 23rd December, 1998 to bring awareness amongst the farmers about the ecological and other consequences of exotic fish culture.

Fish Pathology & Quarantine

The incidence and intensity of parasites in native *Clarias batrachus* and exotic *C. gariepinus* were studied up to generic level. The highest infection was with digeneans in terms of prevalence (62.6%) and with cestodes in terms of intensity (11.2%). The information on introduction of exotics and quarantine guidelines of various countries

were compiled with the help of Internet. As a nodal agency of ICAR to consolidate Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) data entry forms, contacts were made with ICAR fisheries Institutes.

Cytogenetics

Genotoxic screening of malathion on *Mystus vittatus* and *Channa punctatus* revealed dose dependent increase in percentage of micronuclei. Chromosomal abnormalities like chromatid break, gaps polyploidy and occurrence of sister chromatid exchanges were also recorded. The genotoxic effect of the pesticide chloropyrifos and carcinogenic agent p-aminobenzene on *C. punctatus* was also studied which indicated higher levels of micronuclei in treated groups.

Comet assay trials made on *C. punctatus* indicated no specific pattern with respect to control and treated fish in blood samples. Successful blood cell culture was carried out for *C. gariepinus*. Through *in-vitro* colch/ inisation techniques with kidney tissue of cat fishes and rohu, three fold increase in size of metaphase chromosome was obtained compared to conventional techniques.

Biochemical Genetics

Natural genetic variations of eight riverine populations of *Labeo rohita* were analyzed using isozyme and IEF of eyelens markers. Allelic variation in seventeen isozyme loci were quantified. Large number of catla-rohu hybrids were identified in areas adjoining river Rapti and Beas which were stocked with hatchery seed. These areas are subject to inundation and get connected with the river. These fishes of hatchery origin can interbreed with natural stocks and result in contamination of wild stocks. Hybrid one each were also collected from natural collections in Ganga and Naukuchiatal.

In order to identify genetic introgression between endemic *Clarias batrachus* and exotic *C. gariepinus*, both the species were characterized with isozyme and IEF markers. Clear species specific differences were obtained with IEF of haemoglobin than isozyme markers, due to the high amount of genetic variability observed with isozyme markers which masks species specific markers.

The biochemical genetic profile of endangered *Labeo dussumieri* was worked out in comparison with *L. fimbriatus* and *L. rohita*. In all the enzyme systems screened, species specific profiles were found. Quantification of genetic variation in Meenachil river population of *L. dussumieri* indicated fairly high level of variability. The genetic characterization of whitefish *Lactarius lactarius* was continued with analysis of isozyme pattern of specimens from Cochin (West coast) and Kakinada (East coast). The results indicated genetic difference between both populations indicating that they belong to different stocks.

DNA Fingerprinting

Species specific Amplified Restriction Fragment Length Polymorphism (ARFLP) pattern for mtDNA ND5/ND6 was determined for *Clarias batrachus* and *C. gariepinus* using PCR primers. Results indicate that ARFLP can be utilized as genetic marker to quantify introgression

between these two species. Using 12 random Amplified Polymorphic DNA (RAPD) primers intraspecific variation in *Labeo rohita* from three different river system was quantified. Out of 56 bands scored, 27 were polymorphic in the populations tested.

Utilising microsatellite primers available for catla, intraspecies variations in *L. rohita* was studied and polymorphism was detected. Out of five catla primers tested, G1 locus gave repeatable polymorphic bands and 4 alleles were observed. The rare allele of 123 bp was found in Sutlej and absent in Rapti samples. The study indicated that by addition of more polymorphic loci, populations can be differentiated on the basis of microsatellites.

Gene Banking

Cryopreservation on three selected endangered fish species such as *Labeo dussumieri, Tor putitora* and *Schizothorax richardsonii* were undertaken. The efficiency of various extenders were evaluated for three endangered species. In *L. dussumieri* through fertility trials and for other two species through motility studies, optimum extender was selected. *Labeo dussumieri* is the tenth fish whose cryopreservation protocol has been standardized by NBFGR through actual fertilization trials. *Schizothorax richardsonii* is the eleventh species whose cryopreserved milt has been added to NBFGR's mini gene bank.

Technology Assessed and Transferred

The technology for cryopreservation of fish spermatozoa was developed in connection with its programme on gene banking. The techniques for *Labeo dussumieri* was perfected and demonstrated to Regional Agricultural Research Station of Kerala Agricultural University. With the technology of genetic markers of Indian major carps, introgressed individuals were identified. Arrangements have been worked out for utilization of cryopreservation techniques in seed production by a progressive fish farmer of Punjab. Awareness programmes on saving endangered species were conducted in association with Corbett Foundation, Ramnagar and pamphlets in local language were distributed. Similar programmes were organized in North-East States.

Infrastructure developed

The building complex consisting of administrative office, service block, ponds, residential quarters have been completed. The laboratory building is in the final stages of completion. The ARIS cell was further strengthened by addition of softwares and anti-virus packages.

Library and Documentation

The library procured a new computer (Pentium II, 32 X CD ROM Drive and complete multimedia kit), with the prime object of providing information from the Internet. Library has purchased 220 books, 102 reprints and subscribed to 84 National and International Journals. The Library has continued the subscription to the CDROM on ASFA-database and CAP service of INSDOC and procured the relevant papers/ articles from their Journals. The publications brought out were (i) Fish Chromosome Atlas, (ii) Annual Report (1997-98) and (iii) List of NBFGR publications (1984-94).

3. कार्यकारी सारांश

भारत जैसे घनी आबादी वाले राष्ट्र की सामाजिक एवं आर्थिक उत्थान के लिए प्राकृतिक मत्स्य आनुवंशिक संपदा का विवेकपूर्ण दोहन अति आवश्यक है। चुनिंदा मत्स्य प्रजातियों के उत्पादन एवं जैव विविधता में गिरावट, मत्स्य संपदा के अधिक दोहन एवं संरक्षण के संबंध में एक परिपूर्ण एवं सुगम्य अनुसंधान प्रबंध के तरफ संकेत करती है। इस आवश्यकता को ध्यान में रखते हुए भारत सरकार द्वारा सन् 1983 में भारतीय कृषि अनुसंधान परिषद के अन्तर्गत मत्स्य की अनुसंधान संस्थानों की कड़ी में राष्ट्रीय मत्स्य आनुवंशिक संसाधन ब्यूरो की स्थापना की गई। प्रारम्भ से अब तक यह किराए के भवन में रहा। जिसकी प्रयोगशाला भवन आदि तैयार होने की अन्तिम अवस्था में है। अब यह संस्थान अप्रैल, 1999 से कैनाल रिंग रोड, तेलीबाग स्थित अपने परिसर में स्थाई रूप से कार्य कर रहा है ।

अपने स्थापना के पश्चात् अल्प समय में ही यह संस्थान मत्स्य आनुवंशिक संपदा के यथावत् (इन–सीटू) एवं बाह्य प्रयोगशाला में (एक्स–सीटू) संरक्षण के क्षेत्र में देश के एक अग्रणी अनुसंधान संस्थान के रूप में उभरा है।

इस वर्ष के अन्तर्गत मत्स्य जनन द्रव्य संरक्षण के निर्धारित ज्वलन्त क्षेत्रों में आठ अनुसंधान परियोजनाओं के द्वारा अनुसंधान कार्य किया गया। इस वर्ष की प्रमुख अनुसंधान उपलब्धियाँ निम्नवत् हैं।

डाटा बेस

प्रकाशित सूचनाओं के आधार पर भारत में पाई जाने वाली 220 प्रकार की जलशाला मत्स्य प्रजातियों का डाटा बेस तैयार किया गया। पूर्व मत्स्य जैव विविधता डाटा बेस में 800 पर्याय नाम सम्मिलित कर डाटा बेस का परिवर्धन किया गया। प्रायद्वीपीय भारत के विशेष क्षेत्री 64 सजावटी एवं 35 पालने योग्य मत्स्य प्रजातियों की सूची मुख्य डाटा बेस में जोड़ी गयी तथा व्यवसायिक महत्व की 22 मत्स्य प्रजातियों के चित्र को डाटा बेस में समाहित किया गया। उत्तर प्रदेश के दो पक्षी विहार स्थलों के मत्स्य जैव विविधता का अध्ययन किया गया तथा यह पाया गया कि इन पक्षी विहारों में वे मत्स्य प्रजातियाँ मौजूद हैं जो देश के अन्य भागों में संकट ग्रस्त हैं।

भौगोलिक सूचना तंत्र

लुप्तप्राय महाशीर के खाद्य पदार्थ का एक प्रमुख घटक पेरीफाइटम का नमूना एकत्र करते हुए कोसी नदी में महाशीर के सूक्ष्म वासस्थलों को सूची–बद्ध किया गया। रामगंगा (पश्चिमी, पूर्वी) सरयू, गोला एवं काली नदियों में मछलियों के निवास स्थानों की दशा का आंकलन भी किया गया। भौगोलिक सूचना पद्धति द्वारा कोसी नदी का सड़क, वन क्षेत्र, प्रमुख स्थानों एवं सहायक नदियों को दर्शाते हुए जी0आई0एस0 मानचित्र तैयार किया गया। यह सूक्ष्म वासस्थल विवरणों को आच्छादित करने के लिए आधार अंकीय मानचित्र (डिजिटल मैप) का काम करेगा। सुदूर संवेदी तकनीकी एवं जी0पी0एस0 का उपयोग करते हुए वासस्थल सूची के डाटा को बारीकी से जी0आई0एस0 पर व्यवस्थित करने की विधि विकसित की गई है। सूक्ष्म वासस्थल सूची के द्वारा महाशीर के जीवन अवस्थाओं के अनुकूल वासस्थलों

का पता लगाना संभव हुआ था। एक प्राकृतिक प्रक्रिया (घटना) बिसुरिया नाले के मत्स्य वासस्थल सूची पर प्रभाव को भी परिमापित किया गया। इन्टरनेट से अंकीय मानचित्र (डिजिटल मैप) पर मछलियों के वृहत्त रूप से वितरण की सूचनाएँ भी एकत्रित की गई।

लुप्तप्राय महाशीर का संरक्षण

कुमायूं मंडल के कोसी नदी के वर्तमान मत्स्य जैव विविधता, प्रचुरता, वितरण, मीनवेधन सफलता, स्थानीय लोगों की संबद्धता, सामाजिक तथा आर्थिक प्रभाव आदि का सर्वेक्षण किया गया। कोसी नदी के 150 कि0मी0 से भी अधिक विस्तार को लेते हुए बारह चयनित स्थानों से मछलियों के नमूने एकत्र किए गए एवं मत्स्य संरक्षण के विभिन्न पहलुओं के आँकड़ों में वृद्धि की गई। गहरे जलाशयों को भी चिन्हित किया गया जहाँ बड़ी महाशीर मछलियों का प्रवास था। कुमायूँ मण्डल के बड़े एवं छोटे जलस्रोतों में मछली पकड़ने की देशी एवं अन्य विनाशकारी विधियों को भी अभिलेखित किया गया। इनमें से आठ प्रकार के विनाशकारी पाए गए जिसमें डाइनामाइट, कीटनाशक धावन सोडा तथा विघुत धारा का प्रयोग अत्यन्त विनाशकारी थे। महाशीर के अनेक जीवन अवस्था लक्षणों का अध्ययन किया। देहरादून के निकट ढकरानी राजकीय मत्स्य फ़ार्म पर जलाशयीय दशा में महाशीर का प्रेरित प्रजनन कराने का प्रयास किया गया।

संकट, अपनाने योग्य संभावित संरक्षण उपाय एवं मत्स्य जैव विधिता के संबंध में स्थानीय लोगों के प्रत्यक्ष ज्ञान पता लगाने हेतु कोसी नदी के किनारे रह रहे लोगों का सामाजिक एवं आर्थिक सर्वेक्षण किया गया। संरक्षण प्रयासों को लागू करने में स्थानीय लोगों का भारी समर्थन है। कुमायूँ मण्डल में कटिया द्वारा महाशीर पकड़ने के अच्छे सम्भावना वाले स्थानों की पहचान मछली पकड़ने वालों के आँकड़ों के आधार पर किया गया। संकट ग्रस्त महाशीर को बचाने हेतु रामनगर स्थान पर स्थानीय स्वयंसेवी संस्था कॉर्बेट फ़ाउंडेशन के सहयोग से जन जागरण कार्यक्रम का आयोजन किया गया तथा मोहन गाँव में ''महाशीर बचाओ गोष्ठी' बनाई गई। कोसी बैराज के निकट संरक्षण नारों युक्त एक होर्डिग लगाया गया। उत्तर पूर्वी सहयोग प्रायोजना के अन्तर्गत आठ राज्यों में मत्स्य जर्मप्लाज्म पर सर्वेक्षण का कार्य पूरा कर लिया गया। असम के तीन संरक्षित क्षेत्रों (मानस वन्य जीव विहार, डिब्रूचैखोवा, लोहरबन्द) में जर्मप्लाज्म सूची तैयार करने का कार्य किया गया। नवगांव ज़िले में जै–भोरेली नदी के आसपास के गाँवों, बालीपारा मछली बाज़ार एवं मत्स्यकी कालेज राहा आदि स्थानों पर संकट ग्रस्त मछलियों को बचाने के लिए चेतना लाने हेतु एक जन सहयोग कार्यक्रम किया गया।

विदेशागत (एक्सोटिक)

उत्तर प्रदेश राजकीय मत्स्य विभाग के सहयोग से कराये गए सर्वेक्षण के आधार पर विदेशागत मछली क्लेरियस गैरीपाइनस एवं एरिस्टिक्थिस नोबिलिस का विवरण उ0प्र0 के छः ज़िलों में अभिलेखित किया गया। किसानों द्वारा विदेशागत मछलियों के पालने के कारणों का पता लगाया गया। विदेशागत मांगुर के प्राकृतिक प्रजनन को दर्शाने वाल प्रमाण उ0प्र0 के पाँच ज़िलों से प्राप्त किए गए। विदेशगत मछलियों के पालने पर होने वाले परिस्थितिकी एवं अन्य परिणामों के बारे में किसानों के अन्दर चेतना लाने के लिए वाराणसी में 23 दिसम्बर, 1998 को एक कार्यशाला भी आयोजित की गयी।

मत्स्य रोग निदान एवं संगरोधन

देशी क्लेरियस वैट्रेकस एवं विदेशागत क्लेरियस गैरीपाइनस में परजीवियों के लगने एवं तीव्रता का जेनरा स्तर तक अध्ययन किया गया। प्रधानता के तौर पर डाइजेनियन का अत्यधिक संक्रमण (62 प्रतिशत) एवं सिस्टोड संक्रमण (11.2 प्रतिशत) तीव्रता के रूप में पाया गया। इन्टरनेट की सहायता से विदेशजन मछलियों के आगमन एवं संगरोधन पर अनेक देशों के दिशा निर्देशों को संकलित किया गया। जल जीव रोगाणु एवं संगरोधन सूचना तंत्र (एक्वाटिक एनिमल पैथोजेन एवं क्वारेन्टाइन इन्फारमेशन सिस्टम) (ए0ए0पी0क्यू0आई0एस) डाटा इन्ट्रीफार्म को पूरा करने के लिए भारतीय कृषि अनुसंधान परिषद के संगम अभिकरण के रूप में अन्य मत्स्यकी संस्थानों से संपर्क स्थापित किया गया।

कोशिकाणु वांशिकी

चन्ना पंक्टेटस एवं मिस्टस विटैटस में मैलाथियान के आनुवांशिक विषाक्तता परीक्षण पर सूक्ष्म केन्द्रिकाओं के प्रतिशत में मैलाथियान की मात्रा के आधार पर वृद्धि पाई गई। गुणसूत्रीय असमानता जैसे क्रोमैटिड अपभ्रंस, दुराव, बहुसंख्यता एवं क्रोमैटिड एक्सचैंज आदि भी रिकार्ड किए गए। क्लोरोपाइरीफास कीटनाशक एवं पैरा–अमीनो बेन्जीन कैंसर पैदा करने वाला अभिकारक के आनुवंशिक विषाक्तता प्रभाव का चन्ना पंकटेटस पर अध्ययन किया गया, जिसमें उपचारित मछलियों में सूक्ष्म केन्द्रिकाओं का स्तर अत्यधिक पाया गया। चन्ना पंक्टेटस में सिंगिल सेल जेल इलेक्ट्रोफोरेसिस तकनीकी का प्रयोग कर धूमकेतु परीक्षण (कॉमेट एसे) के प्रयोग किए गए। उपचारित एवं नियन्त्रित रक्त नमूनों में कोई विशेष पैटर्न नहीं प्राप्त हुए। धूमकेतु परीक्षण तकनीकी के मानकीकरण की आवश्यकता है। क्लैरियस गैरीपाइनस के रक्त कोशिकाओं का सफलता पूर्वक संवर्धन किया गया। अंतः पात्रः कोल्चीसिनाइजेश्न तकनीकी द्वारा कैट फिशों तथा रोहू में परम्परागत तकनीकी की तुलना में तीन गुना बड़े आकार के मेटाफेज़ क्रोमोसोम प्राप्त किए गए।

जैव रसायन आनुवंशिकी

आई0ई0एफ0 एवं आइसोजाइम चिन्हकों के प्रयोग द्वारा रोहू मछली के नदीय समुदायों के प्राकृतिक आनुवंशिक विविधता/विभिन्नता का विश्लेषण किया गया। सत्रह आइसोजाइम लोसाइ में युग्मिक विभिन्नता परिमाणित किया गया। राप्ती और ब्यास नदियों के सटे हुए क्षेत्रों एवं हैचरी बीजों को संग्रह करने वाले स्थानों में बहुतायत संख्या में कतला–रोहू के संकर पहचाने गए। ये क्षेत्र जलमग्न होकर नदी से जुड़ जाते हैं। हैचरी से उत्पत्ति वाली मछलियां प्राकृतिक समुदायों से परस्पर प्रजनन करती है और परिणामतः प्राकृतिक मछलियों का समुदाय संक्रमित हो जाता है। नौकुचिया ताल एवं गंगा नदी से भी एक एक संकर एकत्र किए गए।

स्थानीय क्लेरियक बैट्रेकस एवं विदेशागत क्लेरियस गैरीपाइनस के बीच आनुवंशिक सम्मिश्रण ज्ञात करने के लिए दोनों प्रजातियों एवं आई0इ0एफ0 चिन्हकों द्वारा चरित्रित किया गया। आइसोजाइम की अपेक्षा रक्त कणिकओं के आइ0इ0एफ0 से स्पष्ट प्रजाति विभिन्नताएं प्राप्त की गई। अधिक मात्रा में आनुवंशिक विभिन्नता के कारण आइसोजाइम चिन्हकों द्वारा प्रजाति विशेषक चिन्हक स्पष्ट नहीं हुए।

लैबियो रोहिता एवं लैबियो फिम्ब्रिएटस की तुलना में लैबियो डुसमेरी का जैव आनुवंशिक प्रोफाइल तैयार किया गया। सभी इन्जाइम विधियों से प्रजाति

विशेष प्रोफाइल प्राप्त हुए। मीनाचिल नदी के लैबियो डुसमेरी में आनुवंशिक विभिन्नता के परिमापन से उच्चस्तर की विभिन्नता का पता चला। कोचीन (पश्चिमी घाट) एवं काकीनाड़ा पूर्वी घाट से प्राप्त श्वेत मछली लेक्टेरियस लेक्टेरियस का आनुवंशिक चरित्रीकरण आइसोजाइम विश्लेषण द्वारा जारी रखा गया। इसके परिणाम समुदायों में आनुवंशिक विभिन्नता दर्शाते हैं। इससे यह पता चलता है कि दोनों समुदाय अलग–अलग उत्पत्ति समूह से संबंधित है।

डी0एन0ए0 फिंगरप्रिंटिंग

पी0सी0आर0 प्राइमर का प्रयोग कर क्लेरियस बैट्रेकस एवं क्लेरियस गौरीपाइनस के माइटोकान्ड्रियल डी0एन0ए0एन0डी0 5/एन0डी0 6 का प्रजाति विशेष ए0आर0एफ0एल0पी0 पैटर्न ज्ञात किया गया। परिणाम यह दर्शाते हैं कि ए0आर0एफ0एल0पी0 का उपयोग इन दो प्रजातियों के बीच परस्पर सम्मिश्रिण को परिमापित करने में किया जा सकता है। 12 आर0ए0पी0डी0 प्राइमर के प्रयोग से लैबियो रोहिता के तीन भिन्न नदियों के समुदायों में अन्तर्जातीय विभिन्नता का परिमापन किया गया। प्राप्त किए गए 56 बैन्ड़ों में से 27 बैन्ड परीक्षित समुदायों में बहुरूपक पाए गए।

कतला के प्राप्त किए गए माइक्रो सेटेलाइट प्राइमर का उपयोग से रोहू में अन्तर्जातीय विभिन्नता का अध्ययन करने पर बहुरूपता ज्ञात किया गया। कतला के पाँच परीक्षित प्राइमरों में से जी 1 लोकस से 4 युग्मकों के बहुरूपक बैन्ड बार–बार प्राप्त हुए। 123 बी0पी0 का एक दुर्लभ युग्मक सतलुज नदी के रोहू में प्राप्त किया गया एवं राप्ती नदी के रोहू में नहीं प्राप्त किया गया। इस अध्ययन से यह पता चलता है कि अधिक बहुरूपक लोसाइ के योग से माइक्रो सेटेलाइट के आधार पर समुदायों में अन्तर किया जा सकता है।

जीन बैंकिंग

तीन चयनित संकटग्रस्त मत्स्य प्रजातियों जैसे लेबियो डुसमेरी, टौर पुटिटोरा एवं साइजोथोरेक्स रिचर्डसोनी के शुक्राणुओं का हिम परिरक्षण किया गया। विभिन्न तनुकारकों के प्रभाव का आंकलन इन तीनों प्रजातियों के लिए किया गया। लैबियो डुसमेरी में निषेचन एवं अन्य दो प्रजातियों में गतिमानता अध्ययन के आधार पर अनुकूलतम तनुकारक चुने गए। लैबियो डुसमेरी दसवीं प्रजाति है जिसके लिए हिम परिरक्षण प्रोटोकाल का रा0म0आ0सं0 ब्यूरो द्वारा वास्तविक निषेचन प्रयोगों के आधार पर मानकीकरण किया गया हैं साइजोथोरेक्स रिचर्डसोनी ग्यारहवीं मत्स्य प्रजाति है जिसके हिम परिरक्षित शुक्राणुओं को रा0म0आ0सं0 ब्यूरो के लघु जीन बैंक में सम्मिलित किया गया है।

तकनीकी मूल्यांकन एवं हस्तान्तरण

जीन बैंकिंग कार्यक्रम मे तहत मत्स्य शुक्राणुओं के हिम परिरक्षण की तकनीकी का विकास किया गया। लैबियो डुसमेरी के लिए दक्ष तकनीकी का प्रदर्शन केरल कृषि विश्वविद्यालय के क्षेत्रीय अनुसंधान केन्द्र पर किया गया। आनुवंशिक चिन्हक तकनीकी द्वारा भारतीय प्रमुख कार्प मछलियों के संक्रमित मछलियों का पहचान किया गया। पंजाब के एक विकासशील किसान द्वारा हिम परिरक्षण तकनीकी का उपयोग कर मत्स्य बीज उत्पादन करने के लिए कार्यक्रम तैयार

किया गया। कार्बेट फाउन्डेशन के सहयोग से संकटग्रस्त प्रजातियों को बचाने के लिए रामनगर में जागृति कार्यक्रम तथा स्थानीय भाषा में पैम्फलेट वितरित किए गए। इसी तरह के कार्यक्रम उत्तर पूर्वी राज्यों में भी आयोजित हुए।

मूलभूत ढाँचागत विकास

प्रशासनिक कार्यालय सर्विस खण्ड, जलाशयों एवं आवासीय भवनों सहित रा0म0आ0सं0 ब्यूरो परिसर पूरा हो गया है। प्रयोगशाला भवन पूरा होने की अन्तिम अवस्था मे है। अन्य साफ्टवेयर एवं एन्टी वाइरस पैकेज को सम्मिलित कर कृ0अ0सू0तं0 प्रकोष्ठ को पुनः सुदृढ़ किया गया है।

पुस्तकालय एवं अभिलेखन

इन्टरनेट से सूचना उपलब्ध कराने के ध्येय से पुस्तकालय में 32 एक्स सी0डी0रोम0 ड्राइव एवं पूर्ण मल्टीमीडिया किट से युक्त नया कम्प्यूटर (पेन्टियम II) मँगाया गया। पुस्तकालय में 220 पुस्तकें, 102 पुनर्मुद्रण एवं 84 राष्ट्रीय एवं विदेशी जर्नल खरीदे गए। पुस्तकालय द्वारा ए0एस0एफ0ए0 डाटाबेस का सी0डी0रोम और आई0एन0एस0डी0ओ0सी0 की सी0ए0जी0 सेवा जारी रखी गई तथा उनके जर्नल के उपयोगी शोध पत्रों को मँगाया गया। क्रोमोसोम ऐटलस वार्षिक प्रतिवेदन 1997–98 एवं लिस्ट ऑफ़ एन0बी0एफ0जी0आर0 पब्लिकेशन इस वर्ष प्रकाशित किए गए।

4. INTRODUCTION

4.1 Brief History

In view of the national programme for improvement and expansion of both inland and marine fisheries sector of the country, it has been recognized that enhancement of aquaculture production alone is not sufficient and conservation of the diversity of fish germplasm is a necessary prerequisite. Appreciating this, the Government of India approved establishment of the Bureau at the end of Sixth Five Year Plan.

The National Bureau of Fish Genetic Resources was thus sanctioned in December, 1983 under the Indian Council of Agricultural Research. The infrastructure development consisting of building and the farm complexes has come up at Canal Ring Road, Lucknow - 226 002, U.P. The administrative block, portions of the service block and farm have been completed. Office shifting from old site was initiated during the end of March and completed by third week of April, 1999.

4.2 Major Achievements

Cataloguing of Fish Genetic Resources of India

Cataloguing of fish germplasm resources of India is highly essential for undertaking any *in situ* or *ex situ* conservation programmes and for staking claim for the benefits of biotechnological products derived from endemic Indian fishes. Under the programme of cataloguing of fish germplasm resources, a checklist of 2118 finfishes of India with details on their taxonomy, distribution and habitat have been compiled. A list of threatened fishes of India comprising of 79 species under different categories of threatened status have been drawn in 1992. Data have been compiled on the riverwise distribution of fish. Three hundred and twenty freshwater fish of India have been assessed through Conservation Assessment and Management Plan (CAMP) workshop in 1997 and a tentative list of threatened freshwater fishes has been prepared.

Genetic Characterisation

For prioritised endangered and wild stocks of commercial species, basic information on population genetics is essential for carrying out conservation and genetic upgradation programmes. The chromosomal banding technique of NOR and C-banding have been developed. So far, NORs have been detected in 12 different endangered and commercial species of fishes. The number of NOR bearing chromosome varies between one to four in the species studied which depict a species specific pattern. Indication of NOR polymorphism have been obtained after studying NOR banding in two different population of *Tor putitora*. Preliminary trials of sister chromatid exchanges (SCE) have been undertaken in *Clarias batrachus* and *Channa punctatus* with encouraging results. Biochemical genetic characterisation using

25 enzyme systems and isoelectric focussing (IEF) of eye lens and haemoglobin has been carried out in fifteen prioritised commercial and endangered species. Population genetic studies presently being carried out indicate genetic variation in isozyme and IEF markers for rohu and the endangered golden mahseer and hilsa. Heamoglobin IEF markers capable of detecting any introgression between exotic *Clarias gariepinus* and endemic *C. batrachus*, have been developed. Genetic introgression of farmed common carp stocks of Himachal Pradesh with gold fish genome has been detected using isozyme genetic markers. With the developed eight species specific genetic markers, genetic introgression has been detected in hatchery stocks of Indian major carps. Under the collaborative programme with CIFA, the six founder stocks used in selection programme have been characterized genetically and results indicate that founder stock sampling setting origin are separated from other stocks. A package has been developed which can provide a cost effective mode of providing vital information on introgression levels and help to maintain pure broodstocks. The genetic characterization of threatened marine fishes *Lactarius lactarius, Tachysurus maculatus* and *T. subrostratus* have also been carried out. The method of directly examining genetic variation at DNA level has greatly enhanced the efficiency of genetic characterization of fish populations. Investigations made on mitochondrial DNA in Indian major carps using standardized PCR techniques has revealed polymorphism.

In situ Conservation Programme

The need for *in situ* conservation programme has only been felt recently in India and therefore appropriate methodology suited for local conditions is yet to be developed. With an ultimate aim of formulating *in situ* strategy for conservation of mahseer which is endangered in North-East region of the country, comprehensive list of rivers/streams harbouring mahseer in the above region was prepared. To develop a *in situ* methodology for conservation of mahseer in Northern Hills of Uttar Pradesh, a pilot scale project has been successfully carried out in Ladhiya stream. Formation of Mahseer Bachao Gosthi involving local community has yielded promising results. Ranching of Mahseer has also been carried out. Fish and habitat diversity, availability of brood fish of endangered mahseer (*Tor putitora*) in the Kumaon region has been documented. Microhabitat inventory of Ladhiya stream was completed. Programmes on induced breeding of endangered mahseer were successfully achieved. The feasibility of using remote sensing and geographical information system for studying fish habitats and reparian vegetaion was evaluated in Ladhiya streams. The changing pattern of Gomti river channel over the last 25 years was also studied using satellite image. A North East collaborative project to assess present status of fish biodiversity has been initiated in 8 North Eastern States including Sikkim.

Gene Banking

In order to establish a gene bank as one of the *ex situ* conservation programmes, studies on cryopreservation of fish milt has been taken up. The Bureau has developed and standardised the technique for cryopreservation of fish milt and a mini gene bank with milt of *Catla catla, Labeo rohita, Cirrhinus mrigala, Cyrpinus carpio, Tor putitora, T. khudree* and *Tenualosa ilisha* has been established. Viabie hatchlings were produced from milt cryopreserved for over five years. Hatchling percentage obtained with cryopreserved milt is close to control (with fresh milt) in *L. rohita, C. catla, C. mrigala, C. carpio, Onchorhynchus mykiss* and *Salmo trutta fario.* For the purpose of genetic upgradation of common carp farm stocks of Himachal Pradesh, cross breeding with wild stock of Ooty and Rewalsar were undertaken using cryopreserved milt and Rewalsar stock was found to be the better stock. Studies on chromosomal engineering with special emphasis on androgenesis has been undertaken for retrieval of genome only from cryopreserved milt. Hybrids of *Tor khudree* and *T. putitora* have been produced using cryopreserved milt of *T. khudree.* Larvae of tiger shrimp was successfully frozen to -30^{0}C. Crossbreeding of Rainbow trout of Nilgiris with faster growing stock from Himachal Pradesh have been done successfully. Electron microscopic studies on cryopreserved rohu and common carp have been used to asses cryo damage and these studies indicate that in out of season collections or those from spent fishes higher levels damage is observed during freezing. Experiments have also been conducted on egg chorion thinning and cryoprotectant sensitivity of cladocerans.

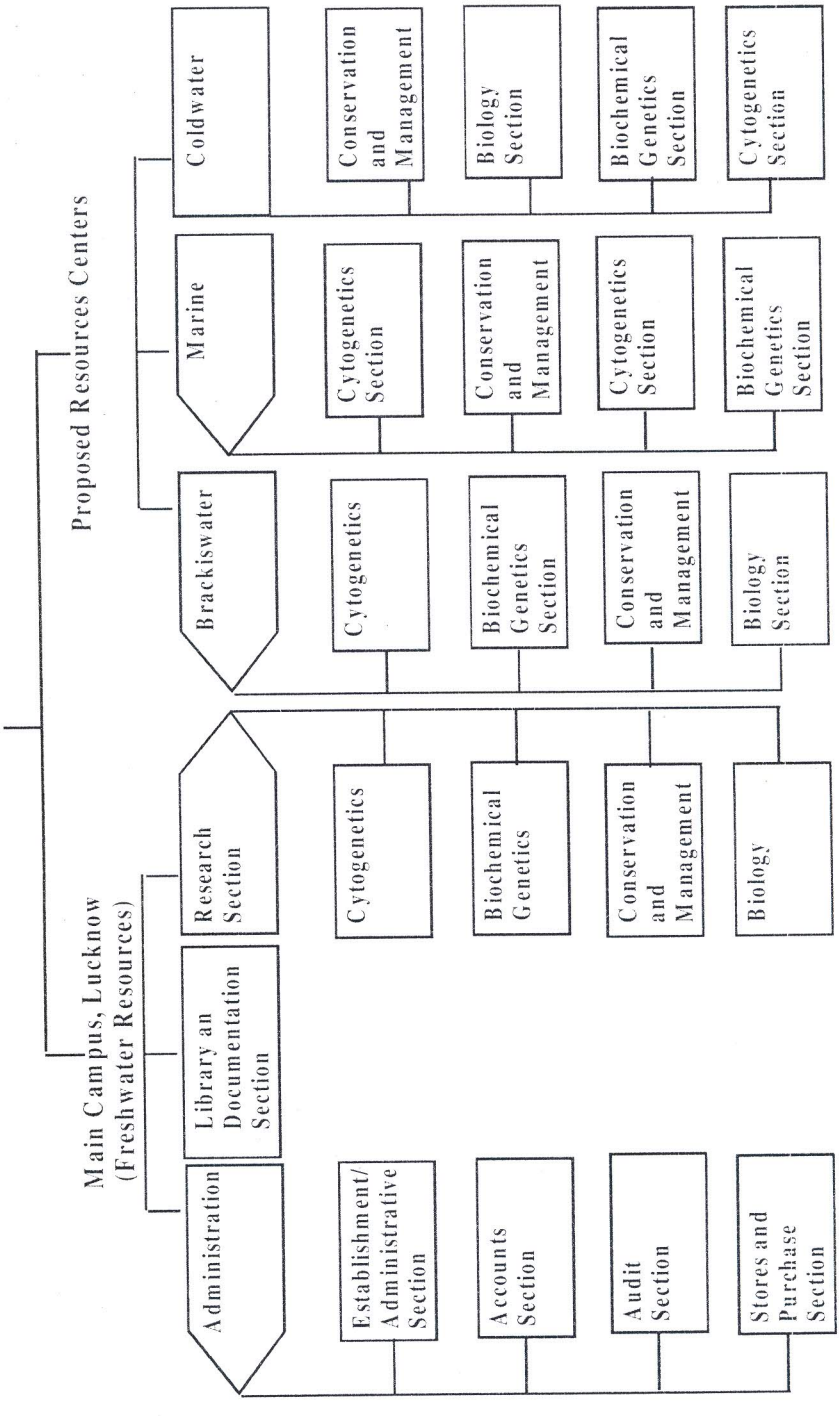
Exotics and Quarantine

In order to increase Indian aquacultural production, exotic stocks and species are being introduced. Monosex population can be used to achieve higher production levels in species where one sex grows larger in size or where prolific pond breeding adversely affects growth. To meet this objective and for ecological testing of exotics, the technique for production of mono sex population was perfected with tilapia. It is also important to safeguard our indigenous fish genetic resources from infectious exotic diseases and to develop a protocol for fish quarantine. For this, studies on fish pathogens and parasites is essential. Preliminary screening of parasites in different fish species have been done. For preparing quarantine database, a format was prepared to access information on fish species and disease prevalent in a particular geographical area. The spread of exotic fish culture in 11 districts of U.P. has been documented in collaboration with U.P. state fisheries department.

4.3 Mandate

- Collection, classification and evaluation of information on fish genetic resources of the country;
- Cataloguing of genotypes;
- Maintenance and preservation of fish genetic material in co-ordination with other agencies and conservation of

4.4 Organizational Chart



endangered fish species; and

- Monitoring the introduction of exotic fish species in Indian waters.

4.5 Staff Position

The overall staff position as on 31st March, 1999 is given below :

Sl. No.	Category of posts	Post sanctioned (No.)	Post created (No.)	Staff in position	Post vacant (out of created posts)
1.	Research Management (Director)	1	1	1	--
2.	Scientific	40	40	17	23
3.	Technical	35	24	24	--
4.	Administrative	16	16	16	--
5.	Supporting	29	15	15	--
	Total	**121**	**96**	**73**	**23**

4.6 Finance

Allocation of funds and expenditure incurred during the year 1998-99.

(Rs. in lakhs)

	Budget Allocation	Expenditure
Plan	310.00	309.81
Non Plan	112.00	109.51
Total	**422.00**	**419.32**

5. RESEARCH ACHIEVEMENTS

5.1 Project No. FB– 9 : To Develop Database on Fish Genetic Resources of India

The project aims at developing a database of fish genetic resources of India which can be utilized in various *in situ* and *ex situ* conservation programmes. The development of fish germplasm database is essential to meet India's obligation under convention on biological diversity and to safeguard India's interests. Documenting fish biodiversity within wildlife sanctuaries can also help in planning conservation programmes since these fishes have some protection within these sanctuaries. One of the major threats to endemic fish fauna is the spread of exotic fishes. Collecting information on the spread of exotics is essential to develop strategies and policy decisions to control them. Information was collected on *Clarias gariepinus*, one of the exotic species illegally introduced in India, which is rapidly spreading.

Updation of database

From published information, a tentative list of 220 aquarium fishes found in India belonging to 72 families was prepared out of which, 120 are marine fishes, 25 are brackishwater fishes and 75 are freshwater fishes. The synonyms of 800 Indian fish species have been collected from various published records and formatted in the computer for easy retrieval. The data on any fish species (scientific name, taxonomy, habitat and distribution) can be accessed through a modified software programme. The river and statewise distribution of fish genetic resources can also be retrieved. A two day workshop on Germplasm inventorisation and gene banking of freshwater fishes was organized at Cochin during 12-13 Oct, 1998, to assess the fishes of Peninsular India with special reference to Western Ghats. A tentative list of 64 potential ornamental and 35 economically important cultivable/sport freshwater fishes endemic to Peninsular India with special reference to the Western Ghats have been compiled and added to the database. Images of 22 commercially important fishes and endangered fishes viz., *Notopterus chitala* and *Tenualosa ilisha* (Fig. 1-2) were scanned and incorporated in the fish database in MS Access.

Various databases were searched on the Internet to collect the information on fish databases. The databases searched were (i) Fish Database developed by California Academy of Sciences, (ii) Database of Tropical fish, (iii) Fish Information Service database of aquarium fishes.

Survey of fish germplasm in Sanctuaries

Samaspur Bird Sanctuary is located in the District Rae Bareilly (Salon block) about 130 kms away from Lucknow. This Sanctuary was established in 1987. It is

visited by about 250 species of both resident and migratory birds from the Himalayan region. The bird sanctuary is spread in an area of about 800 ha with 8 km of water area. The water body is under the Department of Forests and Wildlife, under Endangered Wildlife project. The entire waterbody is protected and the fishing is banned since 1987. The water body was free from aquatic weeds except on the bank. The water was slightly turbid with plenty of phytoplankton and zooplankton. The fish fauna of this sanctuary was collected from published information and through enquiry with the Forest Department officials, local people and from enquiry at local fish markets (Table 1).

Table 1. Fish species found in Samaspur and Nawabganj sanctuaries along with their conservation status.

Sl. No.	Scientific Name	Sanctuaries		Local Name	Conservation status*
		Samaspur	Nawabganj		
1.	*Catla catla*	P	P	Bhos	VU
2.	*Labeo rohita*	P	P	Rohu	LR-nt
3.	*Cirrhinus mrigala*	P	P	Nain	LR-nt
4.	*Channa striatus*	P	P	Saur	LR-Ic
5.	*C. marulius*	P	P	Saur	LR-nt
6.	*Notopterus notopterus*	P	P	Moi	LR-nt
7.	*Mystus vittatus*	P	P	Tengra	VU
8.	*Aorichthys seenghala*	P	P	Tengra	---
9.	*Aorichthys aor*	P	P	Tengra	---
10.	*Mystus bleekeri*	P	P	Tengra	VU
11.	*Puntius* sp.	P	P	Putia	---
12.	*Chanda nama*	P	P	Sidheri	---
13.	*C. ranga*	P	P	Sidheri	---
14.	*Mastacembelus* sp.	P	P	Baam	---
15.	*Heteropneustes fossilis*	P	P	Singhi	VU
16.	*Clarias batrachus*	P	P	Mangur	VU
17.	*Wallago attu*	P	P	Parhin	LR-nt
18.	*Osphronemus goramy*	X	P	Gourami	---

* Conservation status as per Conservation Assessment and Management Plan (CAMP) workshop held at NBFGR during 1997. P - present, X - not recorded.

— Not evaluated, VU—Vulnerable, LR-nt—Lower risk-near threatened, LR - Ic — Lower risk-least concern

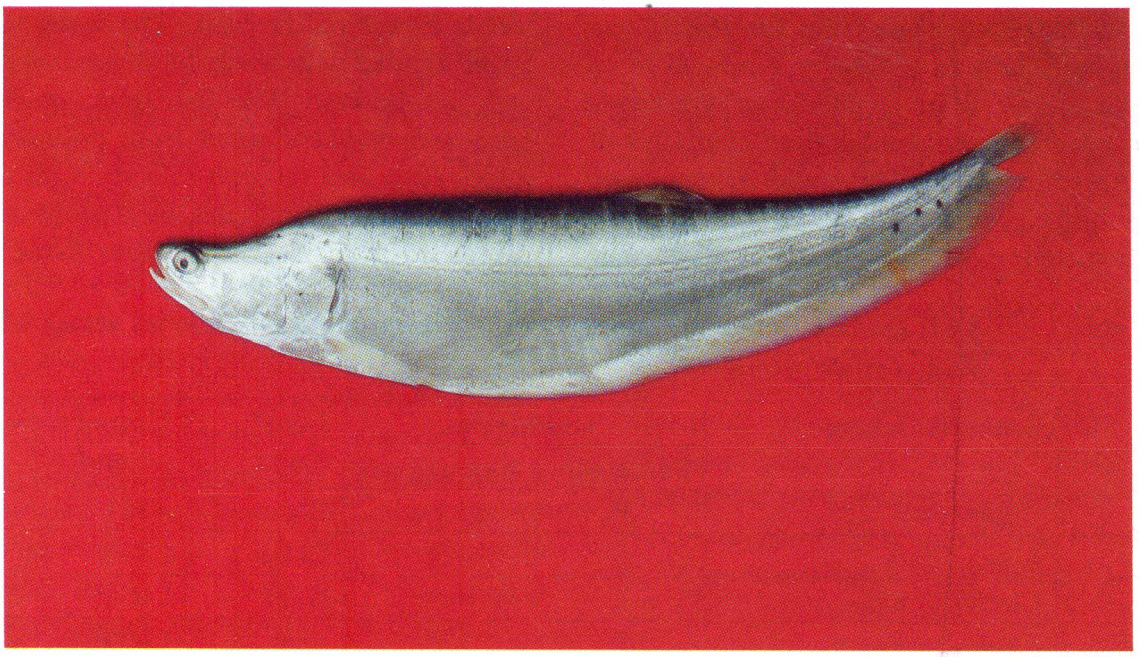


Fig. 1. Endangered freshwater fish *Notopterus chitala*.

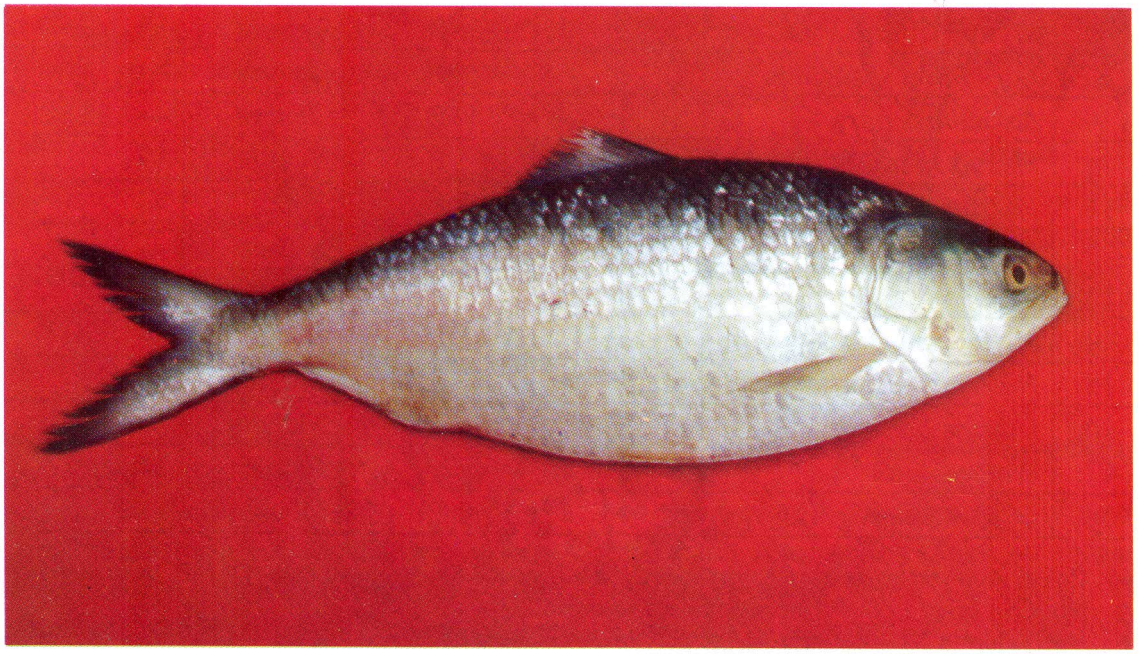


Fig. 2. Endangered fish *Tenualosa ilisha*.

Fig. 3. Exotic air breathing fish *Clarias gariepinus*.

The earlier survey carried out in Nawabganj Bird Sanctuary was strengthened with collection of more information (Table 2). The fish fauna of these sanctuaries was mostly dominated by *Catla catla, Labeo rohita, Cirrhinus mrigala, Channa* and *Mystus* species.

Most of the species found in these bird sanctuaries are of low conservation status (i.e. vulnerable or lower). The conservation

Table 2. Observations on spread of exotics in some districts of Uttar Pradesh.

Sl. No.	Districts	No. of ponds surveyed	Total area approx. (ha)	Approx. No. of fingerlings	Sources of seed
1.	Lucknow	10	1.80	16,000	Howrah
2.	Sitapur	21	8.30	88,000	Howrah
3.	Varanasi	17	1.95	46,000	Howrah
4.	Maharajganj	20	8.97	1,20,000	Howrah/Local
5.	Gorakhpur	05	2.03	11.500	Howrah/Local
6.	Barabanki	10	11.93	29,000	Howrah

status given in the CAMP process was based on a group of experts consensus view taking into consideration, available data on abundance and distribution of these species in some parts of their natural range. Though many of the listed species may not be of conservation concern locally, they are declining in other areas. In this context, documenting fish diversity within sanctuaries and protecting them will help in conserving aquatic resources.

Survey on Exotic spread :

Data were collected on the spread of air-breathing exotic fish *Clarias gariepinus* and bighead through field survey at farmers ponds from Lucknow, Sitapur, Varanasi, Maharajganj, Gorakhpur and Barabanki in collaboration with U.P. State Fisheries Department on a proforma jointly developed. Also feedback from farmers and extension workers was collected from time to time. Analysis of the data indicates a rapid spread of exotic magur (*C. gariepinus*, Fig. 3) and bighead (*Aristichthys nobilis*) in U.P. (Table 3).

The feedback obtained from the fish farmers and extension workers indicated less than satisfactory performance of exotic magur culture along with Indian major carps in polyculture as the fish affected overall production of Indian major carps (IMC). Similarly, farmers culturing bighead, found that catla production in their ponds were below the expected level.

To determine size of exotic magur and bighead harvested from pond, a bench mark survey was carried out in different fish markets. The weight range of exotic magur and bighead reaching the market are given in Table 3. Enquiries reveal that the large size of 3 to 8 kg for magur and 3.5 to 5 kg for bighead were the result of one year culture which is highly encouraging from the farmers point of view. This is one of the reasons for rapid spread of exotic fishes culture in spite of possible long term adverse impact of these exotics on native fauna.

In many ponds, the exotic magur were found to be gravid while in few cases even natural pond breeding was reported. Some information on such cases of natural breeding

Table 3. Market survey of exotic fishes in Uttar Pradesh.

Sl. No.	Place	Weight (kg)	
		Magur	Bighead
1.	Sitapur	0.3 - 2.5	1 - 3
2.	Lucknow	0.4 - 3.0	2 - 3
3.	Varanasi	0. 65 - 2.5	3 - 5
4.	Barabanki	6 - 8	1 - 2.5
5.	Kanpur	1 – 3	2 - 5
6.	Maharajganj	0.7 - 1.5	2 - 3.5

of exotic magur have been collected from different places and the same are described in Table 4. In these ponds, after 7 to 12 months of culture harvesting had been carried out and prior to next stocking fingerlings were observed indicating that the adults that had not been harvested had bred. Such reportings were reconfirmed after netting in ponds from Lucknow, Sitapur and Varanasi district.

The observations on maturity and breeding of magur in pond conditions is indicative of its capabilities of establishing in nature. To bring awareness amongst farmers about the ecological and other consequences of this unauthorized introduction of exotic fish, a seminar was organized at Varanasi in collaboration with U.P. State Fisheries Department during Dec. 23rd, 1998.

5.2 Project No. FB - 14 : Developing Strategies for Conservation of Mahseer and other Threatened Fishes of Kumaon Hills.

In order to develop suitable strategies for conservation of endangered mahseer *Tor putitora* and other threatened fishes in the Kumaon region, the basic requirements are information on the present status of fish biodiversity, species structure, abundance, distribution, fishing methods, life history traits, angling success, local community involvement and socio-economic impact and efforts on fish germplasm conservation. To fulfil the above objectives surveys were carried out in the Kosi river of Kumaon and few stretches of the Garhwal region. An attempt was also made to induce breed the endangered mahseer *T. putitora* based on request of U.P. State Fisheries Department.

Fish biodiversity, abundance and distribution

In stream, the kind and abundance of fish species vary according to wide variety of habitat diversities offered by pools, riffles, run, rapid and morphological features of the convergence of flow, depth, substrate and other physical factors. Fish sampling in twelve selected stations in Kosi river were carried out for quantifying the abundance of species, species composition, assemblage and habitat specialization among different

Table 4. Information on natural breeding of exotic magur from different districts of U.P.

Sl. No.	District	No. of ponds	Pond area (approx.) ha.	Month of observation
1.	Lucknow	1	1.50	May
2.	Sitapur	2	1.00	April
3.	Shahjahanpur	1	0.02	June
4.	Varanasi	1	0.20	July
5.	Kanpur	1	0.20	May

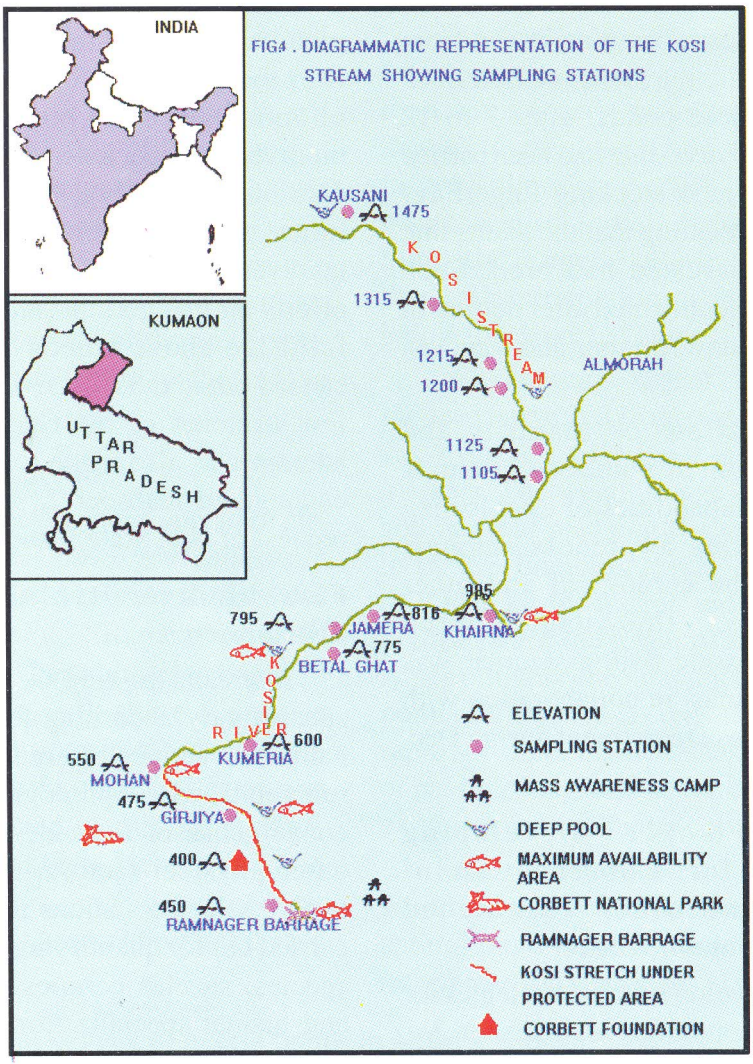


Fig. 4. Diagrammatic representation of the Kosi river showing sampling stations.

species. Out of twelve sampling stations (Fig. 4), the abundance of mahseer (*T. putitora*) was noticed in eight locations. Seventeen species under ten genera were recorded and have been tabulated with reference to microhabitat and elevation (Table 5). The assemblage of mahseer fingerling in riffles, shallow pools and rapids was found with *Garra gotyla* and *Barilius* species. In a batch, the number of mahseer fingerling (*T. putitora*) ranged from 5-20 nos. in pools and riffles (Fig. 5) and 10-25 in rapids, where the water velocity was 0-1.67 km/hour. The abundance of endangered mahseer fingerling

Table 5 : List of Kosi hill-stream fish fauna and distribution pattern.

S. No.	Name of Species	Local name	Microhabitat	Elevation range (m)
1.	*Tor putitora* (Hamilton-Buchanan)	Mahseer, Chadu, Corchula	Pool, Run, Rapid	474 to 1315
2.	*Garra gotyla gotyla* (Gray)	Semera, Pathorchata, Gadhera, Kali	Run, Pool, Rapid	474 to 1105
3.	*G. lamta* (Hamilton-Buchanan)	Semera, Pathorchata, Gadhera, Kali	Run, Pool, Rapid	474 to 1105
4.	*Barilius vagra* (Hamilton-Buchanan)	Gheur, Glar, Dudhnea	Pool, Riffle, Run	474 to 1315
5.	*B. bendelisis* (Hamilton-Buchanan)	Gheur, Glar, Dudhnea	Pool, Riffle, Run	474 to 1315
6.	*B. barna* (Hamilton-Buchanan)	Gheur, Glar, Dudhnea	Pool, Riffle, Run	474 to 1315
7.	*Labeo dero* (Hamilton-Buchanan)	Rohu, Arangi	Run, Pool	1105
8	*Schizothorax plagiostomus* - Heckel	Asaila	Riffle, Pool	816 to 1475
9.	*S. richardsonii* (Gray)	Asaila	Riffle, Pool	816 to 1475
10.	*Puntius ticto* (Hamilton-Buchanan)	Thunnus	Riffle, Pool	816 to 1475
11.	*Nemacheilus botia* (Hamilton-Buchanan)	Gadera, Chitai	Riffle, Pool	474 to 1475
12.	*N. montanus* (McClelland)	Gadera, Chitai	Riffle, Pool	474 to 1475
13.	*Labeo dyocheilus* (McClelland)	Kali, Boalla	Pool	474
14.	*Botia almorhae* - Gray	Jabo	Pool	775 to 816
15.	*Channa gachua* (Hamilton-Buchanan)	Bothua	Pool	1315
16.	*Mastacembelus armatus* (Lacepede)	Baam	Pool	474
17.	*Danio rerio* (Hamilton-Buchanan)	Anju	Pool	474

in various microhabitats during June ranged from 0.10 no/m^2 to 2.5 no/m^2 contributing 10-51.7% share in species composition. In February, the abundance of mahseer juvenile ranged from 2-4 no/m^2 which contributed 7.14 to 29.4% share in species composition.

Fig. 5. A batch of mahseer fingerling in the micro habitat, shallow riffle at Kosi stream.

The species showing maximum abundance was *Barilius* sp. (0.2-6 no/m^2 in June, 25 - 72.6 no/m^2 in February) followed by *Garra* sp. (0.2 - 5.0 no/m^2 in June; 11 - 33 no/m^2 in February) and *Nemachielus* sp. The maximum species diversity of ten species was noticed in sampling station 1 and 5 both pools located at an elevation of 450 and 816 m respectively. It was also revealed that the occurrence of early stages of mahseer was restricted to middle and lower elevations in February which might be due to availability of feed resource in these stretches. The distribution of *Schizothorax* sp. in Kosi river showed restricted distribution, limited to high elevation (816-1475 m). Maximum contribution in species composition (62.5%) by *Schizothorax* sp. was recorded in the riffle habitat located at 1475 m. elevation near Kausani. Fingerling of mahseer took shelter in rock crevices with coarse substrates. The size of mahseer juvenile ranged from 0.06 to 0.27 g and the weight of the fingerlings ranged from 64.6 to 105 g. Big sized mahseer (2 - 5 kg) was noticed in the three deep pools located in the lower and middle stretches at Corbett National Park, Dhikuli, Betalghat and Garija. The deep pools located at Girija are protected by the local people and temple authority. The pools located at Corbett park is protected by the security engaged by the Corbett Foundation. The gravid male and females *T. putitora, Labeo dyocheilus, G. gotyla* were noticed in June-July in the deep

pools. These fishes can be used for captive breeding and producing seed for ranching programmes.

The occurrence of big sized mahseer in the protected areas of Girija (downstream) showed declining trend in February coinciding with changes in habitat due to rising of stream bed and modifications of pools due to flow and siltation. Fishing activity was comparatively less in the upper stretch. Organized fishing was predominant in the Ramnagar area (lower stretch). Once available in large numbers in Kosi river, the *Bagarius* species has become very rare and no specimen was recorded for the last two years.

The species *L. dyocheilus* and *Danio rerio* was sampled from single location exhibiting non-random distribution (Fig. 6). The *Puntius ticto, Channa gachua* and *Macrobrachium choprai* exhibited gregarious habit showing an affinity for few pools in the middle to lower elevations. Random distribution of fishes was observed with respect to *Barilius* sp.(Fig. 7) , *Garra* sp. and *Nemacheilus* species.

Effect of Fishing

Fishing methods

Since the pattern and regulation of fishing have a great bearing on the fish population dynamics in the streams, detailed information on fishing methods in operation were collected in the Kumaon region. Other than the well known commercial or sport fishing methods, details of existing indigenous techniques and modern destructive methods of fishing are highlighted. It is a fact that the abundance of hill-stream fishes was high before the advent of modern or destructive fishing techniques. The survey conducted in the major and minor hill-streams of Kumaon revealed that local people use a variety of conventional methods which have been fabricated using indigenous knowledge. In some of the fishing methods adopted, various fish behaviours are taken advantage along with habitat types. The intensity of practicing various methods was found to vary with the season, location and species. Eight types of indigenously adopted methods were recorded.

Indigenous methods

Goda : It is conical in shape and fabricated by spiny/non-spiny shrubs and size ranges from 1.0-2.5 m. This is generally used in the fast moving water (rapid, riffle and cascade) of stream especially in night hours. The fishes captured by this method includes *T. putitora, T. tor* and *Schizothorax* sp.

Hammering : This method is practiced in the upland streams where fishes like *Garra* sp., *Barilius* sp. and *Nemacheilus* species hide beneath the small/big boulders. Strong hammer blow on boulders are given and injured fishes are collected.

Water diversions : This is practiced during dry seasons. The flowing water of mainstream is diverted into the secondary channel by placing boulders, plants material and mud, thus drained fishes (*Garra* sp., *Nemacheilus* sp., *Barilius* sp., *Mastacembelus* sp.) are collected.

Fig. 6. *Danio rerio* a potential ornamental fish collected from Kosi stream.

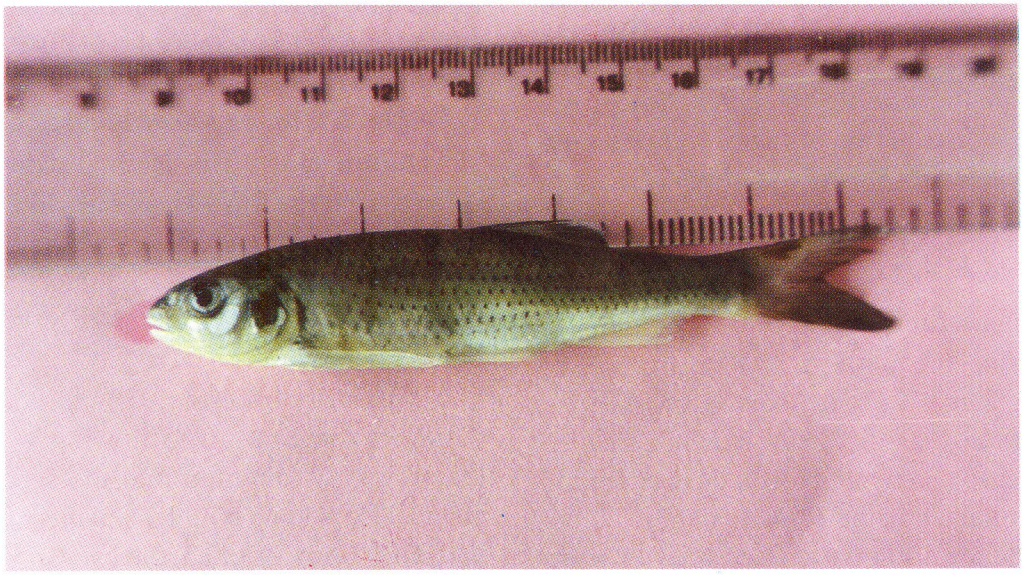


Fig. 7. *Barilius bendelisis* collected from Kosi stream.

Sticks : During monsoon the small streams very often get loaded with mud and boulders and the water becomes highly turbid. Under these circumstances the fishes like *T. putitora* and *T. tor* take shelter in the small shallow streamlets with clear water where it is easily visible. Local people physically stun or kill by beating with sticks and then collect them.

Bagnet : This is a fabricated hand net locally called Kadiyali. The net is pyramidical in shape with two sticks attached to it. Fisherman also use it in night hours especially in the areas where herbicide was used and stunned/dead fishes are collected.

Herbs : Leaf of Khina (*Modhuka* sp.), Rambans (*Agave americana*), Maina, stem bark of Jamun and seeds of cheura are utilized to catch fishes. These are applied in the streams after grinding to a paste in the evening hours. The stunned or paralysed fishes can be easily collected.

Pot and Pan Process : In this method the mouth of a vessel is covered by a thin cloth with a hole in the centre. Flour is sprinkled around this hole and in the bottom of the pot. The pot is then placed in the shallow and slow moving water. The fishes start moving inside the pot and the pot is removed from the stream when sufficient number of fishes (*Barilius* sp., fingerling of *T. putitora*, *G. gotyla*) are trapped.

Cloth Netting : The cloth or mosquito net is held at two sides by two persons in the shallow riffles and fry and fingerlings are captured.

Though some of the methods like water diversion and use of herbs are destructive in nature, the methods using modern input like dynamite, pesticides and bleaching agents and electric current are more destructive.

Destructive methods

Destructive methods outlined below are primarily responsible for decline of fishes in the Kumaon hill-streams. The destructive methods identified are as follow :

Dynamite : In this method, wire is connected with a starter (locally called top) and then it is tagged into the gelatin rod packed in polythene sheet (Fig.8). To this fabricated item is attached a small weight (stone). One end of wire placed outside is fired by cigarette or bidi and the dynamite is thrown into deep/small pools where large size mahseer inhabit. Due to the explosion, fishes are killed or stunned and come to surface where they are collected.

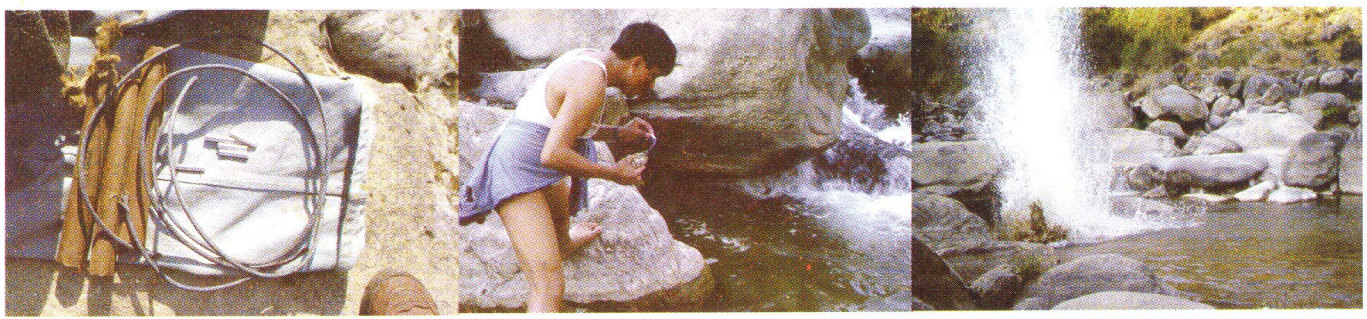
Pesticides and Bleaching : Pesticides like Nuvan, Thiodan, Malathion and bleaching powder are applied in high concentrations in the streams where fish assemblage is high and the stunned fishes are collected by nets.

Electric Current : Depending on the availability of electric current or by using generator a group of people introduce electric wires into the streams and connect it to the source of current. The stream water becomes electrically charged. The stunned fishes are collected thereafter.

As reported by the local people the destructive fishing intensity has been reduced to some extent in the streams like Ladhiya and Kosi where 'Mahseer Bachao Gosthees' were formed by the NBFGR.

Present status of fishery

In Kumaon region, the survey was



The dynamite **A man putting fire to dynamite** **The dynamite blast**

Fig. 8. The various steps involved in dynamiting process.

Fig. 9. Sampling of fish and other biotic parameters in Kosi stream at Betalghat.

initiated from the extreme upper reaches of Kausani hills to extreme downstream upto Ramnagar Barrage covering about 150 km stretch which includes unapproachable area from Betalghat (Fig. 9) to Ramnagar. Different microhabitats were taken into consideration during experimental fishing by cast net. In the middle and lower stretches good vegetation and forest was observed whereas in the upper reaches it was less. The elevation of the Kosi stream varied between 450 m to 1475 m. During survey in Kosi river, it was observed that the fisheries constitute subsistence type in the upper reaches whereas commercial catches was noticed in the middle to lower reaches of Ramnagar area. Interview with local people across the stretch revealed that occurrence of mahseer (*T. putitora*) in Kosi river is decreasing drastically than earlier years. Mahseer provides the main fishery followed by *Labeo dero, Schizothorax* sp., *L. dyocheilus* and miscellaneous fishes like *G. gotyla, Nemacheilus* sp. *Mastacembellus* sp. and *Barilius* sp. The quantity of fish caught by the local people using conventional cast net ranged from 1.0 – 2.0 kg in the upper reaches whereas in the lower reaches it varies from 1.0 kg- 3.5 kg for about 6-7 hours for fishing. The catch consisted of mahseer (*T. putitora*) *G. gotyla, Nemacheilus* sp. contributing 45.45%, 40.60% and 19.95%, respectively.

In Gharwal region, areas around Dehradun such as Kalsi, Dak Patthar, Vikasnagar, Herbertpur, Sahaspur, Kulhal and Niranjanpur (Dehradun) were surveyed. These surveys reveal that Kulhal fish market situated on Dehradun - Chandigarh road is an important landing centre for both *T. tor* and *T. putitora*. Both species are caught between March to September with maximum catch of fishermen recorded was 20-25 kg. in August and minimum of 4-5 kg. in May. Interestingly, we could locate skin of the endangered *T. putitora* weighing 28 kg caught during 1976 in river Yamuna in a fisherman's shop at Kulhal market. Thereafter, no such large-sized specimen was caught in Yamuna in this area. Experimental fishing conducted at Balghat and Byasghat revealed that Nayar river harbours good stock of mahseer. Our surveys also revealed Devprayag, the confluence of Mandakini and Bhagirathi, to be an important point for studying the migratory behaviour of mahseer.

Life history traits of *Tor putitora*

Food and feeding habits

The studies on quality and quantity of food consumed by migratory endangered mahseer is important with regard to fish and habitat conservation. The food and feeding habits of the fry, juvenile and adult fish collected from Kosi river were analysed. The analysis of gut content of fry (30-35 mm) indicated presence of Bacillariophycean algae (66.9%) represented by *Diatoma* sp., *Navicula* sp., *Cymbella* sp. and *Fragillaria* species, detritus (1.5%) and undigested plant matter (11.6%). The major items of gut contents of juvenile (50-95 mm) comprised of detritus (19.6%), phytoplankton (40.2%) represented by (*Characium* sp., *Cymbella* sp., *Gyrosigma* sp.), small insect (15.8%) and miscellaneous items (24.5%). The food of adult (205 mm/64.5 g) comprised of animal matter (Protozoa, crustacea, ephimeroptera, trichoptera, diptera), algae (46.7%) dominated by Bacillariophyceae, detritus (14.8%), sand (5.7%) and undigested matter (32.8%), respectively. So, it is evident that changes occur in food habits with increasing size for endangered mahseer. The results also indicate that good productivity of Bacillariophycean algae in the streams contribute major share for feeding.

The studies on gastrosomatic index (GSI) indicate that the intensity of feeding for three different stages was higher (2.6, 2.8 and 4.4) in February as compared to 0.05, 1.6 and 2.0) in June. The full intestinal bulbs were noticed in the few samples collected in February. The high feeding intensity recorded during February indicates that it is the primary feeding phase of the mahseer.

Induced breeding

Attempts were made to induce breed the endangered *T. putitora* raised under pond conditions at UP State Fisheries Farm Dhakrani, near Dehradun. Golden mahseer *T. putitora* (750-1000 g) were injected with ovaprim in the dose of 0.2 ml/kg of body weight. It was observed that the milt flow is enhanced among ovaprim injected males but the females did not release the eggs even after

stripping. Female mahseer was dissected which revealed presence of immature ovary (stage II). It appears that the female stock were not mature enough to respond to the inducing agent.

The hypothalamus of *T. putitora* (n=12) was studied. It consists mainly of nucleus preopticus (NPO), nucleus lateralis tuberis (NILT) (Fig. 10) and their axonal tracts. NPO is situated on either side of third ventricle anterodorsal to the optic chiasma. Histological examination of the ovary revealed the early maturity phase is oocytes in stage II and III were dominant. Oocytes in Stage 2 possessed several small nucleoli of various sizes along the periphery of the nuclear membrane (Fig. 11). Many oocytes contained a yolk nucleus lying close to the nuclear membrane in the cytoplasm. Oocytes in Stage 3 were a little larger with thin layer of the follicular cells around the cytoplasm and a few nucleoli passed out of the nuclear membrane as they were seen in the cytoplasm, a few oocytes with Balbiani nucleus were also encountered in the ovary of *T. putitora*. Mitotic activity in spermatogonia and numerous primary and secondary spermatocytes were seen in the testis (Fig. 12). The histological picture revealed the testis to be in maturing stage of 3.

Socio-economic aspects of conservation

Common man's perception

A survey to determine common people's perception on the status of fish biodiversity, threats and possible conservation measures was carried out by interaction with the key persons of the local villages, fishermen and other people. Survey covered upstream, middlestream and downstream areas of the Kosi river. Data was collected comprising 3 districts. A total of 183 people were interviewed. Age profile of respondents indicate that 17.3% of the people are under age group of 25 years, 55.5% are 25-50 and 27.2% above 50. Occupation wise 55% people are engaged in agriculture; 30% are unemployed; 2% is in business; 2% in service and 11% other types of work. This indicates that the main income is from agriculture and people are relatively poor with unemployment as high as 30%. Though the people interviewed are residents of banks of the river Kosi, their knowledge of fish was limited to mainly the fishes which are economically important and caught for consumption. About 95% of people opined there is decline in fish, whereas 5% felt that there was no decline. Regarding percentage of fish decline, 34% of people responded that there is a 20% decline over last 10 years; 31% of people opined between 20-50%, 33% told more than 50% and 2% people did not opine about percentage decline in fish. There appears to be a large variation in peoples opinion. Regarding the most endangered fish species, 30% of people felt that mahseer was most endangered followed by *Bagarius* (28%), all fishes (22%), *Schizothorax* sp. (14%) and *Mastacembelus* sp. (6%). The public perception is that use of explosives is the main reason for decline of the fishes (about 50%) followed by natural calamities (23%) fishing by diversion of water (8%) and

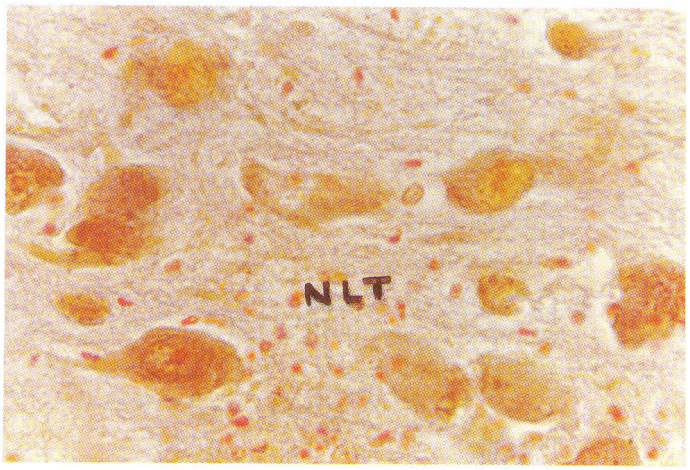


Fig. 10. Nucleus lateralis tuberis (NLT) of the endangered golden mahseer *Tor putitora*.

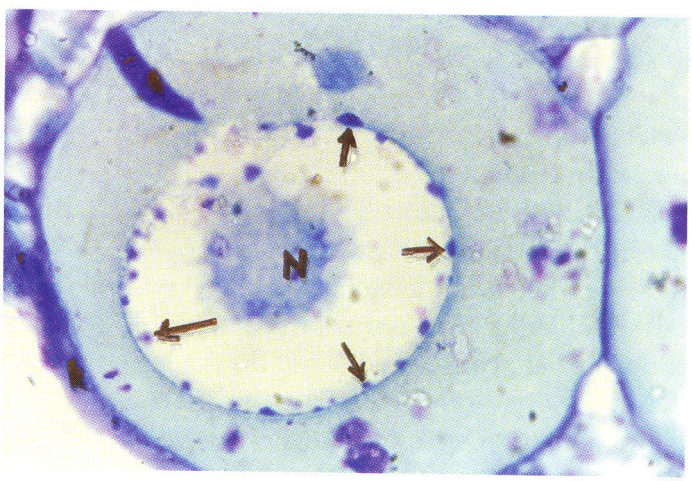


Fig. 11. Immature (Stage 2) oocytes of *Tor putitora* showing central nucleus (N) and numerous nucleoli (arrow) at the periphery X 80.

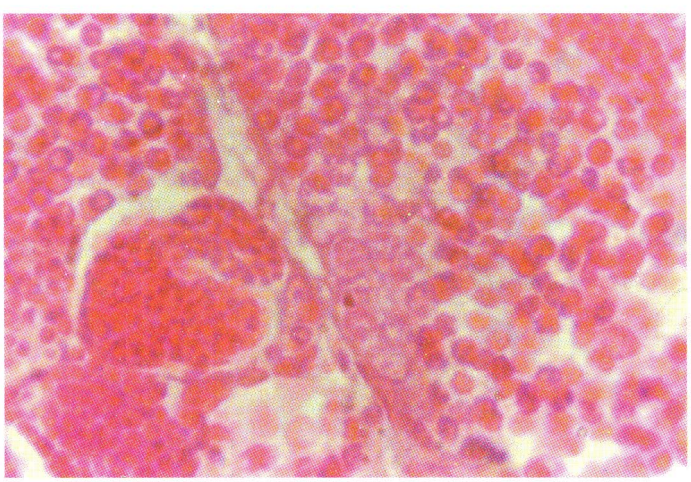


Fig. 12. Testis of *Tor putitora* showing seminiferous tubules with spermatogonia and spermatocytes at various stages of development. X 1000.

use of net (13%) and other means of fish catching (6%). Even now, explosives form the main method of fishing (53%), netting (32%) and other methods such as water diversion, hammering etc. (15%). Regarding ban on fishing there was strong opinion against use of explosives (75%) followed by banning of nets (12%), for all methods (10%) where as only 3% felt banning angling, draining water will help conserve fishes.

Compared to earlier years, the impact of decline is mainly felt by people with respect to non-availability of fishes for consumption (72%), followed by effect on livelihood of fishermen (16%) and increase in cost of fish (12%). The respondents felt that restriction in fishing is the best method for conserving the fish (61%), followed by culture and ranching (15%), mass awareness (11%), habitat improvement and modifications (10%) and observing closed season (3%). It is evident that there is a strong support from the local people in favour of implementing various conservation efforts.

Fig. 13. An anglers catch of endangered mahseer *Tor putitora* from Kali stream.

Role of Anglers in Conservation

For several years now there has been international recognition that sport fishing can be utilized to promote fish conservation and ecotourism. In Kumaon region of India specially the downstream of Kali, Kosi, Ramganga, Sarju rivers offer excellent sport fishing to the Indian as well as foreign anglers (Fig. 13). A survey was conducted during June, 1998 and catch data on endangered mahseer (*T. putitora*) was collected from the anglers. Enquiries reveal that the best fishing zone is the confluence of two streams or the stretch where due to difficult terrain there is hindrance to fishery. The maximum fishing is recorded in the 90 km stretch located between Chukua (Tanakpur) to Jauljibi. The anglers noticed strong seasonal patterns for angling success, which is closely related to seasonal changes in availability of mahseer. Analysis of twenty seven days angling data of three angler groups shows that maximum catch of mahseer ranged from 34 to 96 numbers. The size group of mahseer caught

ranged from 1.1 to 1.8 m. The daily record of total catch through angling by three groups varied from a minimum of 15 lb. to a maximum upto 504 lb. Based on angler's record, the stretches of potential streams can be demarcated into various zones like optimum area for angling, commercial fishing and for sanctuary.

Awareness Programme

Increased public awareness on the status of threatened species and the need for their conservation is an important part of species recovery programme. During the period of report, mass awareness programme on saving endangered fishes and stream habitat was organised in collaboration with the Corbett Foundation, in two places of Kumaon region Dhikuli, Ramnagar located near the stretch of Kosi river. The programmes were aimed at bringing about sense of awareness among the fisherman through film show, photo exhibition on conservation of fish and stream habitat and through illustrative talks. The participants included people, anglers, officials of the Forest Department, Corbett Tiger Reserve and the Corbett Foundation. The local people positively responded and wholehearted expressed their urge for saving endangered mahseer and other threatened fishes. A hoarding with conservation slogan was fixed at Kosi Barrage, Ramnagar as part of a mass awareness programme in presence local MLA, Dy. Director, Corbett Tiger Reserve and other officials from Forest Department, Ramnagar. Fish conservation committees were formed at Mohan and Ramnagar. Pamphlets in local language on 'Save Mahseer' were distributed.

Collaborative work on "Fish Germplasm Resources Evaluation in N.E. States for conservation of threatened species"

North East Region of India, located between 21.57°N - 29.30°N latitude and 89.46°E - 97.30°E longitude has a rich fish biodiversity. Available information in respect to North-East for biodiversity is meagre and abundance of many species have rapidly declined in course of time. In order to assess the present status of these fishes as well as to understand common peoples perception of fish germplasm conservation, surveys have been carried out in North East India. This work has been done in collaboration with local fishery experts in 8 states of North Eastern region including Sikkim.

Fish germplasm inventory in the protected areas/sanctuary/National park of N.E. region have been initiated. The protected areas where studies have been initiated under the supervision of local coordinators are Manas Wildlife Sanctuary, Assam, Dibru Chaikhowa at Dibrugarh and Loharband of Tripura. Fish specimens from the different drainage systems have been collected and preserved for further studies (Fig. 14). The data collected on the fish biodiversity, present status of fishery, physical characteristics of the streams/rivers through survey proformas in eight N.E. states are under analysis.

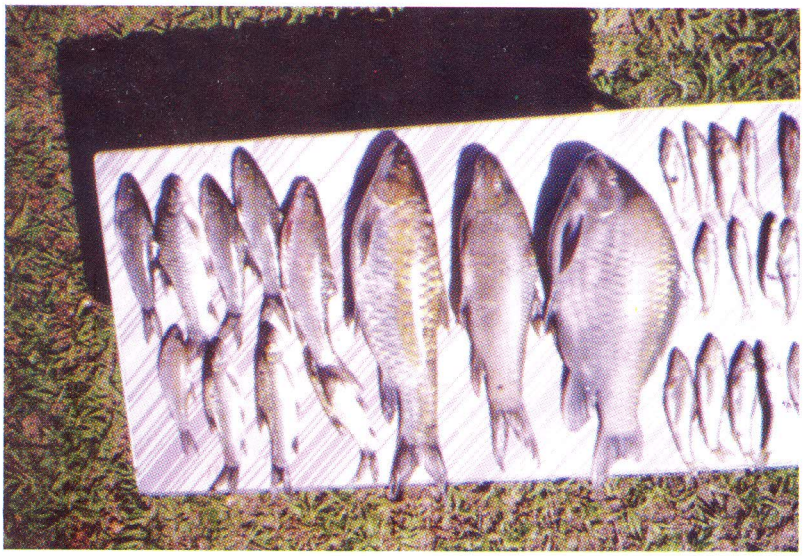


Fig. 14. A collection of endemic fishes from North East Region.

A peoples participatory programme on the awareness of saving the endangered fishes of N.E. region were organised from 1st to 11th April, 1998 in the villages surrounding Jia-Bhorelli river, Fisheries college (AAU) at Raha, Balipara fish market in Nagaon district and in several school through collaboration with Assam (Bhorelli) Anglers Association, Tezpur. In this participatory programme, villagers and youth club members expressed their desire for participating in programmes for saving fish germplasms. Five local fish conservation committees were formed and members of each committee attended a workshop in the eco-camp of A(B)AA, Tezpur. Leaflets in local language were distributed. A meeting was also organised in the Zoology Department, Cotton College, Guwahati with WWF members for N.E. region and several issues on the conservation of fish germplasm resources were discussed.

5.3 Project No. CG-11 : Chromosomal Profile of Endangered Species and Fishes of Economical Importance with Special Reference to Genotoxic Effect of Pollutants.

Agricultural insecticides and industrial effluents containing heavy metals are the major constituents of aquatic pollution. The deleterious effect of these pollutants on fishes are directly linked with public health hazards, reduced productivity of aquatic resources and long term damage to genetic resources. During the period under report, studies were carried out to determine the genotoxic effect of pollutants on fish using micronuclei genotoxic assays developed for the selected species at NBFGR. Trials on further standardization of cytogenetic techniques like comet assay, cell culture and *in vitro* colchinisation were also undertaken.

Genotoxic effect of pollutants :

To quantify genotoxic effect of pollutant, *Channa punctatus* was selected as test species since it is found around the agriculture field where agricultural run off containing high amounts of pesticide is found and *Mystus vittatus* was selected as representative of riverine species.

Mystus vittatus

In *Mystus vittatus*, the effect of organophosphate insecticide malathion at 2.0, 4.0 and 5.0 ppm on blood cells was determined after 24 hours of treatment. The results of the fourth trial is summarized in Table 6. A total of 12600 blood cells from control, 7068 from 2.0 ppm, 10535 from 4.0 ppm and 11940 cells from 5.0 ppm experimental groups were screened. Micronuclei at 0.039% in control, 0.198% in 2.0 ppm, 0.256% in 4.0 ppm and 0.544% in 5.0 ppm were recorded, which indicate a dose dependant increase in percentage of micronuclei.

Two trials were made for study of sister chromatid exchange through incorporation of BrdU at a dose of 5.0 mg/100 gm body weight. Fish were dissected, chromosome spreads were prepared and stained. Sister chromatid exchanges and differentiation were observed only in 18% of the metaphase spreads

Channa punctatus

Trials were carried out on *Channa punctatus* to determine if increasing malathion concentration at sublethal level (1.0, 2.0, 5.0 and 10.0 ppm) elevated the levels of micronuclei. Initially, three trials were carried out to standardize the experimental protocol. The results of the fourth trial is presented in Table 7. A total of 7940 blood

Table 6 : Effect of different dose of malathion on blood cells of *Mystus vittatus* after 24 hours of treatment.

Concentration (ppm)	Blood cells (no.)	Micronuclei (no.)	Micronuclei (%)
Control	12600	5	0.039
2.0	7068	14	0.198
4.0	10535	27	0.256
5.0	11940	65	0.544

Table 7. Effect of different dose of malathion on blood cells of *Channa punctatus* after 24 hours of treatment.

Concentration (ppm)	Blood cells (no.)	Micronuclei (no.)	Micronuclei (%)
Control	7984	10	0.125
1.0	4924	11	0.223
2.0	3748	15	0.40
5.0	1888	12	0.64
10.0	3369	31	0.92

cells from control group, 924 from 1.0 ppm, 3748 from 2.0 ppm, 1898 from 5.0 ppm and 3369 from 10.0 ppm dose of malathion were screened. Low percentage of (0.125%) micronuclei were observed in control while the percentage of micronuclei observed was 0.223% in 1.0 ppm, 0.4% in 2.0 ppm, 0.64% in 5.0 ppm and 0.92% in 10.0 ppm group of specimens. The result indicate increasing percentage of micronuclei with increase in concentration of malathion.

Chromosome slides were prepared for studying sister chromatid exchange and chromosomal abnormalities. Primary screening of slides indicated chromosomal abnormalities like chromatid breaks, gaps, polyploidy and occurrence of sister chromatid exchanges.

Studies were also carried out in *Channa punctatus* to determine the effect of the pesticide chloropyrifos and carcinogenic agent p-aminobenzene after exposure of 24, 48 72 and 120 hours and to determine if alternate staining protocols using accridine orange can help in better scoring of micronuclei. The blood slides were stained in accridine orange and screened under fluorescence microscope (fig. 15). The result, presented in Table 8, shows that in 24 hours, while a low level of 0.082% micronuclei was observed in control

Table 8. Effect of chloropyrifos (Exp. 1) and p-aminobenzene (Exp. 2) on blood cells of *Channa punctatus*

Time (Hrs.)	Group	Blood cells (no.)	RBC	WBC	Micronuclei (no.)	Micronuclei (%)
24	Control	2413	2348	65	2	0.082
24	Experiment 1	2116	2045	71	4	0.277
24	Experiment 2	1272	1216	56	6	0.314
48	Control	866	829	37	1	0.11
48	Experiment 1	1579	1530	49	5	0.316
48	Experiment 2	1498	1415	83	5	0.333
72	Control	1600	1545	55	2	0.125
72	Experiment 1	834	818	16	3	0.359
72	Experiment 2	1540	1510	30	7	0.454
120	Control	1667	1617	50	1	0.059
120	Experiment 1	1694	1642	52	8	0.470
120	Experiment 2	947	902	45	8	0.844

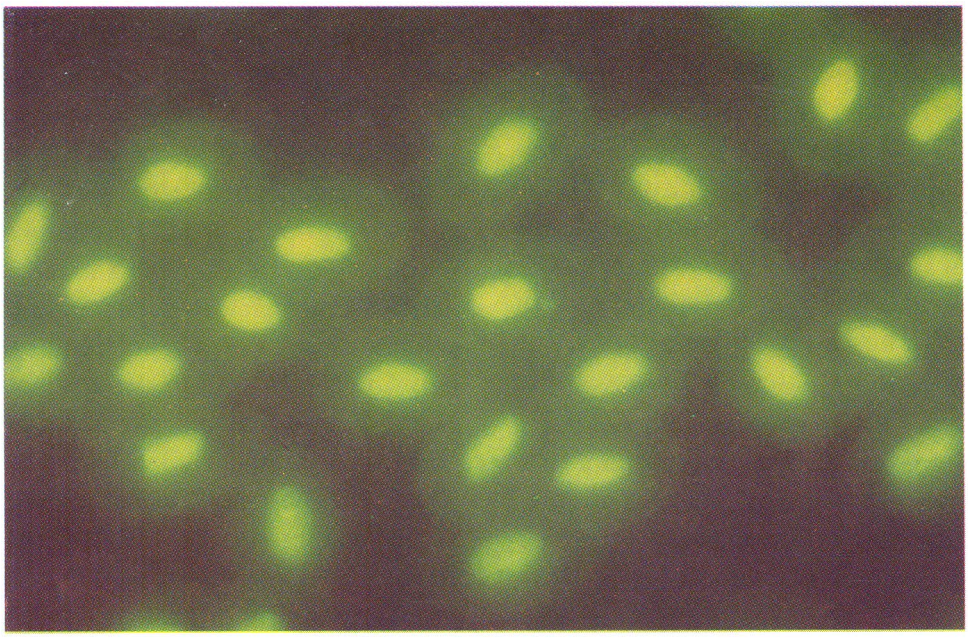


Fig. 15. Accridine orange stained micronuclei in *Clarias gariepinus.*

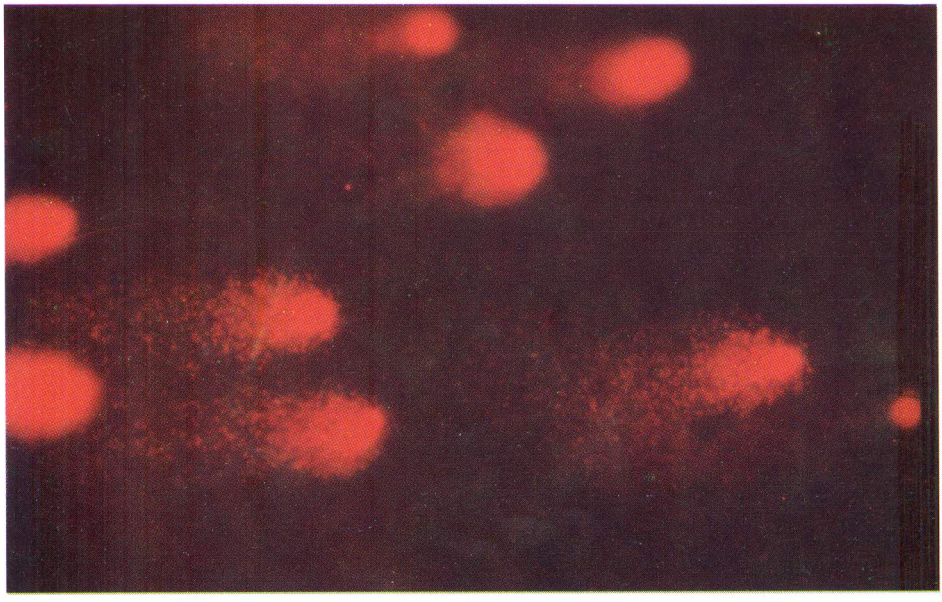


Fig. 16. Fluorescent microphoto of comet assay in *Channa punctatus.*

group, higher levels of 0.277% and 0.314% were seen in chloropyrifos and p-aminoazobenzene treated groups respectively. Increasing trend was observed at 48, 72 and 120 hours. Percentage of micronuclei increased upto 0.47% in case of pesticide treated, and upto 0.844% in case of p-aminobenzene treated fishes at 120 hrs.

The trials also indicated that staining with accridine orange and screening under fluorescence microscope helped in definite scoring of micronuclei and gave better results than the conventional giemsa staining technique.

Development of cytogenetic techniques

Comet assay

There are reports that there are many mutagenic chemicals, which may not induce micronuclei but induce damage on DNA strands which can be quantified through single cell gel electrophoresis (comet assay). Since report on freshwater fishes for comet assay was not found, the method of Yu.F. Sasaki *et al.* (1977) which is reported in mouse was followed. For standardization four trials were carried out.

Live specimens of *Channa punctatus* injected with p-aminoazobenzene and chloripyrifos @ 0.1 mg/10 g body weight were maintained in aquarium. Separately control groups without any treatment were maintained. Fish were sampled at 24, 48, 72 and 120 hour intervals. Liver, kidney and blood cells were analysed for comet assay. About 25 mg kidney and liver tissue from experimental and control group were homogenised in 1.0 ml homogenisation buffer (pH 7.5). Blood was directly collected in homogenisation buffer. To obtain good quality cells, samples were centrifuged at 700 g for 10 minutes at 4°C and precipitate were resuspended in 1.0 ml of homogenisation buffer. The cells, embedded in low melting agarose and layered on microscopic slides were lysed in alkaline buffer (pH-10.0). The lysed cells were subjected to chilled alkali treatment (pH 13.0) for 20 minutes for the expression of alkali labile sites and electrophoresis was performed for 20 minutes at set voltage of 250V and set current to 300 mA. After electrophoresis the slides were washed with 0.4 M tris HCl buffer (pH 7.5) and stained with Ethidium bromide.

The nuclei on slides were examined at 40x magnification using fluorescence microscope equipped with green filter (fig. 16). Frequency of comets (tailed cells) were scored. The cells with separate head and tails were excluded. Through comets were observed in each trial, there were no specific pattern with respect to control and treated fish in blood, liver and kidney cells. Therefore, further modification and standardization of the technique is needed.

Blood cell culture

In *Claris gariepinus*, blood was collected aseptically by heparinised syringe and kept for one hour at room temperature. The upper portion plasma containing WBC was used. A sample of 0.5 ml was mixed in 10 ml of tissue culture medium containing FCS, phytohaemaglutinin, gentamycine and streptomycine and incubated in CO^2 incuba-

tor at 30°C for 72 hours Cochicine at 0.005% (two drops) was added 90 minutes before harvesting of the cells. Chromosome preparations were made by flame drying method. Of the many trials carried out, only three trials could be completed till the final step. All other trials had to be abandoned due to contamination. Of the three completed trials, in two, cells were observed but successful metaphase was not observed. Good meta-phase was recorded from the last trial (Fig. 17).

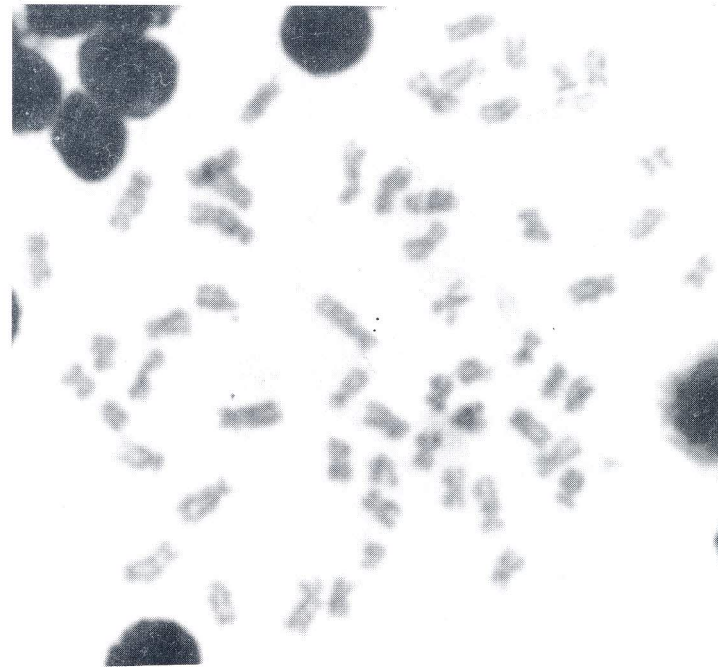


Fig. 17. Metaphase spreads of *Clarias gariepinus* obtained through whole blood culture.

***In-vitro* colchicinisation**

Modification of *in-vitro* colchicinisation technique was carried out in order to obtain good quality metaphase spreads with large size chromosomes so that clear banding pattern could be observed and the technique can be applied in field for big size fish specimen. Kidney tissue of *Heteropneustes fossilis* (n=4), *Clarias gariepinus* (n=10), *Channa punctatus* (n=2) , *Labeo rohita* (n=6), *Mystus vittatus* (n=6) were dissected and treated in RPMI 1640 medium containing growth factor like FCS and antibiotics. The treatment time and colchicine dose were modified and 3 to 4 times larger chromosomes were observed as compared to routine method specially in *Channa punctatus* and *Labeo rohita*. However, the chromosomal spreads of *H. fossilis* and *C. gariepinus* and *M. vittatus* have not shown the increased size of chromosomes by using the protocols of *C. punctatus* and *L. rohita*. Further species specific standardization is required.

5.4 Project No. DNA-15 : Genetic Char acterisation of Commercially Important and Prioritised Endangered Fish Species, using DNA Markers.

In order to evaluate the genetic characterization of various fish populations at DNA level, studies were undertaken on Indian major carps (IMC) and air breathing fishes. In the present study PCR primers were used which allows specific regions of DNA to be amplified and facilitates detection of genetic differences between various population.

Clarias batrachus **and** *C. gariepinus*

Amplified Restriction Fragment Length Polymorphism (ARFLP)

The universal primers for ND5 and ND6 genes of mt DNA were used to amplify the particular fragment of mtDNA. The PCR conditions were (i) 94°C for 5 min, (ii) 94°C for 30 sec, 55°C for 60 sec and 72°C for 2 min and (iii) 72°C for 4 min. The reaction mix contain 25 ng total DNA, 1 X buffer, 0.2 mM dNTPs, 1.5 mM MgCl2, 3 U of Taq polymerase and 0.15 ml each of both primers. Using total DNA from fresh liver, a single PCR product was obtained in both the species but from alcohol fixed blood, the amount of amplified product was very low. The amplified product of approximately 2.5 Kb from mtDNA ND5/ND6 genes from 8 individuals of each species were restricted with eight restriction endonucleases, Hae III, Hha I, Hpa II, Hinf I, Mbo I, Msp I, Rsa I and Eco RI. Except Hha I, remaining seven enzymes showed species specific ARFL pattern (fig.18). The total number of bands amplified along with species specific bands is indicated in Table 9. It is evident that ARFLP can be utilized as genetic markers to quantify introgression between these two species.

Labeo rohita

Random Amplified Polymorphic DNA (RAPD)

RAPD technique was used to determine intraspecific variation in rohu (*Labeo rohita*). Initially a total of 12 RAPD primers were screened using the samples from three river system (Kalibain, Sutlej and Mahanadi) and 9 gave clear and repeatable bands. Out of a total of 56 bands scored, 27 were found to be polymorphic in the populations tested (fig. 19). Of the polymorphic bands, twenty one bands were found to be fixed for one or two populations and polymorphic in other(s). One of the polymorphic band was absent only in Mahanadi samples. Remaining bands were polymorphic in all the population.

Table 9. Amplified Restriction Fragment Length Polymorphism (ARFLP) of ND5&6

Sl. No.	Restriction Enzymes	Fragments			
		Total		Species specific	
		Cb	Cg	Cb	Cg
1.	Hae III	1	8	1	8
2.	Hha I	3	3	0	0
3.	Hpa II	1	3	1	3
4.	Hinf I	4	3	3	2
5.	Mbo I	3	3	3	3
6.	Msp I	1	2	1	2
7.	Rsa I	4	3	3	2
8.	EcoR I	2	1	2	1

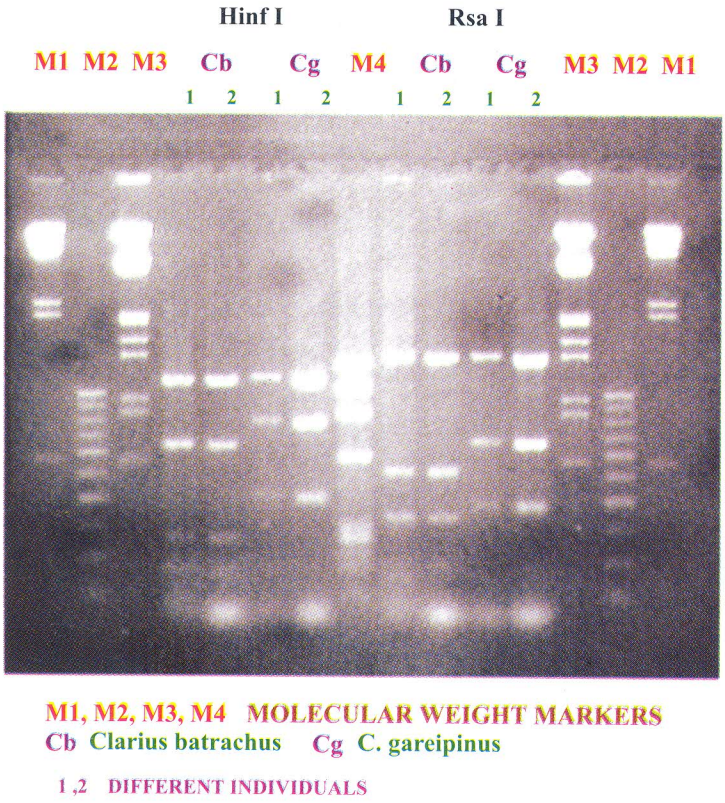


Fig. 18. Amplified Restriction Fragment length Pattern in Air-Breathing Fishes.

Microsatellites

Microsatellites form a useful marker system for study of intraspecies variation among populations. Microsatellite sequences are not available in rohu, so recently published five catla sequences (Gene Bank accession no./ locus — AF045379/Ccat A7, AF045378/ Ccat A12, AF045380/Ccat C3, AF045381/ Ccat G1, AF045382/Ccat G2 were used to determine interspecies cross amplifications of catla (*Catla catla*) microsatellites in rohu. Out of five catla primers tested, one (G1) locus gave sharp, repeatable and polymorphic bands for two only dim multiple bands were visible even with different PCR conditions and with remaining two, there were no bands (fig.20). Unlike the cross amplification of microsatellites observed among salmonid species, in Indian major carps (IMC), the lack of proper amplification of four catla microsatellite sequences in rohu indicates that for each IMC, microsatellite markers have to be developed separately.

For G1 locus, three populations of rohu were studied and the polymorphism detected in the two populations, Sutlej and Rapti, were analysed. A total of 4 alleles were observed of 123, 135, 171 and 187 bp. Most common allele is of 135 bp and the rare allele is of 123 bp, which is found in Sutlej and absent in Rapti river systems. This locus was found to be polymorphic with heterozygosity ranging from 0.6216 to 0.6786. Gst indicates that only 0.5% of the genetic variation at this locus is due to population difference. This study clearly indicates that by addition of more polymorphic loci, populations can be differentiated on the basis of microsatellites.

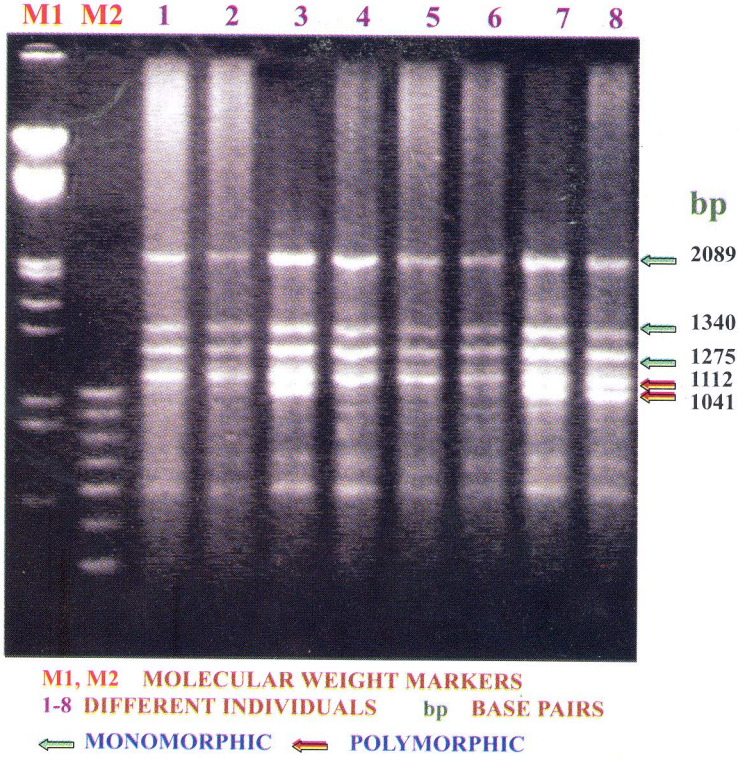


Fig. 19. RAPD pattern in natural population of *Labeo rohita*.

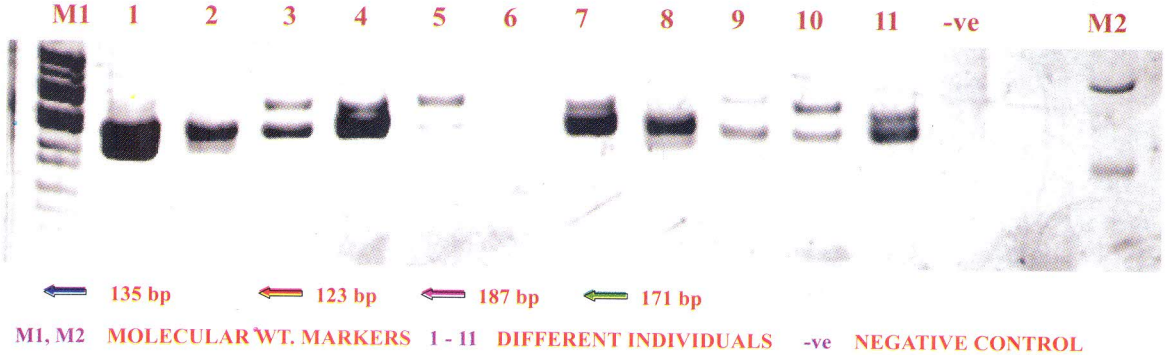


Fig. 20. Microsatellite in natural population of *Labeo rohita*.

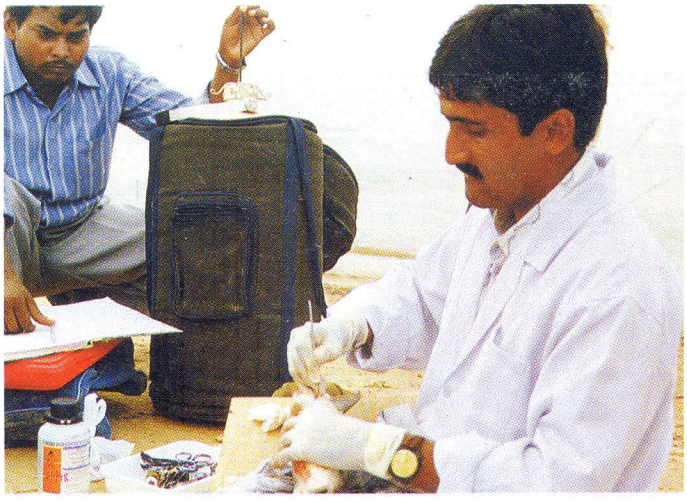


Fig. 21. Sampling of *Labeo rohita* for genetic characterization from Mahanadi river.

5.5. Project No. BG-10: Genetic Profile of Prioritised Endangered Species and Wild Strains of Commercially Important Species.

Conservation of wild stocks of commercially important as well as endangered fish species requires information on the population genetic structure of these species. To fulfil this objective, genetic profile of riverine stocks the commercially important rohu and magur as well as endangered fishes were screened with standardized isozyme and isoelectric focussing markers.

Labeo rohita

Riverine populations (n=8) of *Labeo rohita* have been screened using isozyme and IEF of eyelens markers. The populations belong to (i) *Indus basin* : Beas, (n = 12 at Govindwal Sahib), Satluj (n = 45 at Ladhowal) and Kali Bain (n = 69 at Sultanpur Lodhi). (ii) *Ganga Basin* : Ganga (n = 65 at Allahabad), Gomti (n = 40 at Lucknow), Gomti (n = 59 at Sultanpur) and Rapti (n = 75 at Gorakhpur). (iii) *Mahanadi* basin (n = 78 at Cuttack) (fig. 21).

Total 26 isozyme systems were screened of which 20 isozyme gave clear scorable activity confirming the presence of 41 loci. Total 17 isozyme loci were found to be polymorphic (fig. 22). The genotype distribution obtained is under analysis. Total 443 samples were analyzed for isozyme screening.

The samples of eyelens from riverine collections were analyzed using ultrathin isoelectric focussing (IEF). Polymorphism was detected at pI value of 6.8. The presence and absence of the band was recorded. In all the populations, the percentage of individuals with the band ranged from 22% (Beas) to 36% (Sutlej).

Till now only one hybrid which morphologically looked like catla but on screening with genetic markers was found to be rohu-catla hybrid (fig. 23) had been detected in riverine samples (River Ganga at Allahabad). From Naukuchiatal, U.P. one catla-rohu hybrid was observed in fish collection. However, during the field riverine sampling on Indian major carps, the practice of stocking with hatchery seed areas cut off from adjoining the rivers which gets inundated in floods came to light. Such practice was found in two areas (1) adjoining Beas at Govindwal Sahib (2) adjoining Rapti near Gorakhpur. In the second area, large number of catla-

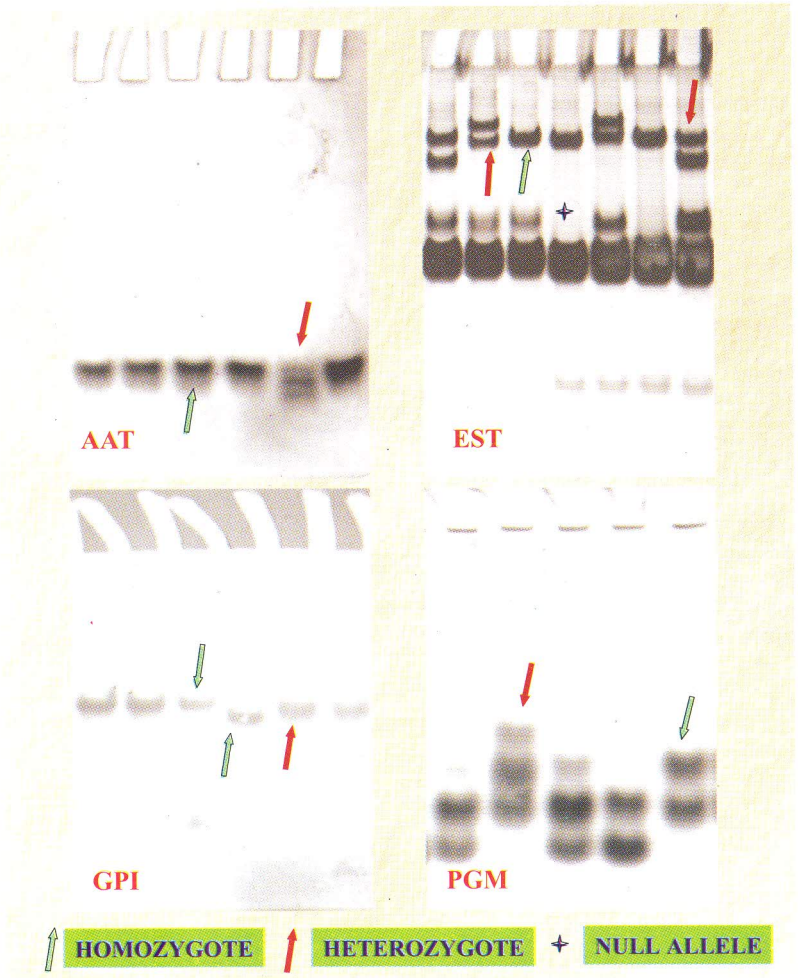


Fig. 22. Polymorphic genetic markers- Aspartate Amino Transferase, (AAT) Esterase (EST), Gluco Phosphate Isomerase (GPI) and Phospho Gluco Mutase in *Labeo rohita*.

rohu hybrids were present. IEF analysis confirms that there were catla-rohu hybrids (fig. 24). This practice of stocking areas adjoining rivers with hatchery seed will lead to contamination of wild stocks with introgressed hatchery stock and will in turn affect the genetic purity of wild stocks.

Clarias batrachus and *C. gariepinus*

To detect if genetic introgression between endemic *Clarias batrachus* and exotic species *C. gariepinus* is occurring in nature,

Fig. 23. Catla-rohu hybrid collected from river Ganga.

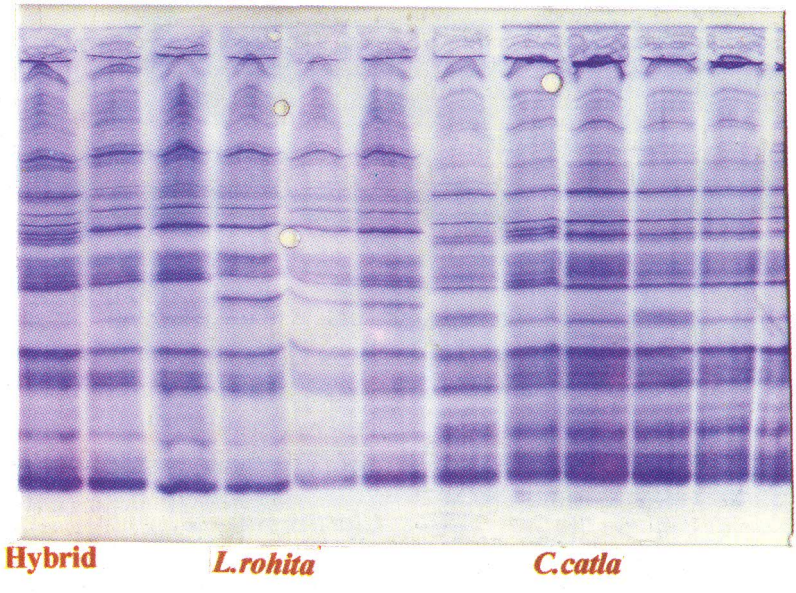


Fig. 24. Ultrathin Isoelectric focussing of lens proteins of *Labeo rohita* (L.r.), *Catla catla* (C.c.) and hybrid (Hy) of *L. rohita X C. catla.*

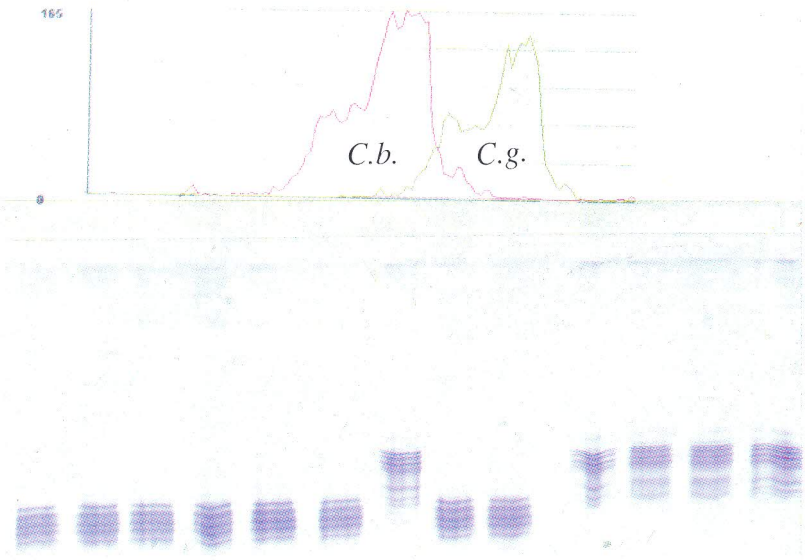


Fig. 25. Ultrathin Isoelectric focussing of Heamoglobin proteins of *Clarias batrachus* (C.b.) and *C. gariepinus* (C.g.) along with scanned profile.

there is need to identify genetic markers. As an initial step, both species were characterized with isozyme and IEF markers. Clear species specific differences are obtained with IEF of haemoglobin (fig. 25) than isozyme markers. Of the isozymes screened species specific differences were evident in GPI (fig. 26) In *C. batrachus* IEF profile, ten major band patterns having pI values between 5.522 to 7.230 and in *C.* gariepinus nine major band patterns (pI 6.617 to 7.687) were observed. Between these two species only three bands have approximately common mobility. The coefficients of similarity between these two species were 0.187 which clearly demonstrates that IEF profile of these two species can be utilized to differentiate them and their possible hybrids. C. *gariepinus* exhibit high degree of polymorphism with respect to isozyme markers which masks species specific differences between species. The polymorphism was observed at Est 4, GPI, G6PDH 1, PGM 1 and 2, SOD 1 and 2 loci.

Endangered species :

Labeo dussumieri

As an initial step at arriving baseline profile, the isozyme band pattern of peninnsular carps *Labeo dussumieri* and *L. fimbriatus* were compared with some hatchery stocks of *Labeo rohita*. A total of 14 isozymes (representing 28 loci) were screened and all the enzymes were found to be species specific.

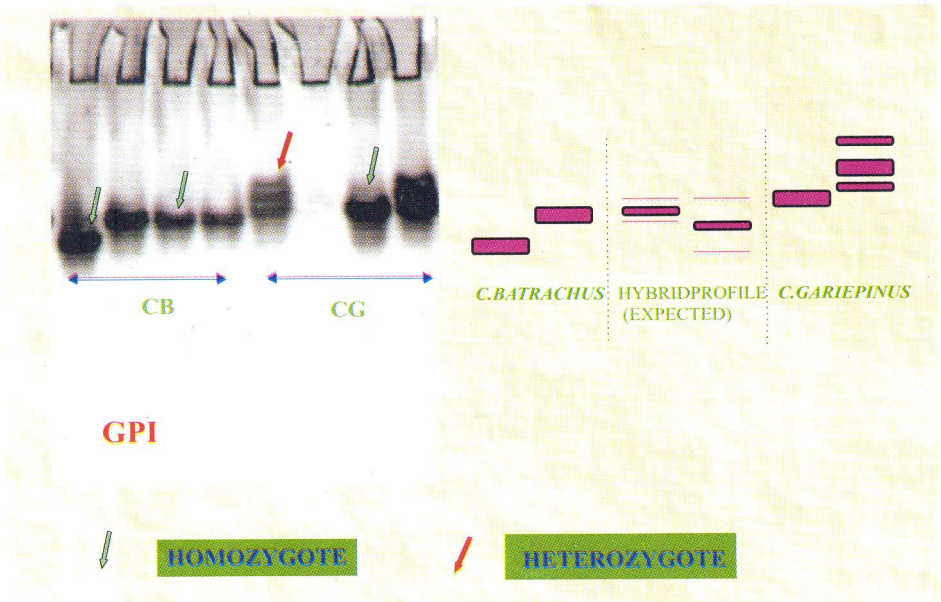


Fig. 26. Species - specific differences in *Clarias gariepinus* (C.g.) and *C. batrachaus* (C.b.).

For exterases, 4 substrates viz. a-napththyl acetate, b-napththyl acetale, a-napththyl propionate and 4 - methyl umbelliferyl acetate were tested in all 3 species and no substrate specificity was observed. Polymorphism was observed at a-GPDH in samples of *Labeo fimbriatus*.

To determine natural genetic variation, wild populations of endangered, endemic and commercially important cyprinid *Labeo dussumieri* of Kerala were screened. Fourteen isozyme (total of 28 loci) systems were analysed and the running conditions were standardised. Samples were collected from the population of the species inhabiting Meenachil river. Polymorphism was observed in the pattern of aspartate amino transferase, superoxide dismutase and a-glycerol phosphate dehydrogenase. Of the 33 individuals analysed, 25 show slow migrating fraction of AAT, 6 were heterozygous and 2 homozygous for fast migrating allele. Heterozygosity at this locus was 0.2571.

In esterase, polymorphism was observed in Zone III with 6 out of 33 individual in this zone showing an additional band. Heterozygosity at this locus was 0.1653. In superoxide dismutase, 27 specimens out of 33 exhibit homozygous state. The remaining six were heterozygotes. Heterozygosity at this locus is 0.1. Presence of polymorphism in a-glycerol 3 phosphate dehyrdogenase has been found in the Meenachil population. The 22 specimens out of 33 exhibits only show migrating single fraction and 11 specimens

showed the heterozygote pattern. The heterozygosity was 0.2778. The mean heterozygosity for the Meenachil population was calculated to be 0.03091.

White fish *Lactarius lactarius*

This part of work was done under the collaborative programme of NBFGR with CMFRI, Cochin. The genetic characterization of *Lactarius lactarius* was continued with analysis of isozyme pattern of specimens from Cochin (West coast) and Kakinada (East coast). Altogether, 68 specimens were screened from Cochin and 36 specimens from Kakinada for interpopulation differences in pattern of 14 isozymes. Out of 14 isozymes, running conditions were standardised for 12. Polymorphism was observed in the pattern of AAT and SOD. In the case of AAT, the slow migrating allele was found fixed in Cochin population while two specimens out of 36 from Kakinada exhibit typical heterozygous dimeric pattern. The pattern of SOD also show some differences between Cochin and Kakinada. All 36 specimens from Kakinada and 62 out of 68 from Cochin exhibit only a fast moving allele, while 6 specimens from Cochin exhibited dimeric heterozygous patterns. Fast moving allele fixed in Cochin population while 6 specimens from Cochin exhibited dimeric heterozygous pattern. The other enzymes did not exhibit any polymorphism. The results analysed so far indicate genetic differences between both populations indicating possibility that they belong to different genetic stocks.

5.6. Project No. FB-16 : Utilisation of GIS Techniques for Endangered Fish Microlevel Habitat Assessment in Selected Streams and Constructing Thematic Maps of Macrolevel Fish Distribution in India.

To implement *in situ* conservation programme one of the main requirements is information on microhabitat of endangered fishes. Geographic information system (GIS) is required for analysis of habitat and biological information so that decisions which are relevant spatially can be taken. The present project aims at determining the microhabitat requirement of endangered mahseer and developing microlevel thematic maps of habitat. Also at macrolevel, fish distribution data are to be arranged on a GIS platform. During the present period, preliminary survey of the Kosi river (Kumaon region) was carried out to identify locations for detailed habitat inventory. To develop methodology for arranging fish distribution data on a digital base map, information from Internet, thematic maps from NATMO, topo sheets from Survey of India and satellite image of the study area have been collected. A case study was carried out at Ladhiya stream, to assess the quality of microhabitat and for arranging them on GIS platform. The feasibility of using remote sensing for studying fish habitat was also explored.

Micro Habitat Survey

A total stretch of 190 km of Kosi river in U.P. was surveyed in two collections.

During one of the survey, periphyton sampling was done at 12 locations and physical parameters of microhabitat were also recorded. Fish distribution in each microhabitat was also recorded. The size of the microhabitat (length, width, depth), pH, temperature, water velocity, elevation and substrate is given in table 10.

Ramganga (west), Saryu, Ramganga (east), Gola and Kali rivers were surveyed to identify one river for comparison with the Kosi for microhabitat inventory. The habitat condition for fish was assessed in all the rivers. It was noticed that Ramganga (W), Saryu, Kali have high discharge rate and pool area was higher than the riffle which could account for higher abundance of big size Mahseer. On the other hand other rivers like Kosi and Ladhiya have less discharge rate, poor ratio of pool to riffle and less number of big size mahseer at most of locations. So to compare microhabitat condition of endangered mahseer between degraded and optimum habitat, the two river systems, Kosi and Saryu were selected. Also the nature of both differ in that the water flowing in the Kosi river is of fluvial origin while that of Saryu is glacial-fluvial nature. Also on Kosi river, a dam is constructed in the downstream at Ramnagar which prevents migration of brood stock of *Tor putitora* during the breeding season while on Saryu no such obstruction is present and *T. putitora* migrates from Kali river for its breeding. The size of *T. putitora* caught also differs between both rivers. The normal size of *T. putitora* caught from river Kosi ranged from 3-5Kg and rarely fishes larger than 10 Kg is caught. On the other hand in Ramganga (east and west), Saryu and Kali, large sized *T. putitora* of 20-30 Kg are caught.

Geographical Information System

Microlevel maps

The path of the Kosi river (fig 27) was extracted from the Survey of India toposheet map using summagrid AO size digitizer and IDRISI for Windows software. A GIS map of the Kosi river was prepared showing road network near Kosi river, forest area, major places and the tributaries joining it. All the maps were georegistered using resampling module of IDRISI for Windows software. This will be the base map for overlaying microhabitat inventory data.

Utilising data on microhabitat of endangered *T. putitora* from Ladhiya, a hilly stream, methodology was developed for arranging habitat inventory and other related data at micro level on GIS platform using GPS and remote sensing techniques (fig 28).

The satellite image of the study area taken from LISS II camera of IRS IA satellite was procured in BIL format from NRSA, Hyderabad. The data was separated into four bands using IDRISI for windows software and a false colour composite (FCC) was created using band 2, 3 and 4. The path of the river was traced using "Digitize" module of IDRISI by on screen digitization and different ideal numbers were given to different identified zones (n=34) which were marked using ground truth data. The length of each zone was calculated by converting

Table 10. Microhabitat found in Kosi stream.

Stn. No.	Microhab. (L x B x D) (m)	Type	Samp. Depth (cm)	Substrate	Sunny SU)/ Shady (SH)	Water Velo-city (km/ hr)	pH	Temp (°C)		Eleva-tion (m)	Periphyton					
								Atm.	Water		Cells/ mm^2	Vol/ cm^2	% composition			
													Chl.	Myxo.	Bacill.	Other
1.	50x6x 0.12	Riffle	10	Cobble, Boulder	SU	~0	8.5	26	25	1475	1004	1.0	10.53	7.02	82.45	--
2.	70x12x 2.5	Pool	10	Sand, clay, undercut bank, bedrock	SU	~0	8.0	32	28	1315	1064	1.2	36.75	--	63.15	--
3.	75x20x 0.15	Riffle	10	Small boulder, large gravel, sand	SH	~3.09	8.0	33	28	1215	72	0.1	33.34	38.09	28.57	--
4.	40x10x .05	Riffle	15	Small boulder, sand, U. bank	SH	--	8.0	33	28	1200	804	<0.1	55.55	--	45.45	--
5.	120x10x2	Pool	15	Bedrock, sand, silt, U. bank	SH	7.0	8.0	33	28	1125	216	<0.1	18.51	14.83	66.66	--
6.	40x5x 0.6	Run	10	Bedrock, large boulder, large gravel	SH	3.0	8.6	33	28	1105	1712	0.26	33.3	2.34	64.36	--
7.	100x12x2	Pool	15	Big boulder, silt and clay	SH	~0	8.5	35	31	995	272	0.12	--	8.82	58.82	2.95
8.	60x10x2	Pool	5	Sand, cobble, silt, bedrock	SH	~0	8.4	34	30	816	1332	0.5	0.8	--	99.20	--
9.	100x15x0.5	Pool	5	Cobble, sand and silt	SH	0.75	8.4	33	29	795	702	<0.1	--	6.03	91.38	2.54
10.	30x5x0.6	Run	15	Bedrock, cobble	SU	7.2	8.4	33	29	775	424	<0.1	--	6.45	93.55	--
11.	100x30x40	Pool	10	Cobble, sand	SU	4.0	8.5	36	31	475	868	<0.1	7.76	0.98	91.26	--
12.	15x35x 0.15	Rapid	15	Cobble, boulder	SU	1.67	8.4	36	31	474	400	<0.1	--	19.7	78.78	1.52

— Not recorded.

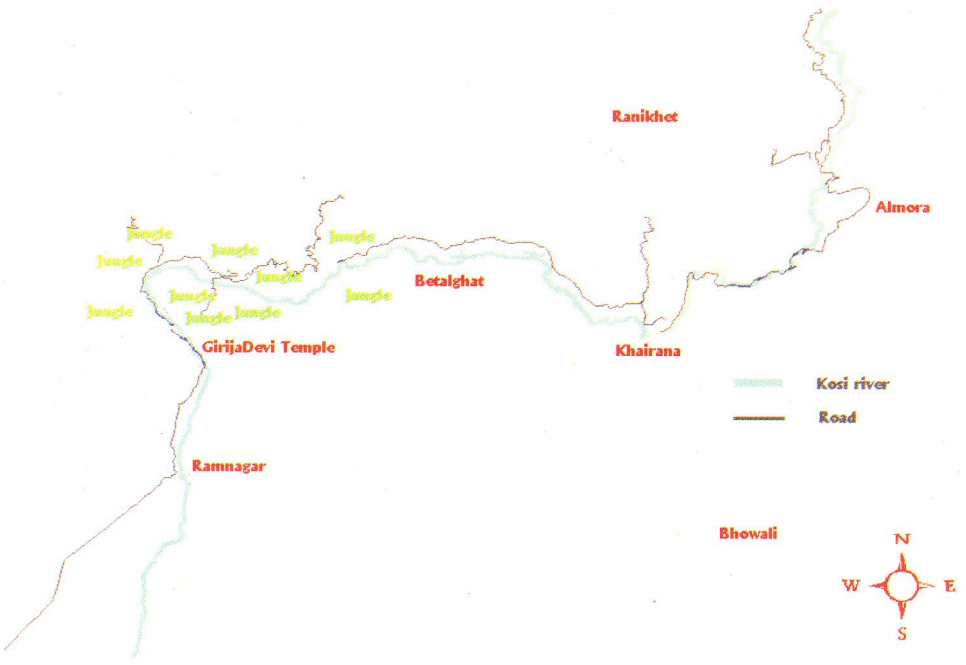


Fig. 27. The path of Kosi river and the road network digitised and extracted from SOI toposhutz.

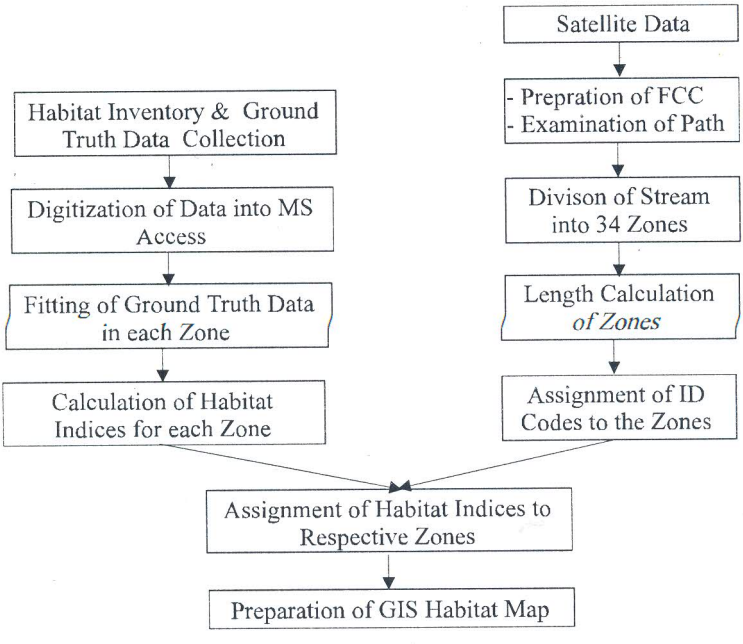


Fig. 28 Flow chart for GIS map preparation.

vector layer into raster by using "vector to raster" and "area" modules. Buffer zone of 2 kms. from the river bank along the path of the river was extracted on the FCC using "distance" and "overlay" modules. The vector image of different zones was displayed with the thickness of 6 and various colours were assigned using users defined palette. The displayed vector image was saved as IDRISI image (raster format) and each zone were assigned the value from 1 to 34 using "assign" module. The image created of different zones was used to display the habitat condition with respect to different parameters using a colour scale from 1 to 20.

The various parameters represented were substrate, instream cover and habitat type. The map showed poor habitat condition in the lower stretch of the stream which was caused because of Bisauria nala which brings large quantity of mud and boulders into the stream. In the study area, the zones falling in middle portion showed higher diversity with respect to the habitat type while the lower and upper stretches showed very less diversity. In zones falling after the confluence with Bisauria, the at microhabit diversity was minimum. Most of the zones showed poor ratio of pool to riffle (Fig 29) particularly in the lower stretch where riffle area was dominant. Only some of the zones in the middle stretch of the river showed pool area on the higher side. If the sheltered pool and rapid ratio is in 1:1, it would be an ideal habitat for *T. putitora*. The optimum ratio of 1:1 pool and riffle was found only in some zones lying in the middle stretch. So the overall habitat type distribution in the Ladhiya stream was not optimum, rather it was a degraded one and except for a few zones most of the zones were lacking deep pools, the habitat preferred by the adult *T. putitora* particularly during summer season. The long stretch of riffle leads to various problems for upstream migration of the fish.

The average depth in most of the zones was over 50 cms. Near the confluences with Sharda which was the entrance for migration of the endangered *T. putitora*, the zones having depth over 50 cm was low. These shallow zones expose the fish to predation and easy fishing. In the Ladhiya stream, mostly undercut banks, depth, and boulders and at few places the woody logs were the main instream cover. The overhanging vegetation and aquatic vegetation were totally absent from the study area.The zones lying in the lower and upper stretches of the stream showed less of total instream cover while the middle portion showed more. The boulders, which are used by early life stage of fish as hiding cover, were present in almost all zones. The depth and undercut banks which are used as hiding cover by later life stage of fish was negligible in the lower stretch. The middle and upper zones showed low to moderate area for the later life stages of the fishes (Fig 29).

In the study area most of the zones had 7-10% of sand and in the middle stretch some of the zones had very high percentage of sand (17-20%). The pool and glide found in the study area had sand as the dominant

substrate. In the zones lying after Bisauria confluence, the riffle habitat type also had 5-15% of sand and gravel which is not an ideal substrate for the growth of macro invertebrates. Cobble, rubble and bedrock which are the ideal substrate of macroinvertebrates ranged from 20-25% in most of the zones but in the zones, after Bisauria confluence its distribution was very poor. The spawning habitat of *T. putitora* is mainly associated with sand and gravel substrate in the stream. The inflow of sand and silt material from Bisauria nala alters the spawning ground during the breeding season and reduce spawning success as combination of high water discharge and silt transport is the most important restricting factor for the development of embryos and larvae of many fish species

Macrolevel fish distribution maps

Information on GIS and remote sensing application was collected using internet to study fish habitat and for arranging fish distribution data on digital map. Various toposheat maps were procured from Survey of India (1:1 million scale) and different thematic maps of different scales were procured from National Thematic Mapping Organisation. Satellite imagery of Kumaon region was procured from NRSA, Hyderabad. For digitisation of water bodies at 1:1 million scale, more than 75% of the maps have been traced and after completion of digitisation it would be possible to have a

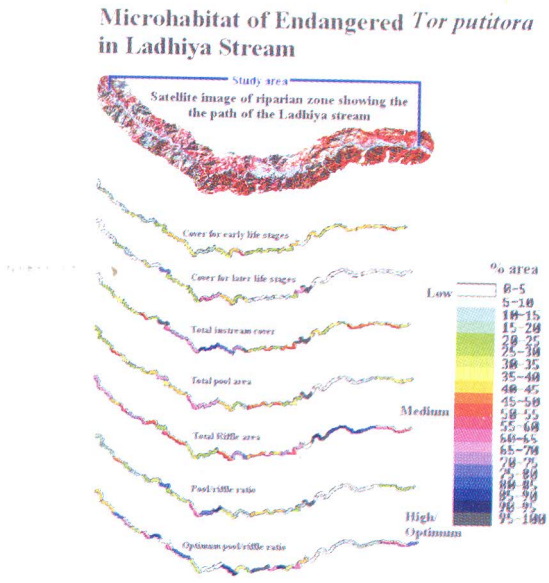


Fig. 29. Microhabitat of Endangered mahseer *Tor putitora* in Ladhiya stream.

base digital map on which the information on macro distribution of fishes can be overlayed. The river system, canal system, lakes and reservoirs were extracted in different colours so that they can be digitised in different layers.

5.7 Project No. CM-8 : Development of Sperm Banking Technique of Selected Endangered Fishes and Wild Strains of Commercial Species.

Gene banking is one of the major strategies for *ex situ* conservation of endangered fish germplasm. Already considerable work has been carried out at NBFGR on cryopreservation of Indian major carps. During the period under study, emphasis was laid on selected endangered species.

Labeo dussumieri

Labeo dussumieri is an endangered fish endemic to Kerala waters and is of commercial significance (fig. 30). The work on cryopreservation of sperm was undertaken in collaboration with Kerala Agricultural University at Regional Agricultural Research Station, Kumarakom, Kottayam. The live brooders were collected from Manimala, Tiruvalla and Meenachal rivers of Kerala. The milt was collected and tested for cryopreservation (fig. 31). Freezing was done with extenders 3, 3B, 6, 7B and 9B using DMSO@10% as cryoprotectant. Post thaw motility of the cryopreserved sperm was found to be between 60 to 100% in different extenders with the highest in extender 3.

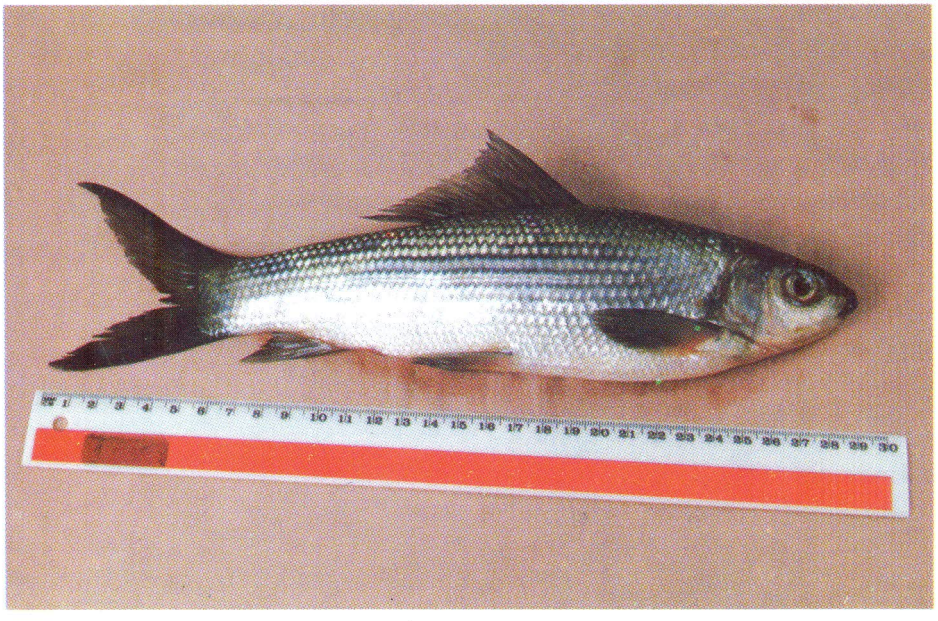


Fig. 30. Endangered fish *Labeo dussumieri*.

The frozen milt was tested for fertility test. Three trials were carried out with eggs from different females. The fertilized eggs were reared till hatching (fig. 32). The data collected on per cent fertilization and hatching were analysed. The two way ANOVA reveal non-significant effect of fish on both fertilization and hatching but significant effect for extenders and interaction. This allowed the data from three trials to be used as replicates. Effect of extenders was tested for one way ANOVA and highly significant difference was obtained. Multiple range test reveal that control (50.6%) is significantly different from highest performing extender 3 (39.69%) which is 78% of control value. The extender 3 differs significantly from extenders 3B, 7B & 6. The extender 9B proved to give significant low hatching success. The statistical analysis (ANOVA) indicates that the fertilization and hatching are not significantly affected by sperm density/egg used in the experiment. It was also observed that sperm density is positively correlated to packed cell volume. Paired t - test indicate per cent fertilization and per cent hatching differ significantly for all the extenders. However, the efficiency of extenders remained same irrespective whether fertilization or hatching was used as the criteria.

Labeo dussumieri is the tenth fish whose cryopreservation protocol has been standardised by NBFGR through actual fertilization trials.

Tor putitora

Endangered *Tor putitora* was taken up as a collaborative programme with National Research Centre on Cold Water Fisheries, Bhimtal (fig. 33). The milters were collected from Bhimtal, Naukuchiatal and Garurtal lakes of the Kumaon region, U.P. The milt was collected and tested for development of cryopreservation protocol as follows. Initially, screening of eight extenders (NBFGR 3, 3B, 4, 4B, 6, 7, 8 and 9B) was carried out. The extenders 7 and 9B induced motility on dilution and hence were rejected for further processing. The milt was cryopreserved using extenders, 3, 3b, 4, 4B, 6 and 8 with cryoprotectant DMSO @10%. Total 175 straws out of 4 freezing trials representing six males were preserved and are held frozen in liquid nitrogen. Screening of 2 days and 4 days frozen milt was carried out through motility assessment. The milt frozen with extenders 4 and 8 exhibited highest post thaw motility ranging from 70 - 80%. The motility duration was found to be in 39-50 seconds and packed cell volume 55.55 ± 8.18% ranging from 52 to 75% (n = 6). Motility of the sperms in post thaw milt indicate that a successful protocol can be developed by further testing through actual fertilization tests.

Schizothorax richardsonii

For cryopreservation of spermatozoa of *Schizothorax richardsonii*, milters were collected from Chafi nalla, Ramgar nalla and Panyali nalla of the Kumaon region, U.P. (Fig 34). The oozing milt was collected and tested for developing cryopreservation protocols. Different extenders (NBFGR 3, 3B, 4, 5, 6, 7, 8 and 9B) were used. The extenders 5, 7 8

Fig. 31. Milt being stripped from endangered *Labeo dussumieri* for cryopreservation.

Fig. 32. Fry of *Labeo dussumieri* produced from cryopreserved milt.

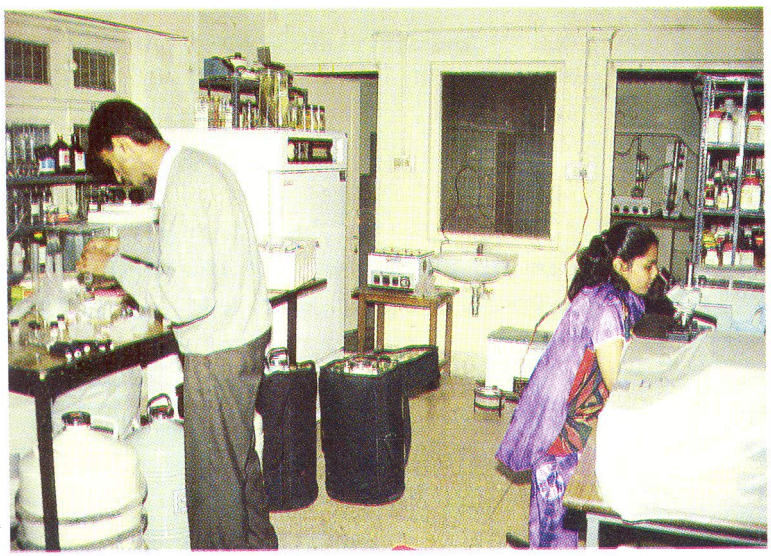


Fig. 33. Collaboratory work with NRC on CW on cryopreservation of *Tor putitora*.

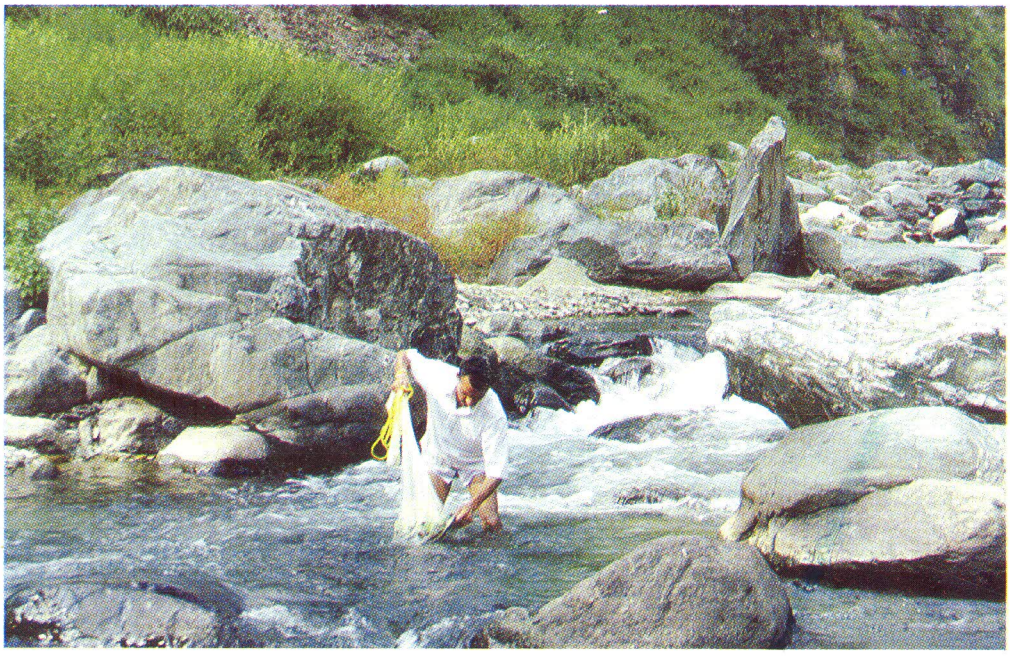


Fig. 34. Sampling for *Schizothorax richardsonii* from Chaffi nala for cryopreservation works.

and 9B were found to induce motility and hence were rejected. The extenders 3, 3B, 4 and 6 were used for subsequent freezing along with variations of extender 4 and 6 (4A and 6A) which contained 2% egg yolk as additional cryoprotectant. DMSO @10% was used in all extenders. Total 70 straws were frozen out of 3 trials covering 21 fishes. The post thaw motility was found to be higher in extender 3 and 4 as compared to extender 6. Packed cell volume ranged from 22 to 57% with the mean of 46.05 ± 9.43 and motility duration was 27 to 37 seconds.

S. richardsonii is the eleventh species whose cryopreserved milt has been added to NBFGR's mini gene bank.

5.8 Project No. FQ-17 : Development of a Database on fish Quarantine

In the light of globalization and expanding trade in live aquatic organisms many countries have adopted quarantine protocols. To meet its international obligations as well as to protect its trade interests it is imperative that India too develops its own set of quarantine guidelines and the capacity to undertake quarantine of live aquatic organisms that are entering or leaving the country. The project is aimed at developing a database that could assist in quarantine work as well as capabilities and protocol for fish quarantine and screening of fish pathogens including fish parasites. As

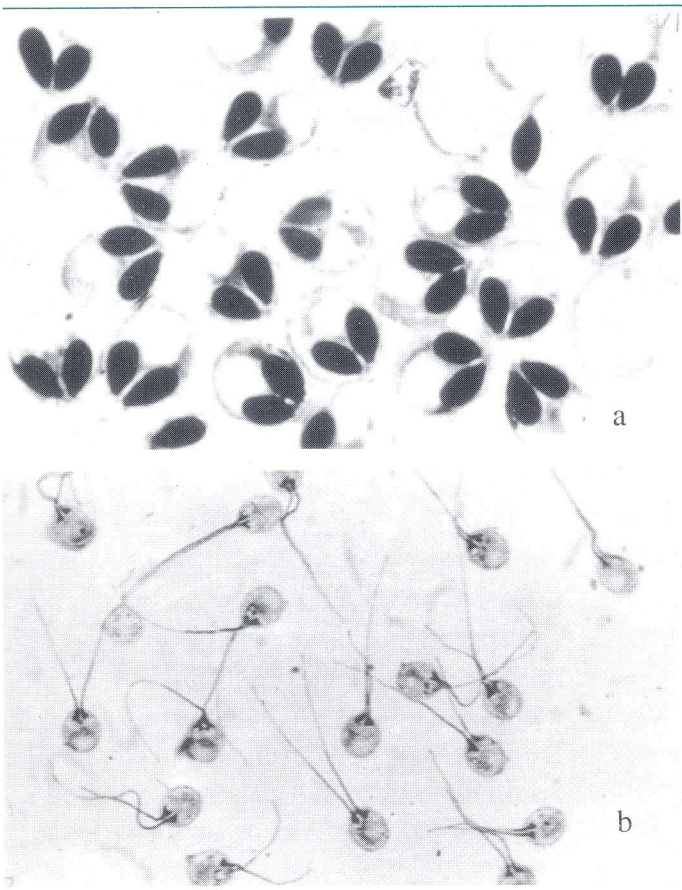


Fig. 35. *Myxobolus* sp. - A protozoan isolated from *Clarias batrachus*; a showing bicapsular structure; b, with extruded filaments.

NBFGR is the nodal agency for monitoring introduction of exotics, work on consolidation of Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) data entry form for Network of Aquaculture Centres in Asia-Pacific (NACA) Food and Agriculture Organisation (FAO) has also been initiated during the period under report.

Parasitological screening

Screening of native *Clarias batrachus* and exotic *C. gariepinus* for parasites was initiated. *C. batrachus* were procured from local fish markets at Mawaiya, Kaiserbagh and Dalyganj whereas *C. gariepinus* were procured from local fish market and a farm at Sidhauli.

One hundred and four fishes (91 *C. batrachus* and 13 *C. gariepinus*) have been screened for ectoparasites and endoparasites. Out of 91 *C. batrachus* examined, 79 were found infected with one or more type of parasite. The prevalence (number of fishes found infected out of the total fishes screened) and intensity of infection (number of parasites per infected fish) was recorded (Table 11).

The protozoans were isolated from spleen, kidney, liver, gonads, mesentry, subcutaneous fat, gall bladder and blood. The protozoa have been identified as *Myxobolus, Myxidium, Trypanosoma* sp. and trichodinids (fig. 35-36). Some of the infected tissues

Table 11. The incidence and intensity of parasites in *Clarias batrachus* .

	Infected	Protozoa	Digenean	Monogenean	Cestodes	Nematodes
Number	79	30	57	9	39	22
Prevalence (%)	86.8	33.0	62.6	9.9	42	24.2
Intensity Mean	--	--	6.9	NR	11.2	2.4

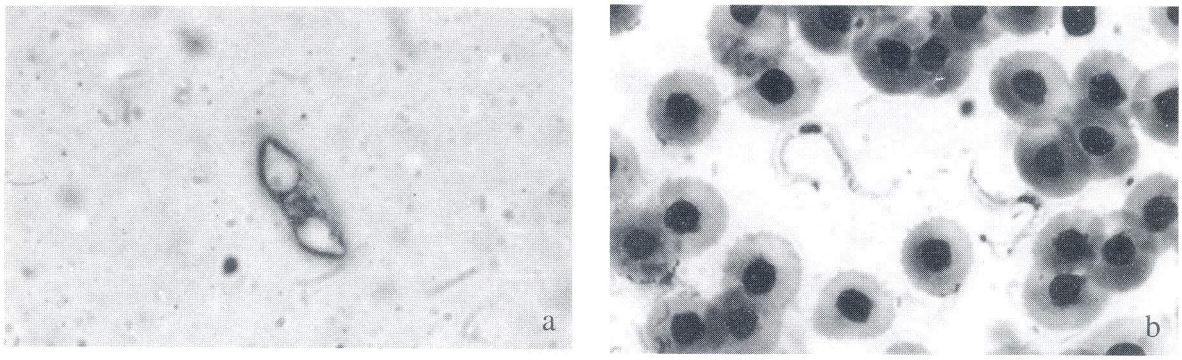


Fig. 36. Protozoan parasites isolated from *C. batrachus;* a Trypanosoma sp.; b, *Myxidium* sp.

were fixed in neutral buffered formalin. Some of these tissues have been processed by routine histopathological techniques and blocks were prepared.

The monogeneans were isolated from gills while digeneans were isolated from the intestine. The cestodes were found embedded in the duodenum and sometimes free in the intestine. Nematodes were isolated from stomach usually along greater curvature. The monogeneans, digeneans and cestodes have been fixed, stained and permanent mounts of these have been prepared. The identification of these parasites upto genus level is being carried out with the help of outside experts. A large number of fishes examined were found infected (86.8%). The highest infection was with digeneans in terms of prevalence (62.6%) and with cestodes in terms of intensity (11.2). No parasite could be isolated from the thirteen specimens of *C. gariepinus* examined. More number of specimens are being screened.

Quarantine database

Information regarding guidelines for introduction of exotics and quarantine has been collected by contacting people and downloading information from Internet. Seventy five key persons from different countries were contacted for getting documents pertaining to introduction of exotics and quarantine guidelines in different countries namely, China, Canada, Australia, USA, Norway, New Zealand and organizations like International Council for Exploration of the Sea (ICES), Department of Fisheries and Oceans, Canada (DFO), North Atlantic Salmon Conservation Organisation (NASCO), Office International des Epizootics (OIE). A database of the Indian researchers working on fish pathology is being prepared. Information regarding quarantine guidelines and protocols was downloaded from the websites of Department of Primary Industries and Energy, Australia (DPIE), Aquatic Nuisance Species Taskforce (ANSTF), Internationl Union for Conservation of Nature (IUCN), Office International des Epizootics (OIE). The information collected is being screened to prepare a master document incorporating salient features from all the documents.

The information regarding parasites found in *Clarias* sp. viz *C. gariepinus, C. lazera, C. macrocephalus, C. theodorae, C. batrachus* in different countries was downloaded from Aquatic Sciences and Fisheries Abstracts (ASFA) and compiled. The parasites reported from *C. gariepinus* include *Euclinostomum heterostomum, Glossidium pedatum, Polyonchobothrium clarias, Proteocephalus glanduliger, Diplostomum mashonense* matacercariae *Macrogyrodactylus clarii, Dolops ranarum* and *Contracacum* sp. whereas, *Trypanoplasma maguri, Arhythmacanthus zdzitowieckii, Pseudolytocestus clariae, Lytocestus parvulus, L. indicus, Pseudocaryophyllaeus indica, Procamallanus* sp. and *Ascaridia alatae* have been isolated from *Clarias batrachus*.

As National Bureau of Fish Genetic Resources had been identified as the nodal Indian Council of Agricultural Research Institute to consolidate Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) data entry forms from fisheries institutes at the National level, it has contacted all the Indian Council of Agricultural Research (ICAR) Fisheries institutes in this regard. Reprints on fish diseases have been collected and are being screened to feed the information in Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) data entry forms.

6. TECHNOLOGY ASSESSED AND TRANSFERRED

6.1. Technology

Since NBFGR is not a capture or culture based fishery Institute, the technology generated by it is an outcome of its work on germplasm conservation. It has developed the technology for cryopreservation of fish spermatozoa in connection with its programme on Gene banking. During the period under report, the technique for cryopreservation of *Labeo dussumieri* was perfected and demonstrated to RARS of Kerala Agricultural University. With the technology of genetic markers on Indian major carps developed, introgressed individuals from nature have been identified.

6.2 Transfer of Technology

For utilization of cryopreservation in seed production, the progressive fish farmer's from Punjab and MP State Fishery Corporation have approached NBFGR. Scientists have visited the progressive fish farmers farm and arrangements have been worked out for testing the technology in the farmers hatchery in the coming season.

The NBFGR participated and actively involved on demonstration of the exhibition

Fig. 37. Awareness camp on Save Mahseer and other threatened fishes at Ramnagar. Mr. G.D. Sarin, Administrative Officer, The Corbett Foundation speaking on conservation. Dr. U.K. Sarkar, Scientist, NBFGR, Mr. K.C. Singh, Local MLA, Dy. Director, Corbett Tiger Reservoir, Ramnagar, Miss Anupama, Research Officer, The Corbett Foundation (L to R).

Fig. 38. Awareness campaign on Save Endangered Fishes with the Foresters at Eco-Camp, Nameri, Assam. Dr. P.C. Mahanta, Sr. Scientist, NBFGR speaking. Standing (from left) Shri S.M. Srivastava, T-5 and Dr. U.K. Sarkar, Scientist, NBFGR.

Fig. 39. Divisional Forest Officer, Tezpur speaking at workshop with the members of Fish Conservation at Nameri, Assam. District Fishery Officer, Mr. S.N. Agarwala, Chairman, Assam Bhorelli Anglers Association, Tezpur and Prof. U.C. Goswami, are sitting in the dias (from left.)

on Genetics held at Tin Murti Bhawan, New Delhi from 14 - 30th November, 1998.

6.3 Radio talks

- Dr. A.K. Singh, Farm Manager (T-7) delivered a Radio talk on "Vaigyanik matsya palan mein adhik labh ke liye aahar vyavastha" on September, 1998 from AIR, Lucknow.
- Dr. A.K. Singh, Farm Manager (T-7) delivered a Radio talk on "Matsya palan hetu talaab ki prarambhik taiyari" on 15 May, 1998 from AIR, Lucknow.

6.4 Mass Awareness

- Two mass awareness programmes were conducted, in order to increase public awareness on the status of threatened species and the need for their conservation, in association with Corbett Foundation, at Dhikuli, Ramnagar, U.P. during March, 1999 (fig. 37). Over 80 people attended the programmes, which included film show and photo exhibition on conservation of fish and stream habitat. Fish conservation committees were formed in Mohan village and Ramnagar and pamphlets in local language on Save Mahseer were distributed.
- A participatory programme on increasing the awareness for saving the endangered fishes of North-East was organised during 1-11 April, 1998 at Fisheries college, Assam in association with Agricultural University, Raha, Assam. More than 100 people, including villagers, youth club members, and anglers participated in the programme (fig. 38-39). Five local fish conservation committees were formed and leaflets in the local language were distributed.

6.5 Other activities

- A team of 34 trainees from CIFE, Calcutta Centre visited the Bureau from 14-16 January, 1999 and were appraised of the research activities going on in various labs.
- A team of 12 students from College of Fisheries, Konkan University, Ratnagiri, Maharashtra visited the Bureau on 1 January, 1999 and were appraised of the research activities going on in various labs.

7. EDUCATION AND TRAINING

The following personnel had undergone training courses as given below :

Sl. No.	Name and Designation	Title of the training	Duration of training	Place of training
1.	Dr. U.K. Sarkar, Scientist.	Mini course on River Biodiversity in South Asia.	8 - 10 April, 1998	Department of Zoology, Patna University, Bihar.
2.	Shri R.S. Patiyal, T-5.	Mini course on River Biodiversity in South Asia.	8 - 10 April, 1998	Department of Zoology, Patna University, Bihar.
3.	Shri P. Chithamparam, T-4.	Internet for Agricultural Information Communication.	15 - 18 April, 1998	National Institute of Agricultural Extension Management, Hyderabad.
4.	Dr. Neeraj Sood, Scientist.	Hybridoma Technology in Fisheries.	1 - 21 May, 1998	College of Fisheries, University of Agricultural Sciences, Mangalore.
5.	Shri Ajay Kumar Pathak, Scientist.	63rd Foundation Course on Agricultural Research.	5 June - 30 Sept., 1998	National Academy of Agricultural Research Management, Hyderabad.
6.	Shri Subhash Chandra, Library Assistant (T-II-3).	Computer Application to Library and Information Activities.	8 June - 10 July, 1998	Indian National Scientific Documentation Centre, New Delhi.
7.	Dr. M. Palanichamy, Research Associate.	Methods for Diagnosis and Treatment of Fish Disease.	15-24 July, 1998	Central Inland Capture Fisheries Research Institute, Barrackpore, West Bengal.
8.	Shri Sanjeev Kumar Srivastava, Scientist.	Fundamentals of Global Positioning System (GPS) and its Applications.	15 - 28 July, 1998	Survey Training Institute, Survey of India, Hyderabad.

Sl. No.	Name and Designation	Title of the training	Duration of training	Place of training
9.	Dr. Kuldeep Kumar Lal, Scientist (Sr. Scale).	Advances in Statistical Genetics & Biostatistics.	31 July	14 Aug., 1998 Indian Agricultural Statistics Research Institute, New Delhi.
10.	Dr. (Mrs.) Vindhya Mohindra, Scientist.	Application of Quantitative Genetics to Aquaculture.	1 - 21 Sept., 1998	Central Institute of Freshwater Aquaculture, Bhubaneswar.
11.	Dr. U.K. Sarkar, Scientist.	Development of Fish Database on Computer.	21 – 25 September, 1998	National Bureau of Animal Genetic Resources, Karnal and National Bureau of Plant Genetic Resources, New Delhi.
12.	Ms. Reeta Chaturvedi T-II-3.	Development of Fish Database on Computer.	21 – 25 September, 1998	National Bureau of Animal Genetic Resources, Karnal and National Bureau of Plant Genetic Resources, New Delhi.
13.	Shri Ashish Srivastava, Junior Accounts Officer.	Central Government Rules on Retirement Benefits, Pay Fixation and Leave.	11 - 13 Nov., 1998	Centre for Research Planning and Action, New Delhi.
14.	Dr. Neeraj Sood, Scientist.	Use of Computer in Agricultural Research.	16 - 28 Nov., 1998	Indian Agricultural Statistics Research Institute, New Delhi.
15.	Shri Babu Ram, Farm Engineering Assistant, T-5.	Introduction to MS-Office.	11 - 23 Jan., 1999	Indian Agricultural Statistics Research Institute, New Delhi.

Sl. No.	Name and Designation	Title of the training	Duration of training	Place of training
15.	Shri Babu Ram, Farm Engineering Assistant, T-5.	Introduction to MS-Office.	11 - 23 Jan., 1999	Indian Agricultural Statistics Research Institute, New Delhi.
16.	Shri S.M. Srivastava, Field Surveyor, T-5.	Introduction to MS-Office.	11 - 23 Jan., 1999	Indian Agricultural Statistics Research Institute, New Delhi.
17.	Shri A. Sah, Superintendent.	Reservation in Appointment to Central Civil Services.	13 - 15 Jan., 1999	Centre for Research Planning and Action, New Delhi.
18.	Shri Ajay Kumar Pathak, Scientist.	Designing Interactive Websites Using CGF/PERL.	15 - 19 Feb., 1999	CMC Limited, New Delhi.
19.	Dr. Neeraj Sood, Scientist.	Polymerase Chain Reaction and Nucleic Acid Probes in Animal Diseases Diagnosis.	29 Jan. - 18 Feb., 1999	Centre of Advanced Studies in Animal Biotechnology, Indian Veterinary Research Institute, Izatnagar, U.P.
20.	Shri R.C. Srivastava, Asst. Finance & Accounts Officer.	Internal Audit for Personal, Safety, Security and Environment.	17 - 18 Feb., 1999	Centre for Research Planning and Action, New Delhi.
21.	Shri Ajay Kumar Pathak, Scientist.	Setting up Internet and Intranet using Linux.	22 - 27 Feb., 1999	Central Institute for Research on Goats, Makhdoom, U.P.
22.	Shri S.P. Singh, Scientist (Sr. Scale).	Computer and Graphical Assisted Multivariate Data Analysis.	8 - 20, March, 1999	Indian Agricultural Statistics Research Institute, New Delhi.
23.	Shri A.K. Dwivedi, Junior Stenographer.	Increasing Effectiveness of Private Secretaries/ Personal Assistant/ Personal Staff.	17 - 19 March, 1999	Centre for Research Planning and Action, New Delhi.

8. AWARDS AND RECOGNITION

- Dr. A.G. Ponniah, Director, Chaired (1) the session on Access Group on Fisheries in the National Level Consultation on Development of Protocols for Access to Biodiversity and Consequent Benefit Sharing held at Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad from 10-12 April, 1998. (2) one of the technical session of the FAO/ NACA/OIC/GOI Workshop on Development of National Technical Guidelines on Health Certification and Quarantine for Responsible Movement of Live Aquatic Animals held at CIFA, Bhubaneswar from 28 - 31 May, 1998.

- Dr. A.G. Ponniah, Director was nominated as a Member of Advisory/Editorial Board of (1) Journal of Environmental Research, Gorakhpur, U.P. (2) Journal of Inland Fisheries Society of India, Barrackpore, West Bengal. (3) Journal "Environmental Bulletin", Gorakhpur, U.P. (4) The National Conference on Plant Biotechnology : Towards Strategic Agriculture and Drug Development held at CIMAP, Lucknow from 15 – 17 March, 1999.

- Dr. A.G. Ponniah, Director was nominated as a member of the Board of Study for revising the syllabus for the PG Programme in Marine Biotechnology of Manonmaniam Sundaranar University, Thirunelveli, Tamil Nadu.

- Dr. A.G. Ponniah, Director, was nominated as a member of the NATP task force on Digitization of Database.

- Dr. A. Gopalakrishnan, Scientist (Sr. Scale), was nominated as Fisheries Expert in the Monitoring Committee of the People's Biodiversity Register, Ernakulam District, Kerala.

- Dr. D. Kapoor, Sr. Scientist was nominated as a member of the Management Committee at NRC Coldwater Fisheries, Bhimtal, Uttar Pradesh.

9. LINKAGES

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2. Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, Orissa.
3. Central Marine Fisheries Research Institute (CMFRI), Cochin, Kerala.
4. National Research Centre on Coldwater Fisheries, Bhimtal, Nainital.
5. Central Drug Research Institute (CDRI), Lucknow.
6. Indian Institute of Remote Sensing, Dehradun.
7. Kerala Forest Research Institute, Peechi, Trichur, Kerala.
8. Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow.
9. CICFRI Regional Centre, Guwahati, Assam.
10. Regional Agricultural Research Station, Kerala Agricultural University, Kumarakom, Kottayam, Kerala.
11. Manonmaniam Sundaradanar University, Tirunelveli, Tamil Nadu.
12. School of Life Sciences, NEHU, Shillong, Meghalaya.
13. Cochin University of Science and Technology, Cochin.
14. Department of Zoology, Gauhati University, Guwahati, Assam.
15. School of Life Sciences, Dibrugarh University, Dibrugarh, Assam
16. Manipur University, Manipur.
17. Assam University, Silchar, Cachar, Assam
18. Government College, Sikkim, Gangtok.
19. Department of Fisheries, Government of Uttar Pradesh, Lucknow.
20. Department of Fisheries, Government of Himachal Pradesh, Bilaspur.
21. Department of Fisheries, Government of Tamil Nadu, Chennai.
22. Directorate of Fisheries of North East States.
23. Department of Fisheries, Kerala.
24. Zoological Survey of India, Calcutta, West Bengal.
25. Department of Biotechnology, Ministry of Science & Technology, New Delhi.
26. International Centre for Living Aquatic Resources Management (ICLARM), Manila, Philippines.
27. Network of Aquaculture Centres in Asia Pacific (NACA), Bangkok, Thailand.
28. Madras Science Foundation, Chennai.
29. M.S. Swaminathan Research Foundation, Chennai.
30. Assam (Bhorelli) Anglers Association, Tezpur, Assam.
31. The Corbett Foundation, Ramnagar, Nainital, Uttar Pradesh.
32. Environment and Anglers Club, Dehradun, Uttar Pradesh.
33. Nature Conservators, Muzaffarnagar, Uttar Pradesh.

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11. LIST OF APPROVED ONGOING PROJECTS

Sl. No.	Project No.	Title of the Project	Project Leader	Year of Start	Likely Year of Completion
1.	FB-14	Developing strategies for conservation of mahseer and other threatened fishes of Kumaun hills.	Dr. U.K. Sarkar	1997	2000
2.	FB-18	To prepare comprehensive fish database and its digitization.	Dr. D. Kapoor	1999	2002
3.	DNA-15	Genetic Characterisation of Commercially Important and Prioritised Endangered Fish Species, Using DNA Markers.	Dr. (Mrs.) V. Mohindra	1998	2001
4.	CM-20	Development and utilization of fish gene banking techniques for conservation and commercial application.	Dr. K.K. Lal	1999	2002
5.	CG-19	Evaluation of genotoxicity in freshwater fishes with reference to agricultural pesticide and industrial pollutants.	Shri. B. Kushwaha	1999	2002
6.	FQ-17	Development of a Database on fish Quarantine.	Dr. (Mrs.) R. Abidi	1998	2001
7.	FB-16	Utilisation of GIS techniques for endangered fish microlevel habitat assessment in selected streams and constructing thematic maps of macrolevel fish distribution in India.	Shri Sanjeev Kr. Srivastava	1998	2001

LIST OF PROJECTS COMPLETED IN MARCH, 1999

Sl. No.	Project No.	Title of the Project	Project Leader	Year of Start	Year of Completion
1.	FB 9	To develop Data Bank of Fish Genetic Resources of India.	Dr. D. Kapoor	01.04.1994	31.03.1999
2.	CM 8	Development of sperm banking technique of selected endangered fishes and wild strains of commercial species.	Dr. K.K. Lal	01.04.1994	31.03.1999
3.	BG 10	Genetic profile of prioritised endangered species and wild strains of commercially important species.	Dr. A. Gopalakrishnan	01.04.1994	31.03.1999
4.	CG 11	Chromosomal profile of endangered species and fishes of economic importance with special reference to genotoxic effect of pollutants.	Shri B. Kushwaha	01.04.1994	31.03.1999

12. LIBRARY AND INFORMATION SERVICES

12.1 Library Services

To keep abreast of the latest information in the field of Fish Biodiversity, Conservation, Fish Genetics and Fisheries, Library has procured 220 Books, 102 reprints and subscribed to 84 National and International Journals during the year under report.

Now the Library has a total collection of 1835 books, 937 Bound volumes of Journals, 121 publications, 1908 reprints and 274 maps and charts. The total expenditure incurred by the Library during the year was Rs. 8,88,000/=.

12.2 Exchange Services

The Library continued to have exchange relationship and resource sharing with 64 leading National and International Research Institute, R&D organizations.

To keep abreast of the activities of the Bureau, the Library has sent the Annual Report to Universities, State Fisheries Departments, FFDAs, Entrepreneurs and Fish Farmers.

12.3 Information Services

A new computer system (Pentium II, 32 MB RAM, 2.5 G.B. Hard Disk, 32 X CD ROM Drive with complete multimedia kit) has been installed in the Library with the prime object of providing information from the Internet. Scientists have retrieved latest information on Fish Biodiversity, Fish Quarantine, GIS applications, Fish Genetics and Conservation.

The Library has continued the subscription to the CD ROM on Aquatic Sciences and Fisheries Abstracts (ASFA) and provided information on various fields of fisheries science to the University Professors, Scientists and Research Scholars. The Library has also continued the subscription of CAP service of INSDOC for content pages of 30 Core International Journals and procured the relevant papers/articles from these Journals.

12.4 Technical Reports

Technical reports on the progress of research activities of the Bureau were compiled and sent to ICAR. Thirty three review and research papers and abstracts of the Director and scientists were communicated to various journals and Symposia/Seminars/ Conferences for presentation and publication.

12.5 Reprography Services

The Section continued active reprography services. The Section also provided comb-binding and electro-data binding facilities for departmental reports.

12.6 General Publications

- Fish Chromosome Atlas, 1998.
- Annual Report, 1997-98.
- विदेशी खाद्य मछलियां अभिशाप या वरदान बिगहेड, विदशी मांगुर, 23 दिसम्बर, 1998
- List of NBFGR Publications, 1984-1996 (with Index).

13. RAC, MANAGEMENT COMMITTEE, SRC MEETINGS

Important decisions were taken during 1998-99 in the Research Advisory Committee, Management Committee and Staff Research Council meetings.

13. 1 Research Advisory Committee

The meeting of the Research Advisory Committee held on 28 April, 1998 at NBFGR, Lucknow. List of members who attended the Research Advisory Committee meeting is given below :

1. Prof. K. Chatterjee Head, Department of Zoology North East Hill University, Shillong	-	Chairman
2. Dr. R.A. Selvakumar ADG (Fy.), ICAR New Delhi-110001	-	Member
3. Dr. A.G. Ponniah Director NBFGR, Lucknow	-	Member
4. Prof. S.R. Verma Zoology Department DAV (PG) College Muzaffarnagar, UP	-	Member
5. Prof. A.R. Khuda Bukhsh Department of Zoology Kalyani University, Kalyani, West Bengal	-	Member
6. Dr. K.C. Majumdar Scientist EII, CCMB, Hyderabad	-	Member
7. Dr. D. Kapoor Sr. Scientist, NBFGR, Lucknow	-	Member-Secretary
8. Shri P.C. Mahanta Sr. Scientist, NBFGR, Lucknow	-	Invitee
9. Dr. U.K. Sarkar Scientist, NBFGR, Lucknow	-	Invitee

Important decisions taken by RAC :

1. The technical programme for 1998-99 under different ongoing projects were examined, discussed, modifications suggested and recommended.
2. Three new research project proposals were examined critically, modifications suggested, found appropriate and recommended.
3. A centralized infrastructure was proposed to keep the major equipments to make it sharable among all the Scientists.
4. Regarding revisions in the cadre strength of number of Scientist in different disciplines, ADG (Fisheries) suggested to send a reminder to ICAR.
5. Chairman and member of the RAC felt that all the project leaders should be present in the RAC meeting for having more interaction.

13.2. Institute Management Committee

Two meetings of the Management Committee were held in 1999. List of members of the Management Committee of NBFGR, Lucknow :

1. Dr. A.G. Ponniah Director NBFGR, Lucknow.	-	Chairman
2. Dr. Anil Agarwal Sr. Scientist (Fy.) ICAR, Krishi Bhawan, New Delhi.	-	Representative of DDG (Fy.)
3. Dr. D. Kapoor Sr. Scientist NBFGR, Lucknow.	-	Member
4. Dr. S.P. Singh Sr. Scientist NBFGR, Lucknow.	-	Member
5. Dr. (Mrs.) R. Abidi Scientist (Sr. Scale) NBFGR, Lucknow.	-	Member - Secretary
6. Dr. K.K. Lal Scientist NBFGR, Lucknow	-	Invitee
7. Shri S. Kr. Srivastava Scientist NBFGR, Lucknow	-	Invitee

8. Shri R.C. Srivastava
Asst. Finance & Accounts Officer
NBFGR, Lucknow. - Invitee

Important decisions taken by Management Committee

1. Recommendation was made for purchase of rest of the equipments of NBFGR and proposal to be submitted immediately on priority basis and depending upon the RE.
2. It was recommended by the Management Committee to initiate the shifting of NBFGR new campus by mid April, 1999.
3. To revise the BE proposal of 1999-2000 giving more details on the additional expenditure on works and send to ICAR immediately.

13.3 Scientific Research Council

The meeting of the Scientific Research Council held on 29 April, 1998 and the annual Staff Research Council meeting held on 30 March, 1999. List of members of Scientific Research Council of NBFGR, Lucknow is given below :

1a. Dr. R. Selvakumar
Asst. Director General (Fisheries)
ICAR, Krishi Bhawan,
New Delhi - Representative of DDG (Fy.) (Meeting No 1)

b. Dr. Anil Agarwal - Representative of DDG (Fy.) (Meeting No. 2)

2. Dr. A.G. Ponniah
Director
NBFGR, Lucknow. - Chairman

3. Dr. D. Kapoor
Sr. Scientist
NBFGR, Lucknow. - Member - Secretary

4. Shri P.C. Mahanta
Sr. Scientist
NBFGR, Lucknow. - Member

5. Dr. (Mrs.) R. Abidi
Scientist (Sr. Scale)
NBFGR, Lucknow. - Member

6. Dr. A.Gopalakrishnan
Scientist (Senior Scale)
NBFGR, Lucknow - Member

7.	Dr. K.K. Lal Scientist NBFGR, Lucknow	-	Member
8.	Dr.(Mrs.) V. Mohindra Scientist NBFGR, Lucknow	-	Member
9.	Shri S. Kr. Srivastava Scientist NBFGR, Lucknow	-	Member
10.	Dr. U.K. Sarkar Scientist NBFGR, Lucknow.	-	Member

Important decisions taken at SRC meeting

1. The technical programmes of all the projects were modified as per RAC recommendations.
2. Three new project proposals were presented to SRC for approval after incorporating the modifications as per RAC.
3. Four projects CM8, FB-9, BG-10 and CG-11 was extended for one more year.

14. CONFERENCES AND MEETINGS

14.1 Important meeting/events

The following were organized by Bureau during April, 1999-March, 1999.

- Meeting of the Research Advisory Committee on 28 April, 1998.
- Two meetings of the Management Committee were held in 1999
- Scientific Research Council meeting on 29 April, 1998 and 30 March, 1999 (Fig. 40).
- Hindi Divas Samaroh, 14 September, 1998 and Hindi Pakhwara Samapan Samaroh, 30 September,1998 (Fig. 41-42)
- ICAR Zonal Sports meet at IVRI, Bareilly, U.P., 2-6 November, 1998. (Fig. 43)

14.2 Participation

Scientists and Technical staff of the Bureau participated in the following conferences/symposia/meetings (fig. 44-45).

Fig. 40. Scientific Research Council Meeting of NBFGR

Fig. 41. 'Hindi Divas Samaroh' was celebrated at NBFGR on 14th September, 1998, Address in Hindi by Mr. P. Chithambaram. Seated are Mr. B. Kushwaha, Hindi Officer and Dr. D. Kapoor, Sr. Scientist (L to R).

Fig. 42. A view of 'Hindi Pakhwara Samapan Samaroh' on 30th September, 1998, addressed by Mr. B. Kushwaha, Hindi Officer. Seated Dr. A.G. Ponniah, Director, NBFGR, Dr. H.M.K. Saxena, Chief Guest and Shri P.C. Mahanta Sr. Scientist (L to R).

Fig. 43. Miss Mamta Roy receving 1st Prize in Discus Throw and 2nd prize in Shot Put at ICAR Zonal Sports meet at Bareilly.

Fig. 44 Workshop on Fishery Resources of Western Himalaya at Punjab University. Dr. A.G. Ponniah, Director, NBFGR chairing the technical sesson.

Fig. 45. Dr. A.G. Ponniah, Director, NBFGR explaining a poster session at CDRI, Lucknow.

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
1.	National Level Consultation on Development of Protocols for Access to Biodiversity and Consequent Benefit Sharing, 10-12 April, 1998.	Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad	'Access' to aquatic biodiversity - issues involved. - A.G. Ponniah	Dr. A.G. Ponniah
2.	National Workshop on Recent Advances in Hormonal Physiology of Fish and Shellfishes Management, 16-18 April, 1998	Central Institute of Freshwater Aquaculture, Bhubaneswar	Role of pineal melatonin during environmental and hormonal sex determination in fishes (Abstract). - A.K. Singh Current Status of fish pheromones and their potential applications. (Special Lecture) - A.K. Pandey	Dr. A.K. Singh Dr. A.K. Pandey
3.	FAO/NACA/OIE/GOI Workshop on Development of National Technical Guidelines on Health Certification and Quarantine for Responsible Movement of Live Aquatic Animals, 28-31 May, 1998	Central Institute of Freshwater Aquaculture, Bhubaneswar	Role of NBFGR in the national programme for aquatic animal quarantine and health certification. - A.G. Ponniah	Dr. A.G. Ponniah Dr. A.K. Singh Dr. Neeraj Sood

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
4.	Indo-Egyptian Workshop on Biotechnology, 2 - 4 June, 1998	Department of Science and Technology, Govt. of India and National Academy of Science and Technology, Cairo, Egypt	--	Dr. A.G. Ponniah
5.	Meeting of the Uttar Pradesh Matsya and Machhua Vikas Parishad, 22 June, 1999	Held at Yojna Bhawan, Lucknow	--	Dr. A.G. Ponniah Dr. A.K. Singh
6.	Lucknow Special Library Consortium Meeting, 27 July, 1998	National Information Centre for Drugs and Pharmaceutical, Central Drug Research Institute, Lucknow	--	Shri P. Chithamparam
7.	Rashtriya Sangoshti : Bharatiya Krishi Ka Bhavi Swarup, 11- 13 August, 1998	Bharatiya Krishi Anusandhan Sansthan Avam Indian Society of Agricultural Science, New Delhi	--	Dr. A.K. Pandey

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
8.	Remote Sensing Day, 98, 12 August, 1998	Indian Society of Remote Sensing, Lucknow Chapter and Regional Science Centre, Lucknow held at Regional Science Centre, Lucknow	--	Shri Sanjeev Kr. Srivastava, Dr. U.K. Sarkar
9.	All India ARIS Incharge's Workshop, 17 - 18 August, 1998	Held at National Bureau of Plant Genetic Resources, New Delhi	--	Shri Sanjeev Kr. Srivastava
10	Working Group Meeting of Mission Mode Project of the NATP on Digitization of Database, 25 Sept., 1998	National Bureau of Soil Survey and Land Use Planning, Nagpur	--	Shri Sanjeev Kr. Srivastava
11.	National Symposium on Trends in Research on Hormones, Reproduction and Animal Productivity, 10 - 12 Oct., 1998.	University of Delhi, Delhi	Methodologies for reproductive containment of fishes with special reference to antigonadal substance melatonin (Abstract). - A.K. Pandey	Dr. A.K. Singh

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
12.	Sixty-Eighth Annual Session of the National Academy of Sciences, India, 23 - 25 Oct., 1998	Central Drug Research Institute, Lucknow.	Characterization of *Clarias batrachus* and *Clarias gariepinus* by using ultrathin isoelectric focussing of heamoglobin proteins (Abstract). - Satish Kumar Srivastava and A.G. Ponniah	Dr. A.G. Ponniah Dr. S.K. Srivastava
			Abundance of plankton, bacterial density and chemical changes in experimental sewage fed fish culture system (Abstract). - U.K. Sarkar, B.K. Pandey and M.L. Bhowmik	--
			Comparative parasite load of exotic *Clarias gariepinus* and native *Clarias batrachus* (Abstract). - Neeraj Sood, A.K. Singh and Rehana Abidi	Dr. Neeraj Sood Dr. A.K. Singh
			Use of GIS and remote sensing techniques to study the channel change in the Gomti river (Abstract). - Sanjeev Kumar Srivastava and A.G. Ponniah	Shri Sanjeev Kr. Srivastava
			Relationship between enzyme heterozycosity and seasonal changes in the body size of chocolate mahseer, *Acrossocheilus hexagonolepis* (Abstract) - M. Palanichamy and - K. Chatterjee	Dr. M. Palanichamy

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
13.	Use of GIS and Remote Sensing for Resource Management and Development, 7 November, 1998.	Indian Institute of Technology, Kanpur	--	Dr. D. Kapoor, Shri Sanjev Kr. Srivastava Dr. U.K. Sarakar, Shri Ajay Kr. Pathak
14.	Nineteenth Annual Session of the Academy of Environmental Biology and Symposium on Biomonitoring and Eco-conservation : Role of NGO's in Rural Uplift, 14-16 November, 1998	Department of Zoology, Bareilly College, Bareilly, U.P.	Hypothalamo - neurosecretary system of the endangered golden mahseer, *Tor putitora* (Hamilton-Buchanan) (Key note Address). -A.K. Pandey	Dr. A.K. Pandey
15.	International Conference on Ecological Engineering, 23-27 November, 1998.	International Society of Ecological Engineering and Dept. of Zoology, Kalyani University, Kalyani held at Science City, Calcutta	On utilization of endangered fish habitat inventory for freshwater stream habitat restoration. - A.G. Ponniah Evaluating the effects of domestic sewage on fish, aquatic ecosystem and public health implications. - U.K. Sarkar, M.L. Bhowmik and B.K. Pandey Decline of genetic diversity on chocolate mahseer, *Acrossocheilus hexagonolepis* from North - Eastern region of India (Abstract). - M. Palanichamy and K. Chatterjee	-- Dr. U.K. Sarkar Dr. M. Palanichamy

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
16.	National Dialogue : Issue in Management of Plant Genetic Resources, 1 December, 1998.	National Bureau of Plant Genetic Resources, New Delhi	The status, ongoing programmes and future thrusts on fish genetic resources of Himalayan region. - A.G. Ponniah	Dr. A.G. Ponniah
17.	Indo-U.S. Workshop on Conservation and Development of Natural Fishery Resources of North-Western Himalayas, 7-8 December, 1998.	Division of Fisheries, Department of Zoology, Punjab University, Chandigarh held at ICSSR Complex, Punjab University, Chandigarh.	Utilization of geographic information system and microhabitat inventory for conservation of endangered fishes. - A.G. Ponniah	Dr. A.G. Ponniah
18.	International Conference on Pest and Pesticide Management for Sustainable Agriculture, 11-13 December, 1998.	C.S. Azad University of Agriculture and Technology, Kanpur.	Histopathological alterations in gill, kidney and liver of *Channa punctatus* exposed to Malathion (Abstract). - A.K. Pandey, B. Kushwaha and Satish Kr. Srivastava Genotoxic effect of malathion on *Channa punctatus* (Abstract). - Basdeo Kushwaha, Satish Kr. Srivastava and Birbal Singh	-- --

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
19.	National Workshop on Coldwater Fisheries, 15-16 December, 1998.	Department of Fisheries, Govt. of Tamil Nadu held at Tamizhagan Hall, Udhagamandalam, Tamil Nadu.	Nilgiri Rainbow trout : Present status and strategies for conservation. -- A. Gopalakrishnan, Kuldeep Kr. Lal, A.G. Ponniah	Dr. A. Gopalakrishnan
20.	IASLIC National Conference and Seminar on Right to Information, 21-24 December, 1998	Kerala Agricultural University, Trichur, Kerala.	--	Shri P. Chithamparam, Shri Subhash Chandra
21.	Workshop on Rajbhasha Karyanvayan Mein Anubhavjanya Prayag, 28-29 December, 1998.	National Academy of Agricultural Research Management, Hyderabad.	--	Shri Birbal Singh
22.	A Discussion Meeting on Taxonomic Research, Teaching and Training, 30-31 December, 1998.	Tata Energy Research Institute, New Delhi.		Dr. A.G. Ponniah
23.	Demonstration on Video Conferencing, 1 January, 1999.	National Informatics Centre, Lucknow.	--	Shri Sanjeev Kr. Srivastava, Dr. U.K. Sarkar

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
24.	National Seminar on Environmental Protection : A Green Vision from 21st Centruy, 2-3 January, 1999.	Greenline India Society, Lucknow and District Administration, Pilibhit, U.P.	Mahseer Conservation : a step towards healthy environment. - Sanjeev Kr. Srivastava Conserving aquatic genetic resources through community participation. - U.K. Sarkar and A.G. Ponniah	Shri Sanjeev Kr. Srivastava Dr. U.K. Sarkar
25.	Workshop on the Use of Gonadal Hormones in the Manipulation of Sex and Growth in Fishes, 18-19 January, 1999.	Fisheries Research Station, University of Agriculture Sciences, Bangalore.	A new approach to hormonal sex control and reproductive containment in fishes (Abstract). - A.K. Singh	Dr. A.K. Singh
26.	FAO/NACA/OIE-Regional Programme for the Development of the Technical Guidelines on Quarantine and Health Certification and Establishment of Information Systems for the Responsible Movement of Live Aquatic Animals in Asia, 1-5 February, 1999.	Network of Aquaculture Centres in Asia - Pacific (NACA), Bangkok, Thailand.	--	Dr. A.G. Ponniah

Sl. No.	Seminar/Symposia/ Workshop	Organized by	Title of the paper and authors	Name of the participants
27.	Interim Project Meeting of Genetic Improvement of Carp Species in Asia and Regional Workshop for Genetics of Carps Species in Asia, 1-2 March, 1999.	ICLARM, Manila, Philippines and held at University of Malaysia, Kuala Lumpur, Malaysia.	--	Dr. A.G. Ponniah
28.	International Workshop on GIS in Fishery Science, 2-4 March, 1999.	Fishery GIS Research Group, Seattle, Washington, U.S.A.	Arrangement of habitat inventory information on GIS platform to identify optimum and degraded areas of endangered fish *Tor putitora* habitat (Abstract). - Sanjeev Kr. Srivastava, U.K. Sarkar and A.G. Ponniah	--
29.	National Conference on Plant Biotechnology : Towards Strategic Agriculture and Drug Development, 15-17 March, 1999.	Central Institute of Medicinal and Aromatic Plants, Lucknow.	--	Dr. A.G. Ponniah

15. WORKSHOPS ORGANIZED AT THE INSTITUTE

NATP workshop on "Germplasm Inventory and Gene Banking of Freshwater fishes"

A two-day workshop on "Germplasm Inventory and Gene Banking of Freshwater Fishes" under the World Bank aided National Agricultural Technology Project (NATP) was conducted at Central Marine Fisheries Research Institute (CMFRI), Cochin, Kerala from 12 and 13 October, 1998 by National Bureau of Fish Genetic Resources (NBFGR), Lucknow (fig. 46-53).

The workshop was aimed at:

1) Developing an overall plan for building database relevant for conservation and sustainable commercial utilisation of freshwater fishes of Peninsular India (covering states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Goa, Maharashtra, Orissa, and U.T. Pondicherry) with special reference to Western Ghats
2) Finalizing sub-project under the NATP.

Dr. A.G. Ponniah, Director, NBFGR, welcomed the participants. In his welcome address, he reiterated that the scientific and sustainable utilization of our rich biodiversity can improve the living conditions of the people. Dr. Ponniah pointed out that the streams and rivers of peninsular India including those originating from Western ghats harbour very rich, varied and endemic aquatic resources, including many cultivable, fishery important and ornamental fishes. These resources are neither properly utilized, nor their potential fully harnessed. There is also paucity of information on several aspects of the biology of many of these fishes including their present distribution and abundance, he added. He emphasized that the workshop is aimed towards drawing the framework for critical evaluation of inventory of fish and building up a database, sustainable utilization and conservation of freshwater aquatic resources of peninsular India with special reference to Western Ghats.

While inaugurating, the Chief Guest, Dr. E. G. Silas, Ex- Vice Chancellor, Kerala Agricultural University and Ex- Director, CMFRI said that there is an urgent need to revisit the type localities for fish species to document eco-habitat conditions, evaluate the status of species, its population density, area utilization and its associated communities. He also called for updating the database on endangered, vulnerable, endemic, commercially important and ornamental species for initiating conservation activities as well as for developing management plans for aquatic systems on a watershed basis.

Fig. 46. Inauguration of NBFGR - NATP workshop on Germplasm inventory and gene banking of freshwater fishes at CMFRI, Cochin. Dr. M. Peer Mohd., Prof. T.J. Pandian, Dr. E.G. Silas, Dr. K.C. Jayaram and Dr. A.G. Ponniah, on the dais (L to R).

Fig. 47. Prof. E.G. Silas, Ex-Vice Chancellor, KAU and Ex-Director, CMFRI, Cochin lighting the lamp during inaugural function of the NBFGR - NATP workshop at CMFRI, Cochin.

Fig. 48. Prof. T.J. Pandian speaking at the NBFGR - NATP workshop on Germplasm Inventory and Gene banking of freshwater fishes at CMFRI, Cochin.

Fig. 49. Distinguished workshop participants in taxonomic group chaired by Dr. K.C. Jayaram.

Fig. 50. Dr. A.G. Ponniah, Director, NBFGR interacting with the participants during the group activities of the NBFGR - NATP workshop at CMFRI, Cochin.

Fig. 51. A view of the participants at the NBFGR - NATP workshop on Germplasm Inventory and Gene banking of freshwater fishes at CMFRI, Cochin.

Fig. 52. A working group discussing issues of life history traits in fishes under leadership of Dr. Sriramachandra Murty, Principal Scientist, and Head Dimersa Fisheries Divison CMFRI, Cochin

Dr. T.J. Pandian, National Professor, Madurai Kamaraj University, presided over the function. In his presidential address, he pointed out that emphasis should be given to veterinary and fishery science in an effort to evolve an effective strategy to meet our future food requirements from diverse resources. He also emphasized that Fish Genetics should be given greater importance in the syllabus of courses in the institutions of higher learning.

Dr. D. Kapoor, Senior Scientist, NBFGR proposed the vote of thanks on behalf of NBFGR and expressed his gratitudes to dignitaries and all delegates for their kind presence as well as to the press and mass-media for their coverage of workshop.

Technical sessions were conducted in two days. Unlike other workshops, the present workshop was a participatory planning one, where all participants have to sit together, interact and contribute towards the goal of the workshop. Dr. A.G. Ponniah, Director, NBFGR explained to the participants the concept behind the workshop and its expected out puts. He pointed out that the workshop would ultimately contribute towards an action plan based on which NATP sub-project will be prepared. The delegates were split into small working groups according to their own expertise, interest and choice. Altogether 13 working groups listed below were formed and each group had a facilitator and 6 to 10 members :

1. Taxonomic group
2. Data base

Fig. 53. Distinguished participants Dr. E.G. Silas, Dr. K.C. Jayaram along with Director at the NBFGR - NATP workshop on Germplasm Inventory and Gene banking of freshwater fishes at CMFRI, Cochin.

3. Parameters and methodology requirement for study of life history traits of species.
4. Parameters and methodology requirement for study of habitat inventory and germplasm survey.
5. Scientific and technical requirement for study of potential ornamental fishes.
6. Scientific and technical requirement for aquaculture/culture based fishery.
7. Scientific and technical requirement for repopulating endangered species, endemic to the region.
8. Scientific and technical requirement for repopulating endemic species for food/ sport.
9. Region wise species prioritisation - Kerala.
10. Region wise species prioritisation - Karnataka, Maharashtra & Goa.
11. Region wise species prioritisation - Tamil Nadu, Andhra Pradesh & Orissa.
12. Sanctuaries.
13. Local knowledge, access, benefits.

The working groups followed a rigorous exercise, carefully prioritizing species, identifying technical and hydrological parameters to be considered for habitat studies and arriving at consensus regarding the taxonomic disputes of selected species. The process continued till late evening of 13th October. Prior to finalization of group reports, facilitator of respective working group presented the report to all the participants and detailed discussions were held.

Workshop concluded on 13th October evening with the valedictory function. Dr. E. G. Silas, Ex- Vice Chancellor, Kerala Agricultural University and Ex- Director, CMFRI chaired the valedictory function. In his address he told that recommendations of the workshop would certainly be of immense help in conserving many Peninsular endemic fish fauna from being endangered. Dr. A.G. Ponniah, in his thanks giving speech, told that the list of prioritised species, were the outcome of the group process of participants of NBFGR-NATP workshop. He thanked all the delegates, on behalf of NBFGR for their active participation in the workshop.

The workshop was attended by 105 participants including Professors, Senior level Scientists, Planners, Officials from State Fisheries Departments, NGOs, exporters of aquarium fishes and research scholars.

Workshop on "Exotic Food Fishes : Boon or Bane"

In order to create awareness among fish farmers on the ecological dangers of exotic fish culture and to get a feed back, National Bureau of Fish Genetic Resources, (NBFGR), Lucknow organised a one day workshop entitled "Exotic Food Fishes : Boon or Bane" on December 23, 1998 in association with Fish Farmers Development Agency, Varanasi of U.P. State Fisheries Department (fig. 54). District Magistrate of Varanasi, Shri Avinash Kumar Awasthi, IAS was the chief guest. Chief Development Officer Shri P.K. Mishra presided over the function.

Dr. A.K. Singh, Technical Officer, NBFGR, welcomed the gathering and took them around the exhibition of exotic food fishes. Shri P. Narayan, Director, Department of Fisheries, U.P. The workshop was inaugurated by lighting the lamp. Dr. A.G. Ponniah in his address to the gathering said

that introduction of exotic fishes for culture is a global issue and exotic fishes have contributed to increasing production. However, there is an urgent need to educate fish farmers about the consequences of unauthorised introduction of exotic fishes in India. The District Magistrate of Varanasi, Sri Avinash Kumar Awasthi, IAS released an extension booklet prepared by NBFGR and U.P. State fisheries. In his address he told that the issue of unauthorised arrival of exotics is serious since they are dangerous to endemic fishes. He directed fishery officers to keep a strict vigil over the spread of illegal entry of exotic fishes.

Three technical sessions were held. Shri P. Narayan opened the first technical session and he addressed the issue of exotic fish culture. He told that among the exotic fishes big head (*Aristichthys nobilis*) and African catfish (*Clarias batrachus*) are being cultured in Uttar Pradesh and its spread is of great concern since big head and catla share the same niche. Dr. A. K. Singh started the second technical session. He said that in polyculture only silver carp, grass carp and common carp were introduced into our system along with Indian major carps, which enhanced the production. He advised the farmers that scientific knowledge should be adopted rather than introducing exotic fishes illegally. In his lecture, Dr. Bechan Lal, Asst. Prof. Zoology, BHU, told that availability of desi magur (*C. batrachus*) specimens was reduced drastically due to wide spread of Thai magur. In the third technical session, Dr. A.C.

Fig. 54. Seminar on Exotic fishes : Boon or Bane organised at Varanasi.

Pandey clarified and summed up the reply to many farmers regarding exotic fishes.

In the evening valedictory function was held. Shri P.K. Mishra, Chief Development Officer presided the valedictory function. In his valedictory address he called farmers for a collective effort to keep away from exotic fishes and enhance fish production using only Indian major carps. Dr. Ram Raj, Dy. Director, Department of Fisheries proposed vote of thanks.

The following recommendations were made in the workshop :

1. State level monitoring cell should be constituted jointly by NBFGR and U.P. State Fisheries to review the spread of exotics and accidental entry of exotic species into natural water bodies.
2. Population reserves of local magur (*C. batrachus*) should be investigated and identified for developing measures to protect them
3. For minimising the spread of big head (*A. nobilis*) and associated risk factors, special incentive should be given for catla culture.
4. No exotic fish should be introduced unless it is scientifically recommended.
5. Legislation should be made to check the spread of exotic fishes.
6. The present U.P. Fishery Act should be modified to stop illegal entry of exotic fish seed.

The workshop was attended by 83 farmers, scientists from Narendra Dev University of Agriculture & Technology, Faizabad, Banaras Hindu University, and Officers from State Fisheries Department, U.P..

16. VISITORS

The folowing distinguished visitors visited the Institute during the year 1998-99 (fig. 55-57)

1. Abidi, S.A.H. (Dr.)	Director, Central Institute of Fisheries Education, Bombay.
2. Gopakumar, K. (Dr.)	Deputy Director General (Fisheries), Indian Council of Agricultural Research, New Delhi.
3. Singh, U.P. (Prof.)	Professor, Fisheries College, G.B. Pant University of Agriculture and Technology, Pantnagar, U.P.
4. Singh, I.J. (Dr.)	Associate Professor, Fisheries College, G.B. Pant University of Agriculture and Technology, Pantnagar, U.P.
5. Raje, P.C. (Prof.)	Associate Dean, College of Fisheries, Shirgaon, Ratnagiri, Maharashtra.
6. Paroda, R.S. (Dr.)	Director General, Indian Council of Agricultural Research, New Delhi.
7. Madan, M.L. (Dr.)	Deputy Director General (Animal Science), Indian Council of Agricultural Research, New Delhi.
8. Goel, M.L.M. (Dr.)	Financial Commissioner and Secretary, Fisheries Department, Haryana Government.
9. Ravindran, K. (Dr.)	Director, Central Institute of Fisheries Technology, Cochin, Kerala.
10. Kamal, M.Y. (Dr.)	Vice Chancellor, Sher-e-Kashmir University of Agriculture and Technology, Jammu, J&K.
11. Selvakumar, R.A. (Dr.)	Assistant Director General (Fisheries), Indian Council of Agricultural Research, New Delhi.
12. Singh, C.S. (Prof.)	Retd. Dean, Faculty of Fisheries, G.B. Pant University of Agriculture and Technology, Pantnagar, U.P. and Member, Management Committee, NBFGR, Lucknow, U.P.
13. Singh, Kirti (Prof.)	Member, Agricultural Scientists Recruitment Board, New Delhi.
14. Dilip Kumar (Dr.)	Fisheries Expert, Network of Aquaculture Centres in Asia and the Pacific, Thailand.
15. Arthur, J.R. (Dr.)	NACA/FAO expert on Quarantine.
16. Dwivedi, S.N. (Dr.)	Director General, M.P. Council of Science and Technology, Bhopal.

Fig. 55. Dr. P.C. Mahanta, Sr. Scientist, NBFGR explaining on the Project work. From left sitting are Dr. S.D. Tripathi, Ex-Director, CIFA & CIFE, Dr. K.K. Lal, Scientist (SS) and Dr. D. Kapoor, Sr. Scientist, NBFGR.

Fig. 56. Dr. U.K. Sarkar, Scientist, NBFGR speaking on the ongoing research on *in situ* conservation to Prof. R.K. Sinha, Patna University.

Fig. 57. Dr. Mangala Rai, DDG (Crop Science) discussing aspects of fish cryopreservation at Biochemical Genetics Lab. Dr. A.G. Ponniah, Director, NBFGR; Dr. (Mrs.) Vindhya Mohindra, Scientist; Dr. S.K. Srivastava, T-4 and Dr. K.K. Lal, Scientis (Sr. Scale) (L to R).

17. Gupta, Rajiv (Dr.)	National Coordinator, NATP Project, Indian Council of Agricultural Research, New Delhi.
18. Sinha, R.K. (Prof.)	University Professor, Patna University, Patna.
19. Tripathi, S.D. (Dr.)	Ex-Director, Central Institute of Freshwater Aquaculture and Senior Aquaculture Specialist and Team Leader, International Centre for Living Aquatic Resources Management, Philippines.
20. Gupta, A.K. (Shri)	Director (Works), Indian Council of Agricultural Research, New Delhi.
21. Chatterjee, K. (Prof.)	Head, Department of Zoology, North East Hill University, Shillong.
22. Verma, S.R. (Prof.)	Zoology Department, DAV (PG) College, Muzaffarnagar, Uttar Pradesh.
23. Khuda Bukhsha, A.R. (Prof.)	Department of Zoology, Kalyani University, Kalyani, West Bengal.
24. Majumdar, K.C. (Dr.)	Scientist EII, CCMB, Hyderabad.

17. PERSONNEL

List of Personnel

Research Management

Dr. A.G. Ponniah	-	Director

Scientific Staff :

1. Dr. D. Kapoor	-	Senior Scientist
2. Shri P.C. Mahanta	-	Senior Scientist (on deputation at NECS, Shillong from 30.9.98)
3. Dr.(Mrs.) Rehana Abidi	-	Scientist (Senior Scale)
4. Dr. A.K. Pandey	-	Scientist (Senior Scale) (Relieved on 2.1.99)
5. Dr. A. Gopalakrishnan	-	Scientist (Senior Scale)
6. Shri S.P. Singh	-	Scientist (Senior Scale)
7. Dr. Kuldeep Kumar Lal	-	Scientist (Senior Scale)
8. Dr. N.S. Nagpure	-	Scientist (on study leave)
9. Shri Peyush Punia	-	Scientist (on study leave)
10. Dr.(Mrs.) Vindhya Mohindra	-	Scientist
11. Shri Sanjeev K. Srivastava	-	Scientist
12. Shri Basdeo Kushwaha	-	Scientist
13. Shri Birbal Singh	-	Scientist
14. Shri V.S. Basheer	-	Scientist
15. Dr. Uttam Kumar Sarkar	-	Scientist
16. Dr. Neeraj Sood	-	Scientist
17. Shri Ajay Kumar Pathak	-	Scientist

Technical Staff :

1.	Dr. A.K. Singh	-	Farm Manager, T-7
2.	Shri A.K. Mishra	-	Electrical Foreman, T-5
3.	Shri Babu Ram	-	Farm Engineering Assistant, T-5
4.	Shri Rajesh Dayal	-	Field Surveyor, T-5
5.	Shri S.M. Srivastava	-	Field Surveyor, T-5
6.	Shri R.S. Patiyal	-	Farm Assistant, T-5
7.	Dr. S.K. Srivastava	-	Sr. Laboratory Technician, T-4
8.	Shri P. Chithamparam	-	Library Assistant, T-4

Administrative Staff :

1.	Shri R.C. Srivastava	-	Asstt. Finance & Accounts Officer
2.	Shri Awadh Sah	-	Superintendent
3.	Shri Ashish Srivastava	-	Junior Accounts Officer

Personnel of Centre for DNA Fingerprinting

1.	Dr. (Mrs.) Anita Mishra	-	Research Associate
2.	Dr. M. Palanichamy	-	Research Associate

Appointments under NBFGR

1.	Shri Ashish Srivastava	-	Junior Accounts Officer joined NBFGR on 17.6.98 (on deputation).

STAFF WELFARE ACTIVITIES :

Institute Joint Staff Council

The Institute Joint Staff Council with the below mentioned members existed at the Bureau and considered the matters of common interest concerning the staff.

Official side :

1.	Dr. A.G. Ponniah Director NBFGR, Lucknow.	-	Chairman
2.	Dr. D. Kapoor Sr. Scientist NBFGR, Lucknow.	-	Member
3.	Shri P.C. Mahanta Sr. Scientist (upto 30.9.98) NBFGR, Lucknow.	-	Member-Secretary
4.	Shri Sanjeev Kumar Srivastava Scientist (from 01.10.98) NBFGR, Lucknow.	-	Member - Secretary
5.	Dr. A.K. Pandey Scientist (Sr. Scale) (upto 2.1.99) NBFGR, Lucknow.	-	Member
6.	Shri S.P. Singh Scientist (Sr. Scale) (from 3.1.99) NBFGR, Lucknow.	-	Member
7.	Dr. (Mrs.) R. Abidi Scientist (Sr. Scale) NBFGR, Lucknow.	-	Member
8.	Shri R.C. Srivastava A.F. & A.O. NBFGR, Lucknow.	-	Member
9.	Shri A. Sah Superintendent NBFGR, Lucknow.	-	Member

Staff Side :

1.	Shri P. Chithamparam Library Assistant (T-4) NBFGR, Lucknow.	-	Secretary
2.	Shri S.K. Paul Junior Survey Asstt. (T-II-3) NBFGR, Lucknow.	-	Member
3.	Shri Navin Kumar Senior Clerk NBFGR, Lucknow.	-	Member
4.	Shri S.N. Srivastava Junior Clerk NBFGR, Lucknow.	-	Member
5.	Shri Inderjit Singh Messenger, SSG-II NBFGR, Lucknow.	-	Member
6.	Shri Santosh K. Singh Fisherman, SSG - I NBFGR, Lucknow.	-	Member

Grievance Committee

The Grievance Committee has been formed with members nominated and elected as stated below :

Nominated :

1.	Dr. A.G. Ponniah Director NBFGR, Lucknow	-	Chairman
2.	Dr. D. Kapoor Sr. Scientist NBFGR, Lucknow	-	Member
3.	Shri P.C. Mahanta Sr. Scientist & Head of Office NBFGR, Lucknow	-	Member

4.	Shri R.C. Srivastava A.F. & A.O. NBFGR, Lucknow	-	Member
5.	Shri A. Sah Superintendent NBFGR, Lucknow	-	Member - Secretary

Elected :

1.	Dr. A.K. Pandey Scientist (Sr. Scale) NBFGR, Lucknow	-	Scientific
2.	Shri Rajesh Dayal T - 5, NBFGR, Lucknow	-	Technical
3.	Shri Navin Kumar Senior Clerk NBFGR, Lucknow	-	Administrative
4.	Shri Om Prakash Driver, NBFGR, Lucknow	-	Technical
5.	Shri Ram Baran Fisherman, SSG-III NBFGR, Lucknow	-	Supporting

Women Cell

The Women Cell has been constituted at NBFGR, Lucknow with the following members w.e.f. 6.2.98

1.	Shri P.C. Mahanta Sr. Scientist/ Head of Office (upto 30.9.98) NBFGR, Lucknow	Head of the Cell
2.	Dr. (Mrs.) V. Mohindra Scientist (from 1.10.98) NBFGR, Lucknow	Head of the Cell

3.	Smt. Chanda Tiwari Assistant NBFGR, Lucknow	Member
4.	Miss Reeta Chaturvedi Computer Operator (T-II-3) NBFGR, Lucknow	Member
5.	Miss Mamta Roy Junior Stenographer NBFGR, Lucknow	Member
6.	Shri R.K. Malhotra Laboratory Attendant, SSG-I NBFGR, Lucknow	Member

From NBFGR, Lucknow to other Institute on transfer / deputation / promotion / selected on higher posts.

1.	Dr. P.C. Mahanta Senior Scientist	– Relieved from the Bureau on the afternoon of 30.9.98 and joined duty as Advisor (Fisheries) in North Eastern Council Secretariat, Shillong.
2.	Dr. A.K. Pandey Scientist (Sr. Scale)	– Relieved from the Bureau on the afternoon of 2.1.99 and joined as Senior Scientist at Central Institute of Freshwater Aquaculture, Bhubaneswar.
3.	Shri K.L. Thakur Laboratory Technician (T-II-3)	– Relieved from the Bureau on the afternoon of 18.11.98 and selected at Lecturer (School Cadre) in H.P. Govt. Education Department.

18. INFRASTRUCTURE DEVELOPMENT

NBFGR Complex

The construction work of the administration block, service block, farm, ponds, residential quarters, overhead tank have been completed. The remaining works in the Laboratory blocks are near completion. Shifting of office was initiated in the end of March and continued upto third week of April. The Fish biology lab has been adjusted in the Administrative block temporarily and the BG and CG labs have accommodated in the Service block. Subsequently the quarters have been allotted to the staff depending on the availability.

ARIS Cell

The ARIS Cell of the NBFGR is functioning with LAN server, three Pentium PCs, laser printer, colour printer, scanner and UPS. To protect computers from virus, anti virus package was installed in all the computers. The internet facility through VSNL was provided to all the Scientists and lot of information was downloaded. A working group meeting was organised by the ARIS cell to determine common operating system and a common work procession software for NBFGR.

APPENDIX-I

Statement showing the total number of employees and member of Scheduled Castes and Scheduled Tribes amongst them as on 31.3.99.

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'A' (Class - I)						
1.	Director	1	-	-	-	-
2.	Senior Scientist	2	-	-	-	-
3.	Scientist (Sr. Scale)	4	-	-	-	-
4.	Scientist	10	1	10%	-	-
5.	Farm Manager (T-7)	1	-	-	-	-
	Total	**18**	**1**		**-**	**-**

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'B' (Class - II)						
1.	Asstt. Finance & Accounts Officer	1	-	-	-	-
2.	Superintendent	1	-	-	1	100%
3.	Junior Accounts Officer	1	-	-	-	-
4.	Technical (T-5)	5	1	20 %	1	20 %
5.	Technical (T-4)	2	-	-	-	-
6.	Assistant	2	1	50%	--	--
7.	Stenographer	1	--	--	--	--
	Total	**13**	**2**		**2**	

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'C' (Class - III)						
1.	Technical (T-II-3)	5	1	20.00%	1	20.00%
2.	Technical (T-2)	3	1	33.33%	--	--
3.	Technical (T-1)	7	1	14.20%	--	--
4.	Senior Clerk	3	1	33.33%	1	33.33%
5.	Junior Stenographer	2	1	50.00%	--	--
6.	Junior Clerk	5	--	--	1	20.00%
7.	Fieldman, SSG - IV	1	1	100.00 %	--	--
	Total	**26**	**6**		**3**	

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'D' (Class - IV)						
1.	Supporting, SSG - III	2	--	--	1	50%
2.	Supporting, SSG - II	3	1	33.33%	--	--
3.	Safaiwala, SSG - II	2	2	100.00%	--	--
4.	Supporting, SSG - I	7	2	28.00%	1	14%
	Total	**14**	**5**		**2**	

Under DNA Fingerprinting project

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'A'						
1.	Research Associate	2	--	--	--	--
	Total	**2**				

Sl. No.	Group/Class	Total No. of employees	SC	% SC	ST	% ST
Group 'C' (Class - III)						
1.	Laboratory Technician (T-II-3)	1	--	--	--	--
2.	Lab Assistant (T-1)	2	--	--	--	--
	Total	**3**				

THE TIMES OF INDIA

30-6-99

Successful captive breeding of fish species

By PB Varma
The Times of India News Service

LUCKNOW: Scientists at the National Bureau of Fish Genetic Resources (NBFGR), Lucknow, have successfully completed captive breeding of an economically important hillstream fish called Lobeo dyocheilus, commonly known as "Kali" fish. It is on the endangered species list.

In a survey conducted in Kosi river, which harbours a rich biodiversity, it had been found that th... population of the fish was... ing rapidly due to ill... of fishing... "dynami...

NBFGR carried out artific... breeding programme in Kosi ri... near Corbett Foundation and Ti... Tops Corbett Lodge near Ramn... gar. The attempt to breed Labe... dyocheilus in nature had not yet been explored, according to Dr Uttam Kumar Sarkar, leader of th... group.

Talking to The Tim... Sarkar said... (Lobeo...

मछलियों के शुक्राणुओं को अनंतकाल

...नऊ, 2 फरवरी (वार्ता)। यहां स्थित राष्ट्रीय मत्स्य आनुवांशिक संसाधन ब्यूरो के ...ों ने गहन अनुसंधान के बाद मछलियों के शुक्राणुओं को हिम-परिरक्षण विधि ...क्षत करने की ऐसी तकनीक विकसित कर ली है जिससे इन्हें अनंतकाल ...

सफलता से भारत विश्व में अग्र... देश में लुप्त हो रहा प्रजातियों को ...ही मछलियों की प्राकृतिक आ... उन्होंने कहा कि मुरक्षि... यों या हैचरियों में ...बीज उत्पादन ...जनन विधि के ...मछली उन पर

Novel scheme to conserve fish sp...

By Archana Srivastava
The Times of India News Service

...NOW: With 79 species of ...endangered list, the ...

the in situ or ex situ conservation programmes and also for the stake... ...ing of claim for the benefits of biotechnological products derived ...mic Indian fishes. ...tor Dr AG Ponni... ...lding of the d... ...aquatic... ...two-f...

The North-Easte... been identifie... biodivers... fishe...

...anthro-... ...fisheries of ...have declined. Consequently, a pro... ...een launched by th... ...ave this 'hot spot' ...

...study the ...o-... ...oeen ...atory ...raged. ...ere are ...tablished ...e policing. ...e want to ...everywhere ...built mecha-... ...te aim is that ...taken shoul... ...efit the peop...

Cryo-preservation technique developed for endangered fish

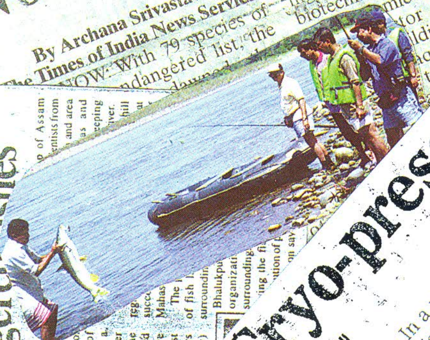
By K S Sudhi

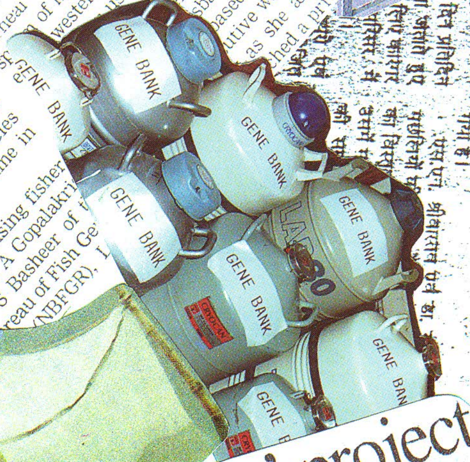
Kochi, Sept 9: In a major breakthrough, the fisheries scientists have developed a cryo-preservation technique for an endangered endemic fish species ...ala for the first time in ...ntry.

...am comprising fisher... ...ists Dr A Gopalakri... V S Basheer of ...reau of Fish Ge... (NBFGR), ...

...cells, embryo and ...of human beings. Wom... ...western countries have ...use of the techni... ...ing from the ...rm of even ...sbands and ...ased high-... ...tive was in ...as she and ...hed a pri-...

...in UP, the ...ating on the ...ain river ...s a tes...





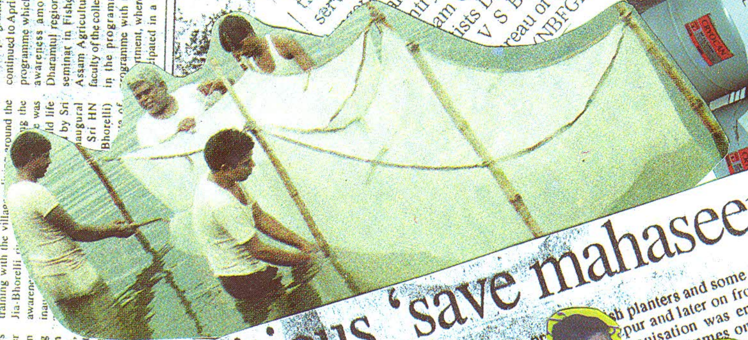
महाशीर मछली की प्रजाति को ...ए जागरूकता जरूरी

NORTH EAST

Awareness campaign to save endangered fishes

GUWAHATI, April 13— A programme on the awareness of saving the threatened species of fishes was organized in the implementation of ... fish conservation, follow-up programmes and ... surrounding Jia Bhoroli river, and at other locations as the Fisheries College (Assam Agricultural University) at Raha, among various fishermen in Nagaon district (in Dharamtul) in fish markets of Bhalukpung, Balipara and in several schools, through a joint collaborative research programme comprising ... (Bhoreli) Anglers Association ... National Bureau of Fish ...

...The programme started from April 1 ... continued to April 7 — a week-long extension programme which disseminated the sense of awareness among the (i) fishermen of Dharamtul region of Nagaon district; (ii) a seminar in Fishery College, Raha, under Assam Agricultural University, where the faculty of the college and students participated in the programme; (iii) an illustrative programme with the foresters of the Forest Department, where about 40 trainee foresters participated in a separate programme; (iv) ...



...ambitious 'save mahaseer' project

...is to organise an awareness pr... ...gramme on the preservation a... ...conservation of threatened sp... ...ociation with the ... Anglers' A...

...sh planters and some citizens ...epur and later on from 1960, ...organisation was engaged in ...us programmes on fish con-... ...ation, par-... ...ation and ... ...arly in m... ...of species.

year, local youth, women, school and ... students are trained ...onservation pro-... ...as well as on overall ...al environ-... ...fish

TUESDAY, APRIL 14, 1998