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Annual Report
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भाकृअनुप
ICAR

राष्ट्रीय मत्स्य आनुवंशिक संसाधन ब्यूरो, लखनऊ
(भारतीय कृषि अनुसंधान परिषद्)

National Bureau of Fish Genetic Resources, Lucknow
(Indian Council of Agricultural Research)

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(Indian Council of Agricultural Research)

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PREFACE

The generation and use of reliable information on biodiversity has emerged as a prime research enterprise world over towards sustainability. In this context, the NBFGR has been constantly striving for building sound research programmes and generating data as inputs for supporting fish germplasm conservation and management in the country. The main mandate and thrust areas of the Bureau include collection, classification and cataloguing of aquatic genetic resources, preservation of endangered fishes and evaluation of the introduction of exotic fish species in the country. The Institute has been able to make significant contributions in the above areas during the year 2006-07 by implementing eighteen in-house projects and seven externally funded projects.

The finfish diversity database was updated with information on 305 additional fish species during 2006-07. The work on molecular genetic divergence studies in prioritized Indian catfish group revealed significant results. The 16S rRNA mitochondrial region was amplified, purified and sequenced for Indian catfish species belonging to eight families of order Siluriformes. The polymorphic microsatellite loci in *Sperata aor, Mystus tengra, M. oculatus* and *Horabagrus brachysoma* were identified and sequenced. A significant research contribution towards phylogeny of mahseer species was achieved. There were two main clusters in the consensus trees of mahseer species; one containing *T. putitora* and *T. mahanadicus;* with *T. tor* and second included *T. khudree* and *T. mussullah*. A significant progress was made in the programme on DNA barcoding of Indian marine fish species. DNA barcodes were prepared for 70 species for the first time in India and the South-East Asia.

Genetic characterization of Green mussel, *Perna viridis*, Brown mussel, *P. indica* and its 'parrot' type morphotype collected from Kerala, was done using RAPD markers. The results indicated that the 'parrot' types might be the morphotype of the brown mussel. A new research work on genetic characterization of the harmful cyanobacteria, *Trichodesmium* spp. from Indian waters was undertaken. The work on development of fluorescence *in situ* hybridization probes was strengthened and cytogenetic studies were undertaken in eight prioritized species from Manipur State in the NE Region.

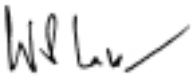
The research efforts on gene banking focused on *in situ* conservation of fish germplasm resources of the selected stretches of the river Ganga. Our results indicated significance of protected habitat in conserving Gangetic fish diversity. As part of the *ex situ* conservation programme, a total of 871 tissue accessions were added to the tissue bank of NBFGR representing 243 freshwater

and marine fish species of the country. The detection of protozoan and monogenean parasites of freshwater exotic fishes continued during the year. A new project was undertaken on molecular detection of viral pathogens of shrimps.

The Institute organized several workshops/seminars including one national, three regional and one state-level workshop and two awareness programmes. The Institute also conducted six specialized training programmes on subjects related to fish biotechnology, genotoxicity and fish disease reporting system. A professional society, named 'Aquatic Biodiversity Conservation Society' was launched and MoUs were signed with two Universities. The Institute was awarded the 'Best Annual Report Award – 2003-04' by the ICAR. A new DNA Barcoding and Training Lab was established at the Institute. The Institute was able to generate revenue of Rs. 10.64 lakhs against a target of Rs. 10 lakhs.

This report presents a summary of the achievements of Team NBFGR during 2006-07 where all the scientists and staff of the Institute have strived hard towards achieving their targets.

I am deeply indebted to Dr. Mangala Rai, Secretary, DARE and DG, ICAR for the visionary guidance and support. I am also grateful to Dr. S. Ayyappan, DDG (Fisheries), ICAR for the continued guidance and encouragement. I place on record my sincere thanks to Dr. A.D. Diwan, ADG (Marine Fisheries), Dr. V.R. Chitranshi, ADG (Inland Fisheries) and other staff members of the SMD for their cooperation and help in our endeavours.



(W.S. Lakra)
Director

EXECUTIVE SUMMARY

The National Bureau of Fish Genetic Resources (NBFGR) was established in 1983 under the Indian Council of Agricultural Research, for providing research inputs to sustainable management and conservation of fish genetic resources of the country. The main mandate of the Institute pertains to collection, classification, evaluation, cataloguing and conservation of fish genetic resources. In addition, the Bureau is also mandated to evaluate the introduction of exotic fish species in India. The Bureau has evolved into a premier institution focussing in research on issues related to characterization and conservation of fish germplasm resources, including fish database management, molecular taxonomy, gene banking, biotechnology, and health management. During the year under report, the research activities were conducted through eighteen Institutional projects and seven externally funded projects.

The existing database on finfish diversity of India was updated by adding 305 fishes. The database now contains detailed information on 2487 finfish species, including 291 exotic freshwater species. Ecosystem-wise finfish diversity of India consists of 1010 freshwater, 113 brackishwater and 1364 marine species. The indigenous fish species added to the database during the year 2006-07 include, nine species reported from the Western Ghats of India; six species reported, for the first time from North-eastern region and from West Bengal; two species from the Andaman waters; one newly reported species each from the Khoh river, Dogadda in Garhwal and a catfish reported from the tributaries of river Ganges in Himachal Pradesh. Details of 28 Indian marine fauna containing bioactive compounds of economic importance were added to the database. Detailed information on different types of nets and other gears was collected and digitized. A new module on chromosomal information was added to the database, which includes images of the metaphase and karyotypes of 114 fish species. A state - level module was prepared in the database to show the occurrence of number of fishes in the different states of India.

Under a comprehensive DNA barcoding programme of Indian marine fish species, 1300 fish samples, covering 300 marine species, were collected from Mumbai, Cochin, Vishakhapatnam, Mandapam, Andaman and Nicobar Islands. The total DNA was isolated and PCR amplification was done for 700 samples, covering 150 species. DNA sequencing was done in 350 samples, covering 100 species. DNA barcodes were prepared for 70 species for the first time in India and the South East Asia.

Molecular genetic divergence studies were continued in prioritized Indian catfish group. The 16s rRNA mitochondrial region was amplified, purified and sequenced for Indian catfish species belonging to eight families of order Siluriformes. The species, belonging to families Siluridae, Schilbeidae (Subfamily: Schilbeinae), Claridae and Bagridae (Subfamily: Bagridae- Mystus and Sperata) formed the clusters with their respective species. The polymorphic microsatellite loci in *Sperata aor, Mystus tengra, M. oculatus* and *Horabagrus brachysoma* were identified through cross species amplification of 27 microsatellite primers. The polymorphic microsatellite loci obtained were sequenced to ascertain number and nature of repeat sequences at these loci and sequences were submitted to NCBI Genbank. All the identified microsatellites were observed to contain repeat sequences, similar to that of resource species. Microsatellite enriched genomic library was constructed for *Pangasius pangasius* to identify sequences containing microsatellite repeat regions. Out of which 29 sequences were found to contain microsatellite repeats. Primers were designed for these 29 loci and tested for amplification of microsatellite loci. The 15 pairs of primers gave amplified products. A total of 36 individuals from two rivers namely, Brahmaputra

and Mahanadi, were genotyped for testing the suitability of these loci for genetic variability studies. Out of these, 9 loci were found to be polymorphic whereas 4 loci were monomorphic. These microsatellite markers were found to be suitable for population studies.

Genetic characterization of Green mussel, *Perna viridis*; Brown mussel, *P. indica* and its 'parrot' type morphotype collected from Kerala, was done using RAPD markers. The results indicated that the 'parrot' types might be the morphotype of the brown mussel. Genetic diversity analyses of natural populations of *Labeo calbasu* from Godavari and Bhagirathi rivers were carried out using microsatellite markers. The phylogeny of Mahseer species, i.e. *Tor putitora, T. tor*, *T. khudree*, *T. mussallah* and *N. hexagonolepis* and one subspecies, *T. mosal mahanadicus* from river Mahanadi (Orissa) was studied through mitochondrial DNA sequence markers, control region (d-loop) and cytochrome oxidase I region of mitochondria DNA, using universal primers.

Genetic divergence studies in two prioritized marine species namely, the Bombay-duck and the Lobsters, were continued. A new work on genetic characterization of the harmful cyanobacteria, *Trichodesmium* spp. from Indian waters, was undertaken, using molecular markers and Scanning Electron Microscopy. Species-specific molecular markers were developed in *Trichodesmium* spp. and genetic divergence between *T. erythraeum* and *T. thiebautii* was studied on the basis of the sequence information of *hetR* partial cds; ITS and 16S rRNA partial sequence information. The samples collected from Indian seas (Andaman waters, Indian Ocean, Wadge Bank and Vizhinjam Coast) were found to be *T. erythraeum* based on partial sequence information of the above-mentioned 3 genes.

Amplified Fragment Length Polymorphism (AFLP) studies were undertaken in *P. fasciatus* (Bleeker) using commercially available AFLP kit. The maximum polymorphism was observed by E -ACA/ M -CTG primer combination. A total of 88 unique bands were observed in primer combination E -ACA/M -CTA that were used for identification of species. The results indicated that AFLP markers could serve as a useful tool in species-specific fingerprinting and biodiversity analysis for the management of this species. The work on development of fluorescence *in situ* hybridization (FISH) probes was strengthened. Studies were undertaken to investigate genetic variation, among *L. bata, L. calbasu, L. dyocheilus, L. rohita* and a new putative species *L. rosius* with respect to different regions of rDNA. Studies were initiated to label the ITS 1 region of rDNA in *L. bata.* Trials were undertaken to hybridize the labeled probe ITS1 with *L. bata* chromosomes.

Cytogenetic studies were carried out in eight fish species, namely, *Anabas testudineus, Colisa fasciatus, Osteobrama belangeri, Channa orientalis, C. punctatus, C. striatus, Rasbora rasbora* and *Clarias batrachus* collected from Manipur State. RAPD studies were carried out to investigate genetic variation among *L. rohita*, *L. calbasu* and a new putative species *L. rosius.* The RAPD band pattern obtained in *L. rohita* was almost similar to that of *L. rosius* except for OPAS 10, 13, 14 and 15. Ironically, the RAPD pattern for *L. calbasu* was entirely different from *L. rohita* and *L. rosius,* indicating *L. calbasu* to be a genetically distinct species than *L. rohita.*

The genotoxicity of two heavy metals namely, arsenic trioxide and chromium nitrate was assessed in freshwater murrel, *C. punctatus.* It was found that both the heavy metals induced DNA damage in the tissues of *C. punctatus.* The heavy metals also induced higher number of micronuclei formation that indicated clastogenic effects of these chemicals. Similarly, genotoxicity of Chlorpyrifos, an organophosphate insecticide widely used to control agricultural pests, was also studied which indicated that this pesticide could induce DNA damage in fishes.

With a view to develop the methodology to assess DNA damage in the sperm cells caused by pollutants, as well as, cryoprotectants; experiments were initiated to study genotoxicity in milt collected from *L. rohita* and *C. mrigala.* The

technique was found to be highly useful for assessment of quality of fish sperms. Trials were undertaken on the lymphocytes of *C. punctatus,* for utilization of neutral comet assay in fishes. The results indicated that the neutral comet assay could also be used as an additional biomarker for genotoxicity assessment in fishes.

Studies continued in the selected stretches of river Ganga to investigate the fish species occurrence, distribution, diversity, life history traits and aquatic habitat parameters. Altogether 60 fish species, belonging to 45 genera of 21 families under 6 orders, were identified from the selected sampling sites of river Ganga near Varanasi and Allahabad. A total of 48 fish species belonging to 30 genera of 18 families under 7 orders was recorded in the river Tones. The occurrence of fish species of high conservation importance, like, *Macrognathus aral* (n =21), *Bagarius bagarius* (n=56), *Pangasius pangasius* and *Chitala chitala* in the study area of Varanasi indicated significance of protected habitat in conserving Gangetic fish diversity. The study indicated the availability of early life stages of 26 species within sanctuary and 17 species from outside sanctuary area of the Varanasi stretch, whereas, in Allahabad stretch early life stages of 23 species were identified.

A study on the status and role of temple sanctuaries in conservation of freshwater biodiversity continued in river Gomti, U.P. It was found that management of three major religious sites (temples) was devoted to protect aquatic biodiversity in front of the temples. Studies continued to assess the potential of selected fishing cooperative societies to utilize them for conservation of fish germplasm resources. It was found that the performance of the fishing cooperative societies in terms of conservation measures followed, as perceived by the fisherfolk, was high. It shows that at the selected locations, compliance to the conservation measures implemented by the state government and the fishing cooperative societies was high. An index was prepared to measure the orientation level of the members of the fishing cooperative societies towards conservation of fishery resources. The conservation interest of the fisherfolk members was appreciably positive in all the studied reservoirs, namely, Gobindsagar and Pong reservoirs in HP and Tawa reservoir in MP. It shows that the fisherfolks are aware of the conservation issues in their area and also perceive their responsibility significantly, towards conservation of fish germplasm resources.

Trials were undertaken for the development of sperm cryopreservation protocols for two fishes of the Western Ghats viz, *Horabagrus nigricollaris* and *Garra surendranathanii,* as well as, two important catfishes viz, *Heteropneustes fossilis* and *Clarias batrachus,* which gave encouraging results. A total of 871 tissue accessions were added to the tissue bank of NBFGR from 243 freshwater and marine species of the country.

The work on detection of protozoan and monogenean parasites of freshwater exotic fishes was undertaken with screening of a total of 392 fish samples. The prevalence of parasites was highest in *O. mossambicus* (80%) followed by *C. batrachus* (75%). Prevalence of protozoan *Myxobolus* was highest in *Clarias batrachus* (73 %), followed by *Carassius auratus* (35%) and *L. rohita* (23%). Detection and identification of monogenean *Gyrodactylus* species were done using molecular techniques. A new work was undertaken on molecular detection of viral pathogens of shrimps. A total of 85 shrimp samples were collected for screening of penaeid viruses, namely, Monodon Baculovirus (MBV), Yellowhead virus (YHV), Taura Syndrome Virus (TSV) and White Spot Disease Virus (WSDV) from Cochin, Kerala. Among them, 15 samples were found positive for WSDV by first step PCR, whereas 22 samples were found positive by nested PCR.

In a study on the impact of exotic fish species in UP, the exotic fishes were found to be cultivated in more than 30% of the grow-out ponds. Information on the catch of exotic fish species was collected from different districts along river Yamuna in Uttar Pradesh. In all the

fish catches from river Yamuna, the exotic fish species namely, *Cyprinus carpio*, *Ctenopharyngodon idella, Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Clarias gariepinus* and *Orechromis niloticus* occured.

The Institute organized one National Workshop on "Fish Introductions in India: Status, Challenges and Potentials - a Public Private Partnership". Three Regional Workshops, (1) "Freshwater Fish Diversity of Hill States of Northern India: Conservation and Management for Sustainable Fisheries" (in Hindi); (2)"Fish Germplasm Exploration, Cataloguing and Conservation for North Eastern Region: New Initiatives"; and (3) "Conservation Assessment of Freshwater Fish Diversity for Central India, were organized at Lucknow, Barapani and Bhopal, respectively. Besides, a state level Workshop cum Training Programme on Fish Culture and Inland Fisheries sponsored by National Fisheries Development Board, Hyderabad was organized for strengthening technical expertise and capacity for enhancing fish production in the state of UP. Two awareness programmes on Exotic Fishes in India were also organized one each at CIBA, Chennai and CIFE, Mumbai, respectively.

The Bureau organized six training programmes, during the year. They include: (1) Symposium-cum-Training Programme on Fish Biotechnology for young researchers from North Eastern region of India; (2) Basic Tools in Molecular Biology Research; (3) Genotoxicity Biomarkers in Fishes; (4) DNA Marker Technologies: Principles and Applications (at NBFGR Cochin Unit, Kochi); (5) Molecular Markers and Genetic Diversity Analysis and (6) Programme on Fish Disease Reporting System for State Fisheries Officers, sponsored by DAHDF, Ministry of Agriculture, Govt. of India.

The meetings of the Research Advisory Committee and Staff Research Council were successfully organized. A total of 19 guest lectures by various experts, were organized at the Institute. A professional Society, named "Aquatic Biodiversity Conservation Society (ABCS)", was formally launched. The NBFGR signed MoUs with HNB Garhwal University and Lucknow University, to develop and share expertise and facilities at mutually agreeable terms and conditions.

The Institute was awarded the 'Best Annual Report Award – 2003-04' by the Indian Council of Agricultural Research, New Delhi. A new DNA Barcoding and Training Lab was established in the laboratory block of the Institute. The assets and farm facilities, along with twenty-two staff members of the Chinhat, Lucknow Centre of the Central Institute of Fisheries Education, Mumbai were transferred to the Bureau w.e.f. February 21, 2007.

The Institute published a total of 21 research papers in peer-reviewed journals, contributed 3 chapters to books/ proceedings and 3 popular articles in national magazines. Besides, NBFGR scientists also submitted 22 abstracts for various seminars and workshops in different parts of the country. The Institute also brought out three publications, in the form of books. Against a target of Rs. 10 lakhs, the Bureau generated revenue of Rs. 10.64 lakhs, during the year under report.

The NBFGR library added a total of 443 documents, during the period under report. The library subscribed to 31 international journals and 51 Indian current journals. In addition, 44 current journals were received on gratis/ exchange basis.

The NBFGR organized a Hindi Day function on September 14, 2006. The Bureau also observed a Hindi Pakhwada from September 15 – 29, 2006. During this period, six Hindi competitions were organized among the NBFGR staff.

कार्यकारी सारांश

राष्ट्रीय मत्स्य आनुवंशिक संसाधन ब्यूरो की स्थापना, भारतीय कृषि अनुसंधान परिषद् के अन्तर्गत सन् 1983 में, देश के मत्स्य आनुवंशिक संसाधनों के विवेकपूर्ण प्रबन्धन एवं संरक्षण हेतु वैज्ञानिक सूचनाएं उपलब्ध कराने के लिए की गई थी। ब्यूरो अपने अधिदेश (मैंडेट) के अनुसार, मत्स्य आनुवंशिक सम्पदा के एकत्रीकरण, वर्गीकरण, मूल्यांकन, सूचीकरण तथा संरक्षण की दिशा में उल्लेखनीय कार्य कर रहा है। इसके अलावा, भारत में विदेशागत मछलियों के प्रवेश का मूल्यांकन करना भी ब्यूरो के अधिदेश में सम्मिलित है। ब्यूरो अपने संक्षिप्त कार्यकाल में ही, मत्स्य सम्पदा के संरक्षण से जुड़े विषयों पर शोध एवं अभिलेखन के क्षेत्र में तेजी से प्रगति करते हुए, एक अग्रणी संस्थान के रूप में उभरा है। इस प्रतिवेदन की अवधि के दौरान 18 संस्थान द्वारा पोषित तथा 7 बाहरी शोध परियोजनाओं के माध्यम से शोध कार्य चलाए गए।

वर्तमान भारतीय फिनफिश विविधता डेटाबेस का, 305 प्रजातियों के बारे में सूचनाएं जोड़कर अद्यतन किया गया। डेटाबेस में अब 2487 फिनफिश प्रजातियों से सम्बन्धित विस्तृत आंकड़े सम्मिलित हैं। पारिस्थितिकी तंत्र के अनुसार भारत की फिनफिश विविधता में अब 1010 मीठाजल प्रजातियां, 113 खाराजल प्रजातियां तथा 1364 समुद्री प्रजातियां सम्मिलित हैं। डेटाबेस में वर्ष 2006-07 के दौरान सम्मिलित की गई देशज प्रजातियों में पश्चिमी घाटों से अभिलेखित की गई 9 प्रजातियां; उत्तर-पूर्वी क्षेत्र व प. बंगाल से पहली बार अभिलेखित की गई 6 प्रजातियां; अंडमान से अभिलेखित 2 प्रजातियां तथा गढ़वाल की खोह नदी तथा हिमाचल प्रदेश से अभिलेखित एक-एक प्रजाति सम्मिलित है। डेटाबेस में 28 ऐसे समुद्री जीवों के बारे में सूचनाएं सम्मिलित की गई जिनमें कि आर्थिक महत्व के बायोएक्टिव कम्पाउन्ड्स पाए जाते हैं। विभिन्न प्रकार के जालों के बारे में विस्तृत सूचनाएं एकत्र करके डिजीटाइज़ की गई। डेटाबेस में क्रोमोसोम से सम्बन्धित सूचनाओं पर एक नया माड्यूल जोड़ा गया जिसमें 114 मत्स्य प्रजातियों के मेटाफेज तथा कैरियोटाइप्स की इमेज सम्मिलित हैं। डेटाबेस में एक राज्यस्तरीय माड्यूल तैयार किया गया जिसके द्वारा भारत के विभिन्न राज्यों में मत्स्य प्रजातियों की संख्या व उपस्थिति प्रदर्शित की जा सकती है।

भारतीय समुद्री मत्स्य प्रजातियों की डीएनए बारकोडिंग के एक वृहत् कार्यक्रम के अन्तर्गत, मुम्बई, कोचीन, विशाखापतनम, मंडपम तथा अंडमान व निकोबार द्वीपों से 300 समुद्री प्रजातियों के 1300 नमूने एकत्र किए गए। कुल 150 प्रजातियों के 700 नमूनों से टोटल डीएनए पृथक किया गया तथा पीसीआर एम्प्लीफिकेशन किया गया, जिनमें से 100 प्रजातियों के 350 नमूनों की डीएनए सिक्वेंसिंग की गई तथा कुल 70 प्रजातियों के डीएनए बारकोड तैयार किए गए।

भारतीय कैटफिश समूह की प्राथमिकताप्राप्त प्रजातियों में आण्विक स्तर पर आनुवंशिक विभिन्नता अध्ययन जारी रहे। साइल्युरिफोरम्स गण के आठ परिवारों की भारतीय कैटफिश प्रजातियों में 16 एस आर आर एन ए माइटोकान्ड्रियल रीजन को एम्प्लीफाई, प्योरीफाई तथा सिक्वेन्स किया गया। साइल्युटिडी, स्चिलवीडी, क्लेरिडी तथा बैगरिडी परिवारों की प्रजातियों ने अपनी-अपनी सम्बन्धित प्रजातियों के साथ समूह बनाए। *स्पेरटा एओर, मिस्टस टेंगरा, मिस्टस ओक्युलेटस* तथा *होराबैग्रस ब्रेकीसोमा* में 27 माइक्रोसेटेलाइट प्राइमर्स के क्रास स्पेसीज़ एम्प्लीफिकेशन द्वारा पालीमारफिक माइक्रोसेटेलाइट लोसाई की पहचान की गई। प्राप्त किए गए पालीमारफिक माइक्रोसेटेलाइट लोसाई को सिक्वेन्स किया गया ताकि इन लोसाई पर रिपीट सिक्वेन्स की संख्या तथा प्रकृति का पता लगाया जा सके। सिक्वेन्सेज़ एनसीबीआई जीन बैंक में जमा कर दिए गए। पहचान किए गए सभी माइक्रोसेटेलाइट में रिपीट सिक्वेन्स पाए गए, जैसे कि रिसोर्स प्रजातियों में थे। *पंगासियस पंगासियस* में माइक्रोसेटेलाइट रिपीट रीजन्सयुक्त सिक्वेन्स की पहचान करने हेतु, माइक्रोसेटेलाइट एनरिच्ड जीनोमिक लाइब्रेरी निर्मित की गई जिनमें से 29 सिक्वेन्सेज़ में माइक्रोसेटेलाइट रिपीट्स पाए गए। इन 29 लोसाई के लिए प्राइमर्स डिज़ायन किए गए तथा माइक्रोसेटेलाइट लोसाई के एम्प्लीफिकेशन हेतु परीक्षण किए गए जिनमें से प्राइमर्स के युग्मों ने एम्प्लीफाइड प्रोडक्ट्स दिए। इन लोसाई की आनुवंशिक विभिन्नता अध्ययनों हेतु उपयुक्तता के परीक्षण के लिए, दो नदियों, ब्रह्मपुत्र व महानदी, से 36 नमूनों को जीनोटाइप किया गया। इनमें से 9 लोसाई पालीमारफिक थे जबकि 4 लोसाई मोनोमारफिक थे। ये माइक्रोसेटेलाइट चिन्हक, जनसंख्या अध्ययनों के लिए उपयुक्त पाए गए।

हरी मसैल, पर्ना विरडिस; ब्राउन मसैल, पर्ना इंडिका तथा इसके केरल से एकत्र किए गए 'तोते' जैसे मारफोटाइप का, आरएपीडी मार्कर्स द्वारा आनुवंशिक चरित्र-चित्रण किया गया। परिणामों से पता चला कि 'तोते' जैसा नमूना, ब्राउन मसैल का मारफोटाइप हो सकता है। गोदावरी एवं भागीरथी नदियों से एकत्र की गई *लैबियो कलबासु* की प्राकृतिक जनसंख्याओं का, माइक्रोसेटेलाइट चिन्हकों द्वारा आनुवंशिक विविधता विश्लेषण किया गया। माहसीर

प्रजातियों; *टौर प्युटिटोरा, टौर टौर, टौर खुद्री, टौर मुसल्लाह* तथा *एन. हक्सागोनोलेपिस* और महानदी (उड़ीसा) से प्राप्त एक उपप्रजाति, *टौर मोसल महानदिकस* में, माइटोकान्ड्रियल डीएनए सिक्वेन्स मार्कर्स, कन्ट्रोल रीजन (डी-लूप) तथा साइटोक्रोम आक्सीडेज I रीजन द्वारा, यूनीवर्सल प्राइमर्स का प्रयोग करते हुए, फायलोजेनी का अध्ययन किया गया।

दो प्राथमिकता-प्राप्त समुद्री मत्स्य प्रजातियों, बाम्बे डक तथा लौब्सटर्स में आनुवंशिक भिन्नता का अध्ययन जारी रखा गया। भारतीय जल में पाए जाने वाले एक हानिकारक सायनोबैक्टीरिया, *ट्राइकोडेसमियम* प्रजाति में, आण्विक चिन्हकों तथा स्केनिंग इलैक्ट्रान माइक्रोस्कोपी द्वारा आनुवंशिक चरित्र-चित्रण पर, एक नया कार्य प्रारम्भ किया गया। *ट्राइकोडेसमियम* प्रजाति में प्रजाति-विशेष आण्विक चिन्हक विकसित किए गए तथा *ट्राइकोडेसमियम एटीप्रिएइयम* तथ *ट्राइकोडेसमियम थीबाटी* के बीच आनुवंशिक भिन्नता का अध्ययन किया गया। भारतीय समुद्री जल से एकत्र किए गए नमूने *ट्राइकोडेसमियम एटीथ्रिएइयम* प्रजाति के पाए गए।

प्रिस्टोलेपिस फासिएटस प्रजाति में, व्यवसायिक रूप से उपलब्ध एएफएलपी किट का प्रयोग करते हुए एएफएलपी अध्ययन किया गया। सबसे अधिक पालीमारफिज्म E-ACA/M-CTG प्राइमर्स द्वारा पाया गया। प्राइमर कम्बीनेशन E-ACA/M-CTA द्वारा कुल 88 अद्वितीय बैंड्स पाए गए जिनका प्रजाति की पहचान करने हेतु प्रयोग किया गया। परिणामों से संकेत मिला कि एएफएलपी चिन्हकों का प्रयोग, प्रजाति के प्रबन्धन हेतु, प्रजाति विशिष्ट फिंगरप्रिंटिंग तथा जैवविविधता विश्लेषण के लिए किया जा सकता है। फ्लूरोसेन्स *इन सीटू* हायब्रिडाइजेशन (एफआइएसएच) प्रोब्स के विकास पर कार्य को आगे बढ़ाया गया। *लैबियो बाटा, लैबियो कलबासु, लैबियो डायोचिलस, लैबियो रोहिता* तथा एक नई पुटेटिव प्रजाति *लैबियो रोसियस* में आरडीएनए के विभिन्न रीजन्स के संदर्भ में आनुवंशिक भिन्नता का अध्ययन किया गया। *लैबियो बाटा* में आरडीएनए के ITS1 रीजन को लेबल करने के लिए अध्ययन आरम्भ किए गए तथा लेबल्ड प्रोब ITS1 को *लैबियो बाटा* क्रोमोसोम के साथ हाइब्रिडाइज़ करने के लिए परीक्षण किए गए।

मणिपुर राज्य से एकत्र की गई आठ मत्स्य प्रजातियों, *एनाबास टेस्ट्युडिन्युअस, कोलिसा फासिएटस, ओस्टिओब्रामा बेलांगेरी, चन्ना ओरिएन्टेलिस, चन्ना पंक्टेटस, चन्ना स्ट्रेटस, रसबोरा रसबोरा* तथा *क्लेरिअस बेट्राकस;* में कोशिकानुवंशिकी अध्ययन किए गए।

मीठाजल मुरैल प्रजाति *चन्ना पंक्टेटस* में, दो भारी धातुओं, आर्सेनिक ट्राइआक्साइड तथा क्रोमियम नाइट्रेट की आनुवंशिक विषाक्तता का अध्ययन किया गया। अध्ययन में पाया गया कि उपरोक्त दोनों भारी धातुओं ने *चन्ना पंक्टेटस* में डीएनए को क्षति पहुँचाई। इन भारी धातुओं ने अधिक संख्या में माइक्रोन्युक्लिआई उत्पन्न किए जिससे इनके क्लास्टोजेनिक प्रभावों का संकेत मिला। इसी प्रकार एक आर्गेनोफास्फेट कीटनाशक क्लोरपायरीफास, जिसका कृषि कीटों को नियंत्रित करने में बहुतायत से प्रयोग किया जाता है, के अध्ययन में भी पाया गया कि यह कीटनाशक मछलियों में डीएनए की क्षति करता है।

प्रदूषकों एवं क्रायोप्रोटेक्टेन्ट्स द्वारा शुक्राणु कोशिकाओं में होने वाली डीएनए क्षति के अध्ययन के लिए प्रणाली विकसित करने हेतु, *लैबियो रोहिता* तथा *सिरहाइनस मृगला* के वीर्य में आनुवंशिक विषाक्तता के अध्ययन पर परीक्षण आरम्भ किए गए। इस प्रकार विकसित तकनीक, मत्स्य शुक्राणुओं की गुणवत्ता का ऐसेसमेन्ट करने के लिए उपयुक्त पाई गई। मछलियों में न्यूट्रल कामेट ऐसे का उपयोग करने के लिए, *चन्ना पंक्टेटस* के लिम्फोसाइट्स पर परीक्षण किए गए जिनके परिणामों से पता चला कि न्यूट्रल कामेट ऐसे को, एक अतिरिक्त बायोमार्कर के रूप में आनुवंशिक विषाक्तता के अध्ययनों में प्रयोग किया जा सकता है।

गंगा नदी के चयनित हिस्सों में मत्स्य प्रजातियों की उपस्थिति, वितरण, विविधता तथा जलीय वासस्थल पैटामीटर्स का अध्ययन जारी रहा। गंगा नदी के वाराणसी तथा इलाहाबाद क्षेत्रों से 6 गुणों के अन्तर्गत, 21 परिवारों के 45 वंशों की कुल 60 मत्स्य प्रजातियां अभिलेखित की गई। इसी अध्ययन में 7 गुणों के अन्तर्गत 18 परिवारों के 30 वंशों की 48 मत्स्य प्रजातियों टोन्स नदी से अभिलेखित की गई। इस अध्ययन में कुछ उच्च संरक्षण महत्व वाली प्रजातियां जैसे *मैक्रोगेन्थस एटल, बेगेरियस बेगेरिअस, पंगासियस पगासियस* तथा *चिताला चिताला* भी वाराणसी क्षेत्र में पाई गई जिससे, गंगा की मत्स्य विविधता के संरक्षण में संरक्षित वासस्थल के महत्व का पता चलता है। इसी अध्ययन में वाराणसी क्षेत्र में, कछुआ विहार (संरक्षित क्षेत्र) में 26 मत्स्य प्रजातियों तथा उसके बाहर 17 प्रजातियों की शैशव अवस्थाओं का संकेत मिला जबकि इलाहाबाद क्षेत्र में 23 मत्स्य प्रजातियों की शैशव अवस्थाओं की पहचान की गई।

उत्तर प्रदेश की गोमती नदी में मत्स्य संरक्षण में मन्दिर विहारों की स्थिति एवं भूमिका पर अध्ययन जारी रहा जिसमें पता चला कि अध्ययन क्षेत्र में तीन धार्मिक स्थलों का प्रबन्ध-तंत्र, अपने सामने के जलीय वासस्थल में जलीय विविधता को संरक्षित करने में संलग्न था। कुछ चयनित स्थानों पर, मत्स्य संसाधनों के संरक्षण में मत्स्यजीवी सहकारी समितियों की स्थिति एवं क्षमताओं का अध्ययन जारी रहा। इस अध्ययन में पाया गया कि चयनित स्थानों पर, मत्स्यजीवी सहकारी समितियों के सदस्यों द्वारा मत्स्य संरक्षण हेतु लागू किए गए उपायों के क्रियान्वयन का स्तर उच्च था। इसी

अध्ययन में यह भी पाया गया कि मत्स्यजीवी सहकारी समितियों के मछुआ सदस्यों में मत्स्य संरक्षण की आवश्यकता के प्रति जागरूकता तथा अपनी जिम्मेदारी की भावना का स्तर उच्च था। यह अध्ययन हिमाचल प्रदेश के गोबिन्दसागर तथा पोंग जलाशयों व मध्य प्रदेश के तवा जलाशय में किया गया।

एक्स सीटू संरक्षण कार्यक्रम के अन्तर्गत, पश्चिमी घाटों की दो प्रजातियों *होराबैग्रस निग्रीकोलारिस* व *गारा सुरेन्द्रनथानी* तथा दो महत्वपूर्ण कैटफिश प्रजातियों *हेट्रोप्न्युसटस फोसिलिस* व *क्लेरिअस बैट्राकस*; हेतु शुक्राणु हिमपरिरक्षण प्रोटोकाल विकसित करने के लिए परीक्षण किए गए। वर्ष के दौरान देश की 243 मीठाजल तथा समुद्री मत्स्य प्रजातियों से कुल 871 ऊतक नमूने, ऊतक बैंक में सम्मिलित किए गए।

मीठाजल विदेशागत् मछलियों के प्रोटोजोअन तथा मोनोजीनियन परजीवियों की पहचान का कार्य जारी रहा जिसमें कुल 392 मत्स्य नमूनों की जाँच की गई। परजीवियों की सर्वाधिक उपस्थिति तिलापिया में थी। झींगा के विषाणु रोगजनकों की आण्विक पहचान हेतु एक नया शोध कार्य आरम्भ किया गया जिसके अन्तर्गत झींगा के कुल 85 नमूने एकत्र किए गए। इन नमूनों की जाँच करने पर इनमें से 15 नमूने सफेद दाग रोग विषाणु हेतु प्रथम चरण पीसीआर द्वारा, जबकि 22 नमूने नैस्टेड पीसीआर द्वारा पाजिटिव पाए गए।

उत्तर प्रदेश में विदेशागत मत्स्य प्रजातियों के एक प्रभाव के एक अध्ययन में, विदेशागत मत्स्य प्रजातियों का पालन प्रदेश के 30% ग्रो-आउट तालाबों में पाया गया। उत्तर प्रदेश में यमुना नदी की मत्स्य उपज में विदेशागत मत्स्य प्रजातियों की उपलब्धता के अध्ययन में, अग्रलिखित विदेशागत प्रजातियां पाई गई : कामन कार्प, ग्रास कार्प, बिगहैड, थाईमांगुर, सिल्वर कार्प तथा तिलापिया।

वर्ष 2006-07 के दौरान संस्थान ने एक राष्ट्रीय कार्यशाला, तीन क्षेत्रीय कार्यशालाएं तथा एक राज्यस्तरीय कार्यशाला आयोजित की। संस्थान द्वारा चेन्नई तथा मुम्बई में, भारत में विदेशागत मत्स्य प्रजातियों के बारे में दो जागरूकता कार्यक्रम भी आयोजित किए गए। ब्यूरो ने 6 प्रशिक्षण कार्यक्रम आयोजित किए। संस्थान की शोध सलाहकार समिति तथा स्टाफ शोध परिषद् की बैठकें आयोजित की गई।

संस्थान में विभिन्न विशेषज्ञों के 19 आमंत्रित व्याख्यान आयोजित किए गए। संस्थान में एक प्रोफेशनल सोसायटी ''एक्वाटिक बायोडायवर्सिटी कन्जर्वेशन सोसायटी'' स्थापित की गई। ब्यूरो ने लखनऊ विश्वविद्यालय, लखनऊ तथा एच.एन.बी. गढ़वाल विश्वविद्यालय, श्रीनगर, गढ़वाल, के साथ एमओयू पर हस्ताक्षर किए।

संस्थान को भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली द्वारा 'बेस्ट एनुअल रिपोर्ट अवार्ड-2003-04' प्रदान किया गया। संस्थान में कुछ नई ढाँचागत सुविधाएं विकसित की गई जिनमें एक नई डीएनए बारकोडिंग तथा प्रशिक्षण प्रयोगशाला भी सम्मिलित है। केन्द्रीय मात्स्यिकी शिक्षा संस्थान, मुम्बई, के चिनहट, लखनऊ स्थित केन्द्र के साधन तथा 22 स्टाफ सदस्य, फरवरी 21, 2007 से ब्यूरो को हस्तांतरित किए गए।

संस्थान के वैज्ञानिकों ने कुल तीन पुस्तकें, 21 शोध पत्र, तीन पुस्तकों में अध्याय तीन प्रचलित लेख तथा विभिन्न संगोष्ठियों में 22 शोध सारांश प्रकाशित किए। संस्थान ने वर्ष 2006-07 के दौरान रु. 10 लाख लक्ष्य के सापेक्ष रु. 10.64 लाख का राजस्व उत्पन्न किया।

संस्थान के पुस्तकालय में कुल 443 नए अभिलेख सम्मिलित किए गए। पुस्तकालय ने 31 अन्तर्राष्ट्रीय तथा 51 भारतीय शोध पत्रिकाएं मंगाई। इनके अलावा 44 शोध पत्रिकाएं, विभिन्न स्थानों से आपसी विनिमय आधार पर प्राप्त हुई।

संस्थान में सितम्बर 14, 2006 को एक हिन्दी दिवस समारोह मनाया गया तथा सितम्बर 15-29, 2006 के दौरान हिन्दी पखवाड़ा का आयोजन हुआ। इस दौरान संस्थान के स्टाफ हेतु 6 हिन्दी प्रतियोगिताओं का आयोजन किया गया तथा सभी विजेताओं को निदेशक डा. वजीर एस. लाकड़ा द्वारा पुरस्कार वितरित किए गए।

INTRODUCTION

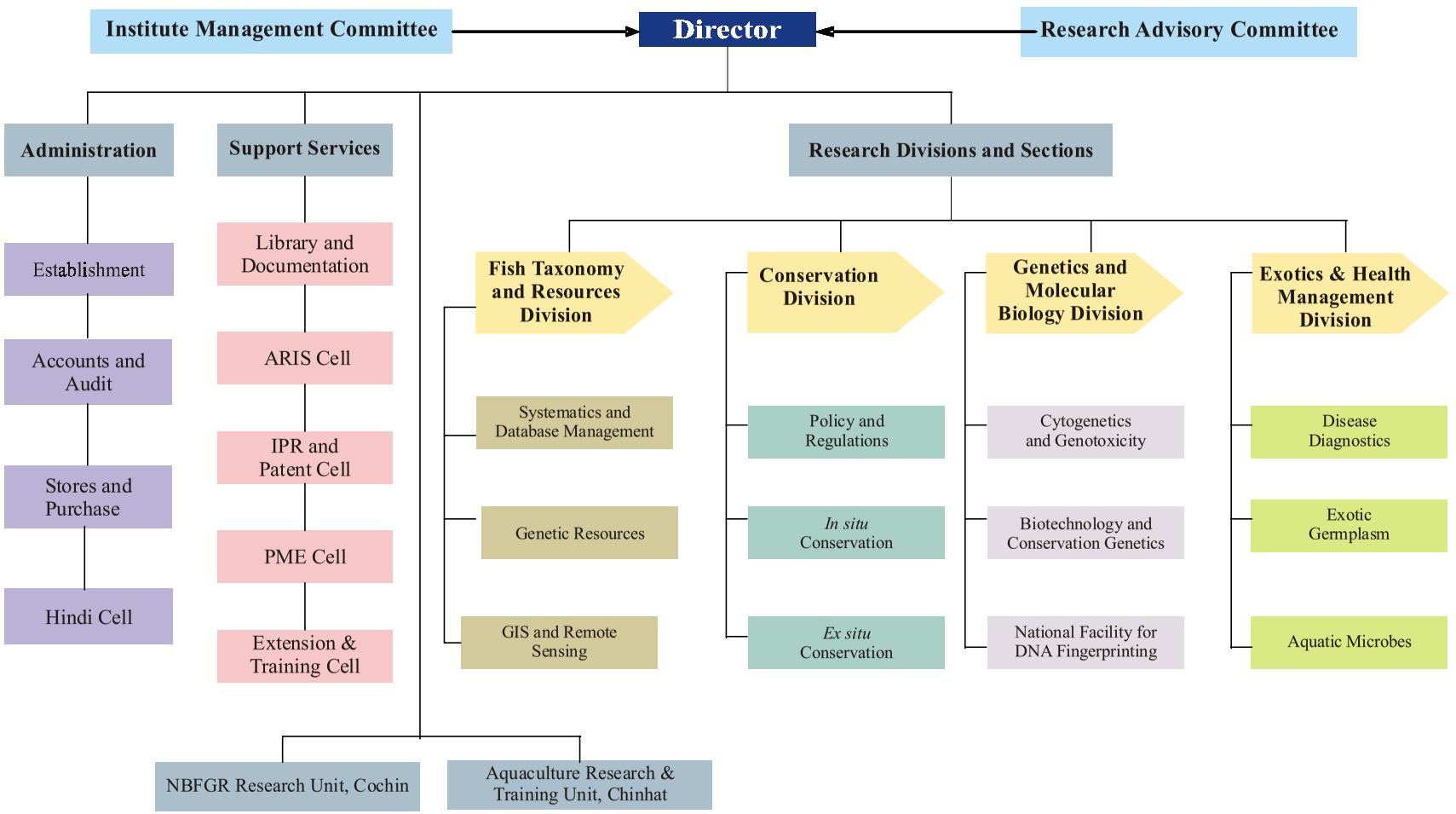
Brief History

The fish genetic resources of India are represented by a wide variety of species in different aquatic ecosystems viz., freshwater, brackishwater and marine. However, several anthropogenic and natural environmental changes have posed serious threat to our rich fish fauna. In view of this, besides the increase in fish production; conservation of fish germplasm resources has become imperative for the management of our fishery resources. Because of this significance, a Bureau of Fish Genetic Resources was established at Allahabad in December, 1983 under the Indian Council of Agricultural Research with the objective of sustainable management and conservation of fishery resources. It was elevated to the status of a National Institute in 1984 and re-named as National Bureau of Fish Genetic Resources (NBFGR). Since then, the NBFGR has developed into a premier research institute and a Center of Excellence in the field of fish germplasm cataloguing, characterization and conservation. The Bureau was shifted to Lucknow in 1994 to its new building with a farm complex at Rae Bareli road.

Mandate

- **Collection, classification and cataloguing of fish genetic resources of the country.**
- **Maintenance and preservation of fish genetic material for conservation of endangered fish species.**
- **Evaluation and valuation of indigenous and exotic fish species.**

ORGANISATIONAL CHART



Staff Position

The overall staff position as on 31st March, 2007 is given below:

S. No.	Category of posts	Posts created	Staff in position	Post vacant (out of created posts)
1.	Research Management (Director)	01	01	--
2.	Scientific	40	27	13
3.	Technical	36	36	--
4.	Administrative	19	18	01
5.	Supporting	20	20	00
	Total	**116**	**102**	**14**

Financial Statement

Allocation of funds and expenditure incurred during the year 2006-2007.

(Rs. in lakhs)

	Budget Allocation	Expenditure
Plan	209.07	209.05
Non Plan	304.00	303.99
North East Component	15.00	14.99
Total	**528.07**	**528.03**

RESEARCH ACHIEVEMENTS

5.1 Cataloguing of Fish Genetic Resources of India

The Bureau has specific mandate for collection and cataloguing of information on fish genetic resources of India, which is a prerequisite for sustainable management of fish germplasm resources. In view of this, NBFGR is engaged in collecting, maintaining and updating valuable information about fish diversity of India.

During the period under report, the existing database on finfish diversity of India was updated by adding 305 fishes (Fig.1). Out of 305 fishes, 291 are exotic. The database now contains detailed data about 2487 finfish species. Ecosystem-wise finfish diversity of India consists of 1010 freshwater, 113 brackishwater and 1364 marine species (Table 1).

Table 1 Fish diversity of India

Ecosystem	Fish species (No.)
Freshwater	1010
Brackish Water	113
Marine	1364
Total	2487 (including 291 Exotic freshwater fishes)

The indigenous fishes included in the database during the year under report include (Table 2 and Fig. 2), nine species reported from the Western Ghats of India namely, *Horadandia atukorali, Mesonemacheilus menoni, Mesonemacheilus remadevi*; *Pristolepis fasciata, Puntius bimaculatus, Puntius exclimato, Puntius nigrofasciatus*, *Schistura nagodiensis* and *Schistura sharavathiensis*; six species reported, for the first time, from North-eastern region and from W. Bengal, namely, *Batasio fasciolatus, Batasio spilurus, Conta pectinata, Pseudolaguvia foveolata, Erethistiodes sicula* and *Schistura papulifera;* two species reported from the Andaman waters, namely, *Centrophorus acus* and *Squalus megalops* and one newly reported species each from the Khoh river, Dogadda in Garhwal, namely, *Puntius khohi* and a catfish reported from the tributaries of river Ganges in Himachal Pradesh namely, *Pseudechensis suppaetula.*

Digital images of fishes were collected and added to the database as per details given in Table 3. Details of 28 Indian marine animals containing bioactive compounds of economic importance were added to the database (Table 4). Detailed information on different types of nets and gears was collected and digitized (Table 5). Details of about 13 exotic food and aquarium fishes, established in India, were also added to the database (Table 6).

Upgradation of the software programming of the database "Fish Diversity of India 2007"

- A new module on chromosomal information was added to the database, which includes images of the metaphase and karyotypes of 114 fish species. The matter was collected from the Chromosomal Atlas published by NBFGR.
- Some additional fields viz. ornamental fishes, Western Ghats, threatened fishes and reservoirs were added in the database, with their relevant information.
- Re-evaluation of web-pages of threatened fishes of India was done. New HTML pages were developed to enhance the information regarding threatened fishes with the help of scripting language like 'Java script visual basic'. Besides, additional information like photographs, were added in the web-pages.
- An additional module of U.P. fishes, with all updated information regarding classification, morphology, colouration, occurrence and distribution up to district level, economic importance, fishery information, photographs and remarks, was added.

Fig. 1. A screen print from database on finfish diversity of India

- State level module was prepared to show the occurrence of fishes in the different states of India.
- Remodeling of the data entry form was done.
- In order to get the summary of all fishes, five active X reports, which give the complete report of all 2455 fish species in 3010 pages, were developed.

Table 2. Newly reported fishes in Indian waters from Western Ghats, North-Eastern Region, Andamans, Garhwal and Himachal Pradesh

S. No.	Name of Species	Family	Size recorded	River	Distribution	Reference
Freshwater aquarium fishes of Western Ghats						
1	*Horadandia atukorali*	Cyprinidae	2 cm. (smallest barb in India)	Young ones thrive in low saline water, adults can acclimatize in freshwater. Survive in freshwater aquarium tanks	Western Ghats, Sri Lanka. Inhabits weedy freshwater ponds of coastal plains	Talwar and Jhingran, 1991
2	*Mesonemacheilus menoni*	Balitoridae	--	Periyar river Kerala	Western Ghats	Zacharias and Minimol, 1999
3	*Mesonemacheilus remadevii*	Balitoridae	7.4 cm.	--	Western Ghats	Shaji 2002

4	*Pristolepis fasciata*	Nandidae	--	Mekong River, coastal region Kerala.	Western Ghats, Burma, Thailand, Malay Peninsula, Sumatra, Borneo and Java.	Talwar and Jhingran, 1991
5	*Puntius bimaculatus*	Cyprinidae	6 cm.	--	Western Ghats (India), Sri Lanka	Talwar and Jhingran, 1991
6	*Puntius exclimato*	Cyprinidae	--	Kallada river	Western Ghats, Kallada river in Kerala.	Pethiyagoda and Kottelat, 2005
7	*Puntius nigrofasciatus*	Cyprinidae	--	--	Western Ghats, Maharashtra, Southern Sri Lanka.	Talwar and Jhingran, 1991
8	*Schistura sharavathiensis*	Balitoridae			Sharavathi river, Western Ghats	Sreekantha *et.al.* 2006
9	*Schistura nagodiensis*	Balitoridae		Sharavathi river	Western Ghat	Sreekantha *et.al.* 2006
North-Eastern Region						
10	*Batasio fascilatus*	Bagridae		Brahmaputra River drainage	Assam	Hoek Hee NG, 2006
11	*Batasio spilurus*	Bagridae		Brahmaputra River drainage	Assam	
12	*Pseudolaguvia foveolata*	Erethistidae		Teesta river	North Bengal	Hoek Hee NG, 2005
13	*Conta pectinata*	Erethistidae		Brahmaputra river drainage	Assam	Hoek Hee NG, 2005
14	*Schistura papulifera*	Balitoridae	male female	Cave of Synrang Pamiang	Meghalaya	Maurice *et.al.*,2007
15	*Erethistiodes sicula*	Erethistidae	15.7-37.2 mm SL	Scutunga river (tributary of Mansi river)	W. Bengal	Heok Hee NG, 2005
Garhwal						
16	*Puntius khohi*	Cyprinidae	55 mm TL	Khoh river	Dogadda in Garhwal Himayala	Dobriyal *et.al.* 2004
Andamans						
17	*Centrophorusacus*	Centro-phoridae	924-1007cm (female) 808-891cm (male)		Andaman waters	Soundararajan and Dam Roy, 2004
18	*Squalus megalops*	Squalidae	709-827cm (female)		Andaman waters	Soundararajan and Dam Roy, 2004
Himachal Pradesh						
19	*Pseudechensis suppaetula*	Sisoridae	male female	Tributaries of Ganges rivers in India	South Asia, Himachal Pradesh	Hoek Hee NG, 2006

Table 3. Details of digital images of fishes collected and added to the database

S. N.	Category of fishes	No. of species
1	Marine fishes	65
2	Freshwater fishes	120
3	Exotic aquarium and food fishes	13
4	Fishes of Lakshadweep	122
5	Threatened species	73
6	Freshwater and marine fishes	1137
7	Family Sygnathidae	8
8	Chromosomal information	114

Table 4. Details of 23 Indian marine animals containing bioactive compounds of economic importance

S. N.	Species	Group	Bioactive compound	Economic importance	Ref.
1.	*Stocheospermum marginatum*	Seaweed	Methanol extract (yet to characterize the extract)	Anti-cancer	Vinayak & Chatterji, 2006
2.	*Penicillium chrysegenum*	Bacteria	Citrinin	Anti-bacterial, Anti-fungal	Prabha Devi *et al.*, 2006
3.	*Holothuria scabra*	Echinodermata	Methanol extract (HSMM)	Anti-microbial, Anti-carcinogenic	Ku *et al.*, 2006
4.	*Mugil cephalus*	Teleost	Mvp1 & Mvp2 neuropeptides	Controlling visceral contractions of gastrointestinal tract	Senaratne *et al.*, 2006
5.	*Crinoid sp.*	Echinodermata	Methanol extract; one fraction	Anti-angiogenic activity through the antiproliferative effect on endothelial cells	Pandit & Indap, 2006
6.	*Loligo duvauceli*	Echinodermata	Acetone dissolved ether – extract	Immuno modulatory and anti mitotic activity	Balakrishnan & Indap, 2006
7.	*Halomonas marina CST*	Bacteria	Glycolipid	Biosurfactant	Satpute *et al.*, 2006
8.	*Pinctada fucata*	Mollusca (Bivalve)	Pearlin – EDTA insoluble protein	Negatively regulates aragonite $CaCo_3$ crystal formation	Takagi *et al.*, 2006
9.	*Portersia coarctata*	Angiosperm in mangroves	Rhizosphere plant growth promoting bacteria (PGPB)	Promotes plant growth	Ramesh Kumar & Nair, 2006
10.	*Meretrix casta*	Mollusca (Bivalve)	Methanol & PBS extract	Anti-microbial	Sharma *et al.*, 2006
11.	*Polymesoda erosa*	Mollusca (Bivalve)	Methanol & PBS extract	Anti-microbial	Sharma *et al.*, 2006
12.	*Perna viridis*	Mollusca (Bivalve)	Methanol & PBS extract	Anti-microbial	Sharma *et al.*, 2006
13.	*Crassostrea gryphoides*	Mollusca (Bivalve)	Methanol & PBS extract	Anti-microbial	Sharma *et al.*, 2006
14.	*Villorita cyprinoides*	Mollusca (Bivalve)	Methanol & PBS extract	Anti-microbial	Sharma *et al.*, 2006

15.	*Scylla serrata*	Crustacea	Acetonitrile extract	Anti-microbial	Sabu *et al.*, 2006
16.	*Cladiella sp.*	Cnidaria (Soft Coral)	6 – Hydroxy polyanthellin (tetracyclicditer penoid)	Anti-fouling	Kunnath *et al.*, 2006
17.	*Tachypleus gigas*	Horse-shoe crab (Crustacean)	Haemolymph	Anti-microbial	Wakankar *et al.*, 2006
18.	*Sepia pharaonis*	Mollusca (Cephalopoda)	Liver oil	Anti-atherogenic	Joseph *et al.*, 2006
19.	*Sepia pharaonis*	Mollusca (Cephalopoda)	Uronic Acid rich peptidoglycan from ink	Anti-cancer	Senan *et al.*, 2006
20.	*Perna viridis*	Mollusca (Bivalve)	Crude extract	Wound healing	Therwath *et al.*, 2006
21.	*Conus amadis*	Mollusca (Gastropoda)	Protease inhibitor from Venom	Neurotoxin	Santhanakrishnan *et al.*, 2006
22.	*Conus betulinus*	Mollusca (Gastropoda)	Protease inhibitor from Venom	Neurotoxin	Santhamakrishnan *et al.*, 2006
23.	*Conus figulinus*	Mollusca (Gastropoda)	Protease inhibitor from Venom	Neurotoxin	Santhamakrishnan *et al.*, 2006
24.	*Conus loroisii*	Mollusca (Gastropoda)	Protease inhibitor from Venom	Neurotoxin	Santhamakrishnan *et al.*, 2006
25.	*Halidona exigua*	Sponge (Porifera)	Methanol extract	Anti-fouling	Limna Mol *et al.*, 2006
26.	*Didemnum psammatode*	Ascidian	Ethanol extract	Anti-fouling	Satheesh & Wesley, 2006
27.	*Molgula ficus*	Ascidian	Ethanol extract	Anti-fouling	Satheesh & Wesley, 2006
28.	*Holothuria scabra*	Echinodermata	Coelomic fluid extract (Lectin) – basic protein	Anti-bacterial	Gowda *et al.*, 2006

Table 5. Details of different types of nets and gears added to the database

Name of nets and gears with common name in local parlance	Mesh sizes in stretched condition	Size in metre/cm
I. **Dragnets/seine nets**		
1. Chatt jal or kapra jal (a kind of seine/drag net)	Up to 10 mm	L=90 to 120 m, W=5.0 m
2. Barsati jal or ghanni jal (a kind of seine/drag net)	6 to 20 mm	L=90 to 180 m, W=5.4 m
3. Maha jal or pauri jal (a kind of deep seine net)	40 to 70 mm	L=90 to 180 m, W=6.0 m
II. **Simple drag nets**		
4. Chhanti jal (a kind of simple drag net)	8 to 14 mm	L=60 to 90 m, W=2.7 m
5. Jhoa jal or jharalka chhanti jal (a kind of simple drag net)	15 to 30 mm	L=27 to 45m, W=1.58 m

III. **Gill nets**		
6. Espee jal (a bottom set gill net)	20 to 40 mm	L=45 to 90 m, W=2.7 m
7. Chaondhi jal (a drift gill net)	40 to 70 mm	L=60 to 110 m, W=3.6 m
8. Dheri jal or sutraili jal (a column drifting gill net)	20 to 28 mm	L=45 to 76.5 m, W=2.7 m
9. Current jal (a monofilament drift gill net)	28 to 40 mm	L=45 to 112.5 m, W=2.7 m
10. Gochhail jal or barka bhansa jal (a multifilament column drift gill net)	250 to 300 mm	L=70 to 180.5 m, W=43.5 to 6.3 m
11. Bhasaona jal (a surface drift gill net)	140 to 250 mm	L=67.5 to 112.5 m, W=3.6 m
12. Bhansal jal or pjansa jal (a fixed gill net)	70 to 100 mm	L=67.5 to 112.5 m, W=3.6 m
13. Pachaondhi jal (a kind of gill net)	70 to 100 mm	L=67.5 to 90 m, W=3.6 m
14. Satavna jal (a kind of gill net)	100 to 140 mm	L= 67.5 to 112.5 m, W=3.6 m
IV. **Purse nets**		
15. Sunghail jal (a kind of purse net)	220 to 300 mm	L=4.32 m, W=3.6 m, Mouth Opening=1.35 m
V. **Lift nets/dipnets**		
16. Pelni jal (a kind of lift net)	6 to 10 mm	L=1.8 m, W=1.35 m
17. Dondi jal (a kind of dip net)	4 to 8 mm	L=1.8 m, W=0.9 m
18. Pelni jal or tingoriya (a triangular push net or lift net).		
VI. **Scoop nets**		
19. Bishar jal (a kind of scoop net)	6 to 10 mm	L=610.8 m, W=10.8 m
VII. **Cast nets**		
20. Phekail jal or bhauri jal (a kind of cast net)	6 to 22 mm	L=4.05 m, W=10.8 m
VIII. **Long lines**		
21. Bansi or kanta jal (kind of hooks)	Size-3,4,6,7,8,9,10 and 19	
22. Bansi – hazara (a kind of long line)	Gape of hooks 6 to 24 mm	800 to 1000 hooks per small boat
23. Bansi – doni (a kind of set long line)	Gape of hooks 6 to 24 mm	800 to 1000 hooks per small boat
24. Lahka or lapkaooah (hook fishing with the use of dolphin oil)	Gape of hooks 7,8 and 10 mm	
25. Chhip or laggha (line fishing with bamboo stick)	Various size of hooks	
26. Bansi – dengi (kind of line fishing with shallop)	Various size of hooks	
IX. **Plunge basket trap & bamboo barrier trap**		
27. Beerti chilaon (a plunge basket barrier trap)	Gls=10 mm Lmg=450 mm Wmg=140 mm	L=3.15 m, W=1.35 m.
28. Jhangi jal (a small plunge basket bottom set trap)	Gls=10 mm	L=0.68 m, W=0.45 m
29. Beerti (a kind of plunge basket trap)	Gls=10 mm LMG=450 mm Wmg=140 mm	L=1.0, W=0.45

30. Korwa (a fine split triangular basket trap)	Mg=30 mm	L=0.6 m, W=0.3m
31. Bari jal or pinjra (a cage with screen barrier trap)	Gls=10 mm	Made up of 1.5 m long bamboo pieces tied together to form a 12-18 m long screen like structure Pinjra is a cubical structure of size=120 x 45 x 45 x 60 cm.
32. Jhappa or tappi (a cover pot or plunge basket trap)	Gls=4 mm	DTO=0.145, DB=0.54, HB=0.6 L=45 to 75 cm, H=60 to 90 cm, W=25 to 30 cm
33. Pinjra or janjir (a rectangular trap)		L=60 to 130 cm, D=27 to 175 cm
34. Lumba janghi or kumbi (conical trap)		
35. Chilaon or chilman (a bamboo screen)	Gls=10 mm	
36. Dholak or jhanppa (a plunge basket trap)		L=8 to 10 m, W=1.5 to 2.0 m
37. Jhappa or tappi (a cover pot or plunge basket trap)	Gls=4 mm	DTO=0.145 m, DB=0.54 m, HB=0.6 M
X. **Other kind of fishing method** 38. Bhala or gargof (a kind of harpooning) 39. Kholnai-dengi (a white screen with shallop trap)		L= 5.4 m, W =0.45 m
XI. **Spawn trapping** 40. Khorjal pumpa aur hapa (spawn collection through shooting net or shoaling net) 41. Ghaila or hariya (spawns ready for transport in earthen hundies)		Conical in shape and connected by 'Puchhra' or 'Gamchha'. Spawn generally transported in earthen pot.

L= Length, W = Width, D = Diameter, GLS = Gap between two longitudinal strips, LMG = Length of Mouth Gap, WMG = Width of Mouth Gap, MO = Mouth Opening, MG = Mouth Gap, LC = Length of Chialon, WC = Width of Chilaon, DTO = Diameter of Top Opening, DB = Diameter of Bottom, HB = Height of Basket, m = meter, cm = centimeter

Table 6. Details of exotic food and aquarium fishes established in India

S. N	Species	Common name	Aquarium	Max length (cm)	Climate zone	Introduced in India		Reason	Introduced by	References
						From	Year			
1.	*Aristichthys nobilis*	Bighead carp	Never/ rarely	34.2	Temperate	Japan	1987	Aquaculture / Fisheries	Government	Shetty et.al, 1989
2.	*Barbonymus gonionotus*	Java barb	Commercial	41	Tropical	Indonesia	1972	Aquaculture	Unknown	Shetty et.al, 1989

3.	*Carassius carassius*	Crucian carp	Commercial	64	Temperate	UK	1870	Aquaculture/ ornamental	Individual	FAO, 1997
4.	*Clarias gariepinus*	North African catfish	Never/ rarely	170	Subtropical	Unknown	Unknown	Unknown	Unknown	Gopi, 2000
5.	*Ctenopharyngodon idela*	Grass carp	Never/ rarely	27.5	Temperate	Hong Kong	1959	Aquaculture / weed control	Government	Shetty et.al, 1989
6.	*Hypophthalmichthys molitrix*	Silver carp	Never/ rarely	105	Temperate	Hong Kong	1959	Aquaculture /Fisheries		FAO, 1997
7.	*Oncorhynchus mykiss*	Rainbow trout	Public aquariums	120	Temperate	Germany	1906	Angling/ sport/ aquaculture	Unknown	FAO, 1997
8.	*Oreochromis mossambicus*	Mozambique tilapia	Commercial	39	Tropical	Thailand	1952	Aquaculture / Fisheries		FAO, 1997
9.	*Oreochromis niloticus niloticus*	Nile tilapia	Never/rarely	16.5	Tropical	Thailand	1990	Diffusion from neighboring countries / fisheries	Individual	Shetty et.al, 1989
10.	*Pangasius sutchi*	Sutchi catfish	Never/rarely		Tropical	Malaysia	Unknown	Unknown	Unknown	
11.	*Salmo trutta fario*	Brown trout	Never/rarely	100	Temperate	UK	1863	Angling/ sport	Individual	Shetty et.al, 1989
12.	*Salmo trutta trutta*	Sea trout	Never/rarely	140	Temperate	UK	1900	Angling/ sport	Unknown	FAO, 1997
13.	*Salvelinus fontinalis*	Brook trout	Never/rarely	85	Temperate	Canada	1960	Aquaculture / Fisheries	Government	FAO, 1997

Horadandia atukorali

Mesonemacheilus remadevi

Puntius bimaculatus

Puntius exclimato

Puntius nigrofasciatus

Pristolepis fasciata

Fig. 2. A few of the newly reported species from Western Ghats added to the database

Indian species genetic database

A web database, exclusively about the genetic data on model fishes, on a single platform, is designed to help user to access rapidly and efficiently the information about materials, methods and experimental results related to molecular biology of the fishes including sequence analysis, molecular sequence data, genome data, data on aqua-genetics, database on publications and important genetic analysis softwares (Fig. 3). It could be a good source of information for researchers working in fish genetics and biotechnology.

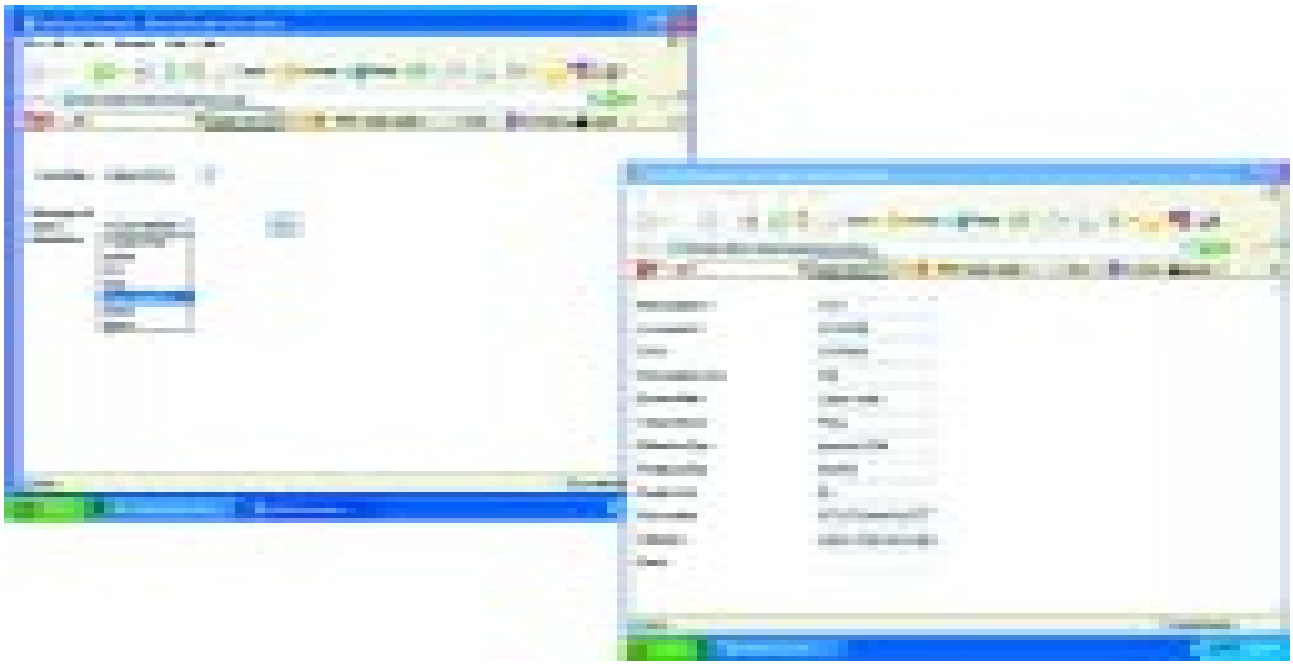


Fig.3. Views from the Indian species genetic data base

Information was collected on aspects like sequences, annotations and comparative genomics, etc, on 11 fishes including, Fugo, Medaka fish, Pufferfish, Tilapia and Zebrafish. The database also provides online links to various servers and sites related to bacterial and virus databases and other topics related to molecular biology, providing user to access information on single window.

Database development for marine ornamental and shell-fishes of Indian waters

The work on developing an electronic database on the diversity of marine ornamental fauna and shell-fish species of Indian waters was continued. The secondary data were collected on mollusks, crustaceans and ornamental fishes from internet browsing and literature search. Preliminary checklists of 300 ornamental fishes, 1400 mollusus and 700 crustaceans of Indian waters were prepared. Information on synonyms, distribution, references, authors' names, classification and biology of mollusks reported from Andaman Islands, Lakshadweep Islands, Kerala, Tamil Nadu, Andhra Pradesh and Maharashtra coasts was collected. Voucher specimens of ornamental fishes (50) and mollusks (60) were collected from Andman Islands, Gulf of Mannar (Mandapam and Tuticorin) and Lakshadweep Islands. Images of mollusks (150) and ornamental fishes (80) were collected. Information on coral reef ecosystems (Kerala, Goa, Gulf of Kutch, Andaman Islands, Gulf of Mannar, Palk Bay and Lakshadweep Islands) was collected. A data sheet was designed for entry of information on individual species collected from the survey sites and information browsed from websites and literature review. Tables were made for each group in MS Access for data entry, which will later be used for retrieval of information on the query based front page in Visual Basic.

5.2 Genetic Characterization

Documentation and analysis of genetic variation in natural populations is of vital importance for evolving conservation and aquaculture strategies for long-term sustainability of the resources. Realizing this, NBFGR has developed and strengthened state-of-the-art facilities in this area of work so as to provide significant research inputs to facilitate the conservation and management of different natural stocks of prioritized fish species.

DNA barcoding

Under a comprehensive DNA barcoding programme of indigenous fish species, 1300 marine fish samples, covering 300 species, were collected from Mumbai, Cochin, Vishakhapatnam, Mandapam, Andaman Islands. The total DNA was isolated and PCR amplification was done for 700 samples, covering 150 species. DNA sequencing was done in 350 samples, covering 100 species. DNA barcodes were prepared for 70 species for the first time in India and the South East Asia (Fig. 4). The voucher specimens of all marine fish species were collected and are being maintained at the National Fish Museum of NBFGR.

Fig. 4. DNA barcode (655 bp mtCoI fragment)

Genetic divergence studies in prioritized Indian catfish group

The Siluriformes or Catfish are among the richest fish orders with regard to number of families and genera. India is the home to a wide variety of catfishes, belonging to 13 families. Most of them are confined to freshwater while some are marine. The relationship between various catfish families has been studied on the basis of osteological, myological and arthrological structures. However, much remains to be done to attain a satisfactory knowledge about catfish phylogeny. Therefore, molecular genetic divergence studies were conducted in prioritized Indian catfish group. Mitochondrial DNA has been used in the molecular systematics of catfishes. The 16S rRNA gene evolves at a slower rate, so it was selected to recover the maximum phylogenetic information on molecular genetic divergence in prioritized Indian catfish group through mtDNA polymorphism. The 16s rRNA mitochondrial region was amplified, purified and sequenced for Indian catfish species belonging to eight families in Siluriformes. Neighbour joining method was used for analyzing the phylogeny of these species (Fig.5). Species belonging to families, Siluridae, Schilbeidae (Subfamily: Schilbeinae), Claridae and Bagridae (Subfamily: Bagridae- *Mystus* and *Sperata*) were forming the clusters with their

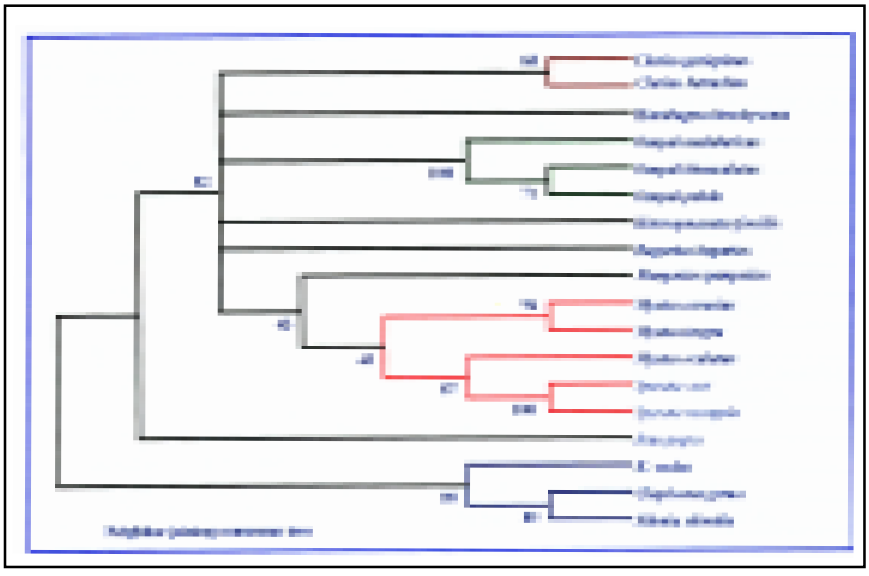


Fig. 5. Phylogenetic relationships among Indian catfishes (based on 16s rRNA)

respective species. More catfish species with this marker, as well as, with other mitochondrial markers, are being studied for catfish phylogeny.

Sequencing of microsatellite *loci* in four species of Family Bagridae

Microsatellites are among the most useful markers for detecting genetic variation and may be useful in evolutionary studies and in generating population genetic data for wide range of species. The polymorphic microsatellite *loci* in *Sperata aor, Mystus tengra, M. oculatus* and *Horabagrus brachysoma* were identified through cross species amplification of 27 microsatellite primers. The identified polymorphic microsatellite *loci* were sequenced to ascertain number and nature of repeat sequences at these *loci* and sequences were submitted to NCBI Genbank. (Table 7). All the identified microsatellites were observed to contain repeat sequences, similar to that of resource species.

Genetic variability studies in *Pangasius pangasius* with molecular markers

Identification of species-specific microsatellite markers through microsatellite enriched partial genomic library

Microsatellite enriched genomic library was constructed for *Pangasius pangasius* to identify sequences containing microsatellite repeat regions, out of which 29 sequences were found to contain microsatellite repeats. Primers were designed for these 29 *loci* and tested for amplification of microsatellite *loci*. The 15 pairs of primers gave amplified products. A total of 36 individuals from two rivers namely, Brahmaputra and Mahanadi, were genotyped for testing the suitability of these *loci* for genetic variability studies and out of these, 9 *loci* were found to be polymorphic, whereas, 4 *loci* were monomorphic. These microsatellite markers were found to be suitable for population studies.

Identification of polymorphic mitochondrial DNA markers

In *P. pangasius*, 16s region was amplified using primers, L2510 and H3080. Total length of the PCR amplified product was 617 bp after sequencing, including the primers. For 7 individuals sequenced for this fragment, 2 haplotypes were found varying at base 48 to be A/C.

The 12s region was amplified using primers, L1091 and H1478. Approximately, 450 base pair fragments were amplified and selected PCR products were purified. Total length of the PCR amplified product was found to be 454 bp, including the primers. A total of 3 haplotypes were observed for 5 individuals sequenced for this fragment. The polymorphism was observed at the

Table 7 : DNA sequencing of identified Microsatellite Loci

S. No.	Locus	Acc. No.	Nature	Alleles/size range	Repeat motiaf
Sperata aor					
1	Pi-h25	DQ888903	P	4/254-216	(TG)25
2	Pi-h34	DQ8888905	P	3/249-226	(CT)2 T(CT)6 N13 (TC)4 T(CA)2CTT (CA)2N5(CA)9
3	Pi-h45	DQ888904	P	3/238-209	(AC)29+n
Mystus oculatus					
6	Pi-h34	DQ888907	P	4/218-208	(TA)13(GA)16
7	Pi-h45	DQ888906	P	3/214-212	(GT)14C(GT)2AT(GT)2
Mystus tengara					
8	Pi-h45	DQ888902	P	3/193-215	(AT)3(AC)13G(AC)2
Rita pavimentatus/Rita gogra					
4	Pi-h25	DQ8888897	P	3/224-265	(TG)7 TA(GT)5ATGA(GT)2GCAAGTTC(TG)5CA(TG)11AT(GT)2
5	Cga06	DQ888898	P	4/109-124	(GT)10
Horabagrus brachysoma					
9	Pi-h25	DQ888901	P	4/188-211	(GT)18GACGAT(TG)4
10	Pi-h34	DQ888900	P	3/193-201	(CA)5A(CT)2(CA)4
11	Pi-h42	DQ888899	M	1/197	(GA)8GT(GA)11

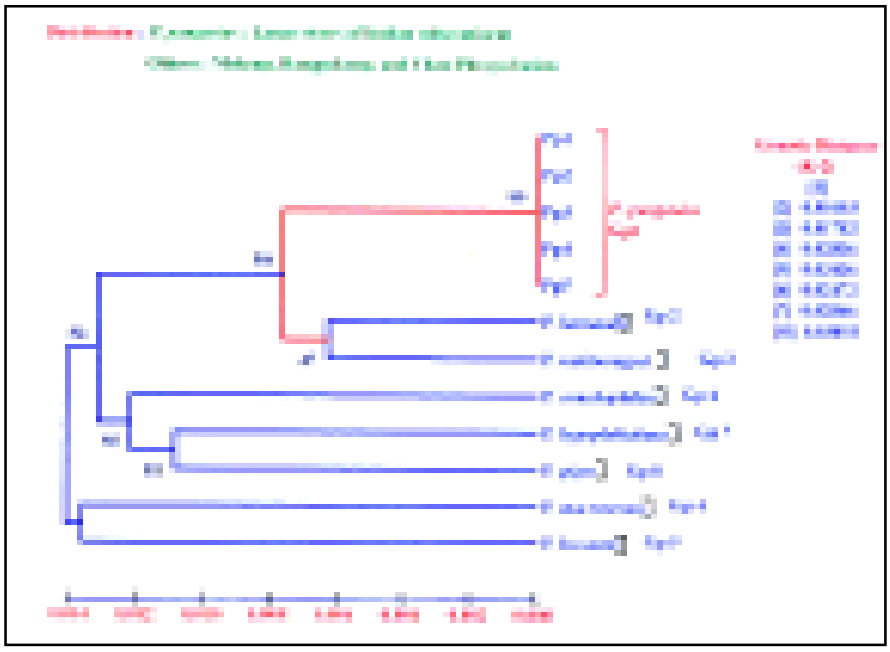


Fig. 6. Genetic relatedness of *P. pangasius* to other *Pangasius* species (based on 16s rRNA sequences)

bases 52 (C/A), 90 (A/G) and 116 (T/G). The mitochondrial sequences of *P. pangasius* were analysed with other species of *Pangasius* from Mekong, Bangpakong and Chao Phraya basins (reported in literature). It was found that Indian species, *P. pangasius*, is closer to *P. larnaudii* and *P. sanitwongsei* than other species (Fig. 6).

Genetic diversity analysis of edible mussels *Perna virdis* and *P. indica* through RAPD analysis

A parrot type of mussel is reported from Kollam coast of Kerala, whose morphotype is in between the two species of mussels (Fig. 7). The study was carried out to identify species-specific markers, as well as, to study whether this is a morphotype or a real hybrid. Green mussel, which has much wider distribution, was collected from Goa, Kerala (n=30), Chennai (n=30) and Visakhapatnam. Brown mussel, which has restricted distribution, was collected from Kollam (n=24) and Vizhinjam (n=30). Morphotypes (22 samples) were collected from Kollam coast of Kerala.

Genetic characterization of Green mussel *Perna viridis;* Brown mussel *P. indica* and its morphotype collected from Kerala was done using RAPD markers. The RAPD PCR conditions were optimised and 30 RAPD primers were screened which included OPAH (1-20) series and OPA (1-10) series. Among these, 15 primers that gave amplification included, OPAH-1, 3,4,5,6,8,12,14,15,19,20 and OPA-2, 8,13 and 19. Seven primers, OPAH-1, 3, 4, 5,6,12 and 19, which gave considerably good number of reproducible bands for all the individuals of different species, were selected for further screening (Fig. 7).

The amplification of the DNA from 15 individuals with above mentioned seven primers produced a total of 48 amplicons. The molecular weight of amplicons ranged from 500-3030 bp. Fragments AH03-3 and 6 were common to *Perna* spp. Fragments AH01-4; AH05-1, 2, 3; AH06-2, 5

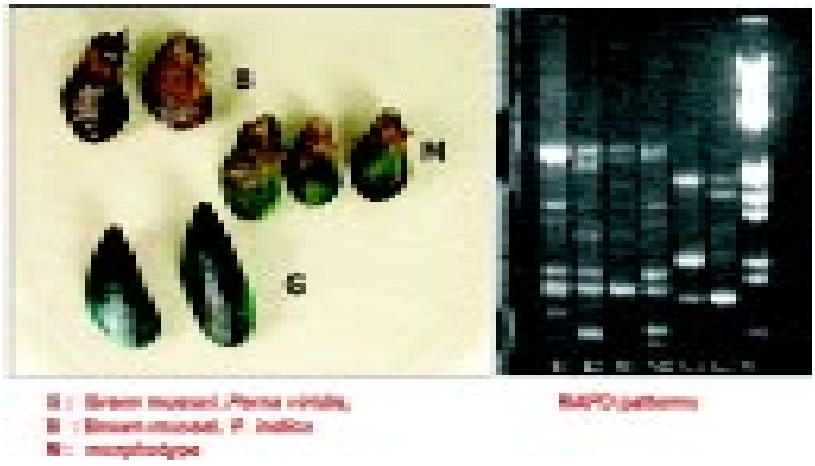


Fig. 7. Characterization of Green mussel *Perna viridis;* Brown mussel, *P. indica* and its morphotype

and AH12-1 were unique to brown and the morphotype reported. The results indicated that the parrot types may be the morphotype of the brown mussel. Further analysis of RAPD data is being carried out.

Genetic diversity analysis in natural population of *Labeo calbasu*

Labeo calbasu is widely distributed in commercial catches of the rivers Narmada, Godavari, Yamuna and Ganga. This fish is of interest for aqua-entrepreneurs due to its faster growth rate, high consumer preference and high market price. The blood samples of the *L. calbasu* were collected from commercial catches from the rivers, Godavari (n=16) and Bhagirathi (n=9). Totally 112 primers of *loci,* available for eight cyprinid species (resource species), were used for the cross priming tests in *L. calbasu*. Fourty six primer pairs exhibited amplification in *L. calbasu*. A total of 16 *loci* were found to be polymorphic. The mean numbers of alleles per *locus* in Godavari and Bhagirathi were 7.90 and 5.70, respectively. Expected heterozygosities ranged from 0.774 (Godavari) to 0.775 (Bhagirathi) and observed heterozygosities from 0.686 (Godavari) to 0.689 (Bhagirathi). No evidence of linkage disequilibrium was detected in any locus-pair comparisons. The results indicate that the identified microsatellite *loci* are useful in population structure analysis. The genotyping of more number of samples from different riverine sites is in progress.

Taxonomic validation and phylogeny of fishes under group Mahseer using moleculer markers

The phylogeny of Mahseer species, i.e. *Tor putitora, T. tor, T. khudree, T. mussallah* and *N. hexagonolepis* and one subspecies *T. mosal mahanadicus* from River Mahanadi (Orissa) were studied through mitochondrial DNA sequence markers, control region (d-loop) and cytochrome oxidase I region of mitochondria DNA using universal primers. Approximately, 450 and 650 base pair fragments were amplified respectively, and PCR products were purified and sequenced bi-directionally.

The PCR product of fragment of control (d-loop) region amplified was approximately 450 bp. After removing the tRNA Prosequences and alignment of sequences from all species under study, 327 bp were analysed. The average base composition was 32.8% thymine (T), 15.7% cytosine (C), 38.4% adenosine (A), and 13.1% guanine (G). Out of a total 327 sites, 88 sites were variable, 234 constants and 52 parsimony informative. The ratio of transition to transversions was found to be 1:2. The consensus tree with MP analysis revealed a similar topology to that of NJ tree. It is evident from both the analysis that there are two main clusters in the consensus trees; one containing *T. putitora* and *T. mahanadicus*; with *T. tor* and second includes *T. khudree* and *T. mussullah* (Fig. 8). The nodes in both the consensus trees, formed from NJ and MP methods, were supported by significant bootstrap values (>50%). The pair of *Tor putitora* with *T. mahanadicus* exhibited small distance value. The pair-wise distance between different species ranged from 0.0017 to 0.4688. Similar pattern of clustering and similarity among these species were also observed with RAPD markers. Analyses of COI sequences are being carried out.

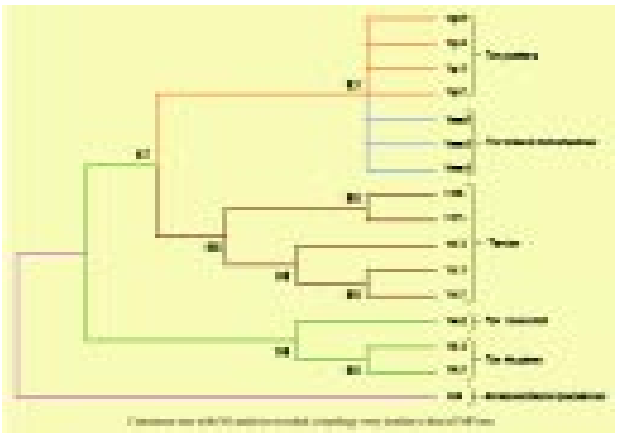


Fig. 8 Maximum-Parsimony bootstrap consensus tree showing relationship among *Tor* species inferred from D-loop region.

Genetic divergence studies in prioritised marine finfish and shellfish species

India has vast and diverse marine finfish and shellfish genetic resources. Documentation of genetic variation of this valuable fish fauna is a prioritized area of work for NBFGR. Genetic divergence studies in prioritized marine species, that were initiated last year, were continued during the year under report.

Bombay duck

'The Bombay-duck', *Harpadon (=Harpodon)* is an important fish for domestic use and also a valuable export item in dried or laminated form. Fresh extracts from Bombay duck is believed to have considerable medicinal properties. The fishery is supported by a single species *H. nehereus*, popularly known as Bombay duck in English. Bombay duck is an abundant species along the north-west coast of India contributing around ninety percent of all Indian landings of these resources followed by northeast coast. The population genetic structure of the stocks confined to north-east and north-west coast of India is unknown till date. In addition, occurrence of one more species *viz. H. squamosus* in the commercial landings in Visakhapatnam, also needs to be ratified using molecular markers. This study aims to address these issues.

During the period under report, sampling was done from *Dol* net catches at Mumbai (New Ferry Warf and Sasoon Dock). Truss landmarks were taken from a total of 101 fishes of length (Total length) range 170 –262 mm. Muscle, heart and fin clippings were collected from a total of 45 fishes for genetic analysis (total samples = 80 from the North-West coast). Samples of Bombay duck were also collected from Bag net operations (second sampling) in Kakdwip, West Bengal. A total of 121 specimens in the length range of 150 to 255 mm was collected for truss morphometric measurements. Tissue samples (Fin clippings, heart and muscle (n=30 each; total samples from the North East Coast of India = 60) were collected for genetic analysis. Genomic DNA, extracted by using the phenol-chloroform method and PCR, was carried out for 45 individuals from each coast with RAPD (7 primers selected after the initial screening of 25) and for 10 samples each using mtDNA (16SrRNA, CO I and Cyt-b and ATP Synthase -6) primers producing amplicons of ~ 700 and 650bp, respectively. Based on RAPD, the initial results indicated the overall G_{ST} of the two populations was 0.2194, with significantly high inter-population genetic difference (Student's t: t=59.2, P<0.01). Paired t test showed significantly lower (t=1.97, df =181, P<0.01) intra-population GD values (mean=0.32) compared to inter-population GD values (number of pair-wise comparisons=182, mean=0.45). In order to establish them as two distinct genetic stocks, more RAPD primers will be screened and mt DNA PCR (fast evolving ATP Synthase 6 partial sequence information) /microsatellite analysis will be done on more DNA samples from both locations (each stock ~ 100 samples). A perusal of the canonical scores based on standardized Discriminant Function Analysis (DFA) indicated clear-cut differences in shape between populations (Fig. 9)

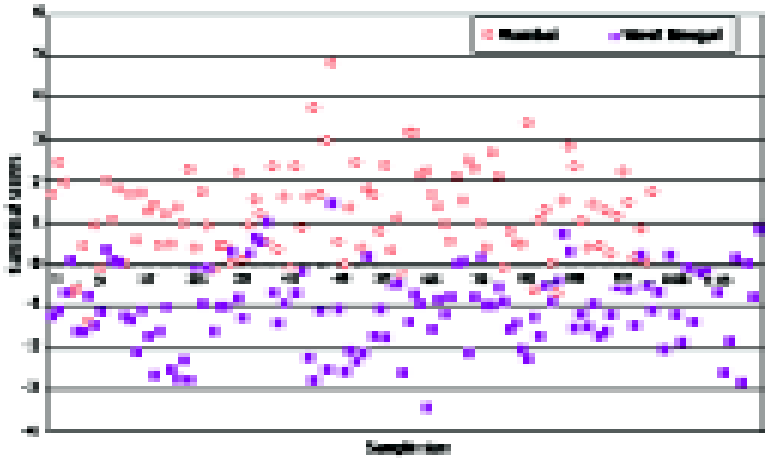


Fig. 9. Canonical scores based on standardized Discriminant Function Analysis of body measurements of Bombay duck from North East and North West coasts of India.

that are due mainly to the distance measurements in the posterior region of fish body behind the dorsal fin. To confirm the occurrence of morphological heterogeneity, in-depth DFA with more samples will be carried out.

Lobsters

Lobsters are among the most valuable and highly priced seafoods. In India, though the lobsters form only 0.12 ± 0.06% of total marine landings, they form an important export commodity. Heavy demand and attractive price for lobsters in the international market has resulted in increased exploitation of lobsters in recent years. The genetic diversity of the lobster species from Indian waters is yet to be understood. In addition there are reports of occurrence of 3 sub-species of *P. homarus* namely, *P. homarus homarus, P. homarus rubellus* and *P. homarus megasculptus* from Indian waters, which also needs to be confirmed using molecular markers.

During the year under report, samples of *Panulirus homarus* (sub-species: *P. homarus homarus* (?) from Kollam, Kerala – 65 nos.; sub-species: *P. homarus megasculptus* (?) from Chennai, Tamil Nadu – 55 nos.), *P. polyphagus* (60 nos. from Veraval), *P. ornatus* (6 nos. from Chennai, Tamil Nadu), *P. versicolor* (5 nos. from Chennai, Tamil Nadu), *Petrarchus rugosus* (4 nos. from Coromandal Coast) and *Thenus orientalis* (Fig. 10) (Kerala Coast 73 nos.; Chennai Coast 45 nos. and from Veraval, 10 nos.) were collected for genetic analysis. Primers for 21 polymorphic microsatellite *loci* were identified from other palinurid species leading to successful amplification by cross priming and amplification in *P. homarus* and *T. orientalis* by slightly altering the primer annealing temperature in the recipient species (7 tri nucleotide repeats; 14 tetra nucleotide repeats). All these 21 polymorphic microsatellite *loci* generated 4 – 7 alleles in the initial screening and these are now used to score genetic differences in these two species of lobsters. With a view to score differences at species level, partial gene sequencing of 16SrRNA, Cyt – b and COI genes

Fig. 10. ***Thenus orientalis***

was also carried out in the 6 species using the universal primers and the sequences generated.

Genetic characterization of *Trichodesmium* spp. from Indian waters

Trichodesmium spp. are a group of globally significant, most widespread and abundant marine cyanobacteria and are believed to be of important source of fixed nitrogen in open oceans. Taxonomic ambiguity exists in *Trichodesmium* species. One of the five species of *Trichodesmium, T. thiebautii* is reported to secrete toxin similar to paralytic shellfish poison (PSP). There is no information on the species diversity of *Trichodesmium* in Indian waters. Hence, occurrence of this species in Indian coast needs to be examined. Therefore, work on genetic characterization of the harmful cyanobacteria *Trichodesmium* spp. from Indian waters has been undertaken, using molecular markers and Scanning Electron Microscopy (SEM).

Development of species - specific molecular markers in *Trichodesmium* spp.

Sequence information of genes such as 16SrRNA, regulatory gene – *het R* and Internal Transcribed Spacers (ITS) region are reported to be species-specific in various cyanobacterial species. Experiments were done to amplify and generate sequence information of these genes to

examine whether the genetic divergence levels were adequate to identify different species of *Trichodesmium*. In order to amplify above genes in *Trichodesmium* spp., primers for these genes were identified from different cyanobacteria and cross-priming was attempted in both the species. Successful amplification was achieved with all the primer-pairs (Fig. 11).

Fig.11. PCR amplified products of different genes of *Trichodesmium erythraeum* and *T. thiebautii*

(From left: lanes 1 & 2 – amplified *het R* gene using primers of Orcutt *et al*., 2002; lanes 4 & 5 – amplified ITS region using primers of Janson *et al*., 1999; lanes 7 & 8 – amplified 16S region using primers of Nubel *et al*., 1997; lanes 10 & 11 – amplified 16S region using primers of Stiller and McClanahan, 2005; lane 12 – 100bp molecular weight ladder).

Genetic divergence between *T. erythraeum* (Te) and *T. thiebautii* (Tt) based on sequence information of *hetR* partial cds; ITS & 16S rRNA partial sequence

The PCR products were sequenced and partial sequence information of all the 3 genes and genetic divergence values allowed the two *Trichodesmium* species to be distinguished accurately (Table 8**).**

Table 8. Genetic divergence between *T. erythraeum* (Te) and *T. thiebautii* (Tt) calculated based on sequence information of *hetR* partial sequence; ITS (16S-23S intergenic spacer); and16S ribosomal RNA gene (partial sequence).

***hetR* (partial sequence)**	**Te**	**Tt**
Te	----	0.1089
Tt	0.1089	----
ITS (16S-23S intergenic spacer)		
Te	----	0.1165
Tt	0.1165	----
16S ribosomal RNA gene (partial sequence)		
Te	----	0.0234
Tt	0.0234	----

Identification of *Trichodesmium* samples collected from Indian coasts

The samples collected from Indian seas (Andaman waters, Indian Ocean, Wadge Bank and Vizhinjam Coast) were found to be *T. erythraeum* based on partial sequence information of above mentioned 3 genes.

Development of Fluorescence *in situ* hybridization probes

Amplification of ribosomal DNA (rDNA) in *Pristolepis* spp.

The ribosomal regions of genomic DNA of *P. marginata* and *P. fasciatus* were amplified using appropriate primers. In both the *Pristolepis* species, amplifications for ITS 1 and IGS regions were obtained with annealing temperatures of 55.8^0 and $60.7\ ^0$C, respectively. After electrophoresis of the DNA on agarsoe gels, variation in size of amplicons was observed, which could be due to variation in rDNA sequences between the two species (Fig. 12).

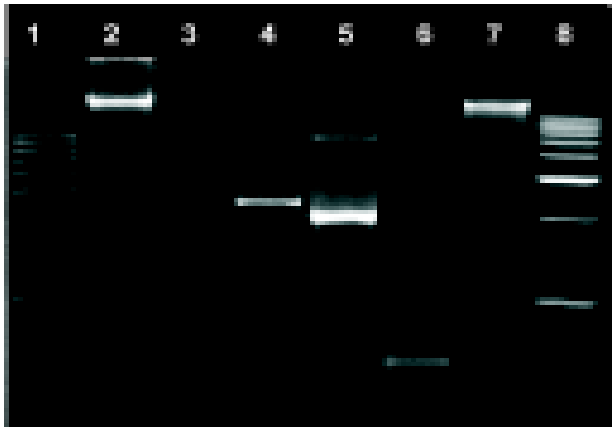


Fig. 12. Amplification of ITS 1 and IGS region in *Pristolepis* spp.

Lane 1: 500 bp DNA marker; Lane 2: *P. marginata* genomic DNA; Lane 3: *P. marginata* ITS 1; Lane 4: *P. marginata* IGS; Lane 5: *P. fasciatus* IGS; Lane 6: *P. fasciatus* ITS 1; Lane 7: *P. fasciatus* genomic DNA; Lane 8: 1 kb DNA marker.

Amplification of rDNA in *Labeo* spp.

Studies were undertaken to investigate genetic variation, among *L. bata, L. calbasu, L. dyocheilus, L. rohita* and a new putative species *L. rosius* with respect to different regions of rDNA. Appropriate primers were custom synthesized for amplification of ITS1, IGS and 28S RNA gene. A variation in the size of amplicons was observed with ITS 1 rDNA primer. In *L. bata*, sequencing of the amplified fragment confirmed its size to be 536 bp that included 152 bp of 18S, 354 bp of ITS 1 and 30 bp of 5.8 S regions (Fig. 13). Similarly, information was also generated with the use of other rDNA primers.

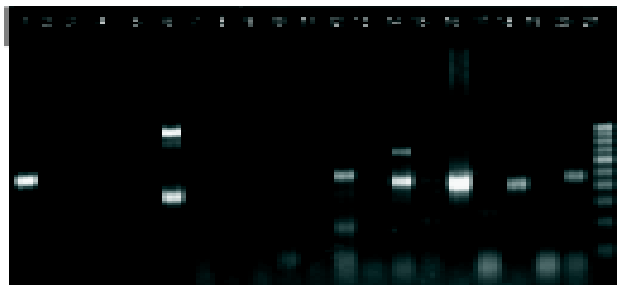


Fig. 13: Amplification of rDNA sequences in *Labeo* spp.

Lane 1-5= amplified ITS 1 region; Lane 6-10= domains of 28S region; Lane 11-15= IGS region; Lane 16-20= ITS 1 region.Lane 1, 6, 11, 16=*L. bata*; Lane 2, 7, 12, 17= *L. calbasu*; Lane 3, 8, 13, 18= *L. dyocheilu* ; Lane 4, 9, 14, 19= *L. rohita* ; Lane 5, 10, 15, 20= *L. rosius*; Lane 21= 100 bp DNA marker.

Labeling of ribosomal DNA with fluorescent tags

Studies were initiated to label the ITS 1 region of rDNA in *L. bata* using both polymerase chain reaction (PCR) as well as nick translation (NT). The amplified product was resolved on 1.4% agarose gel (Fig. 14). The labeled product was purified, precipitated with ethanol for its use as a probe for fluorescence *in situ* hybridization (FISH). In nick translation, 10X NT buffer (Tris-Cl, pH 8.0, $MgCl_2$, BSA, b-mercaptoethanol) dNTP mix and DNAse were initially prepared for setting up of the reaction. DNA polymerase I and DNAse (0.001U/µl) was added to the reaction and the mixture was then incubated at 15^{0}C for 2 hr. for nicking and addition of labeled nucleotides.

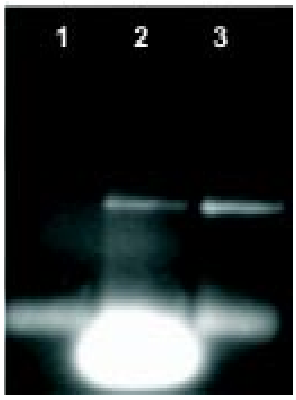


Fig. 14: Labeling of ITS 1 fragment of *L. bata* by PCR.

Lane 1= with dNTP set; Lane 2= with labeled dUTP and dNTP set; Lane 3= with dNTP mix.

Utilization of labeled probes for *in situ* hybridization

Trials were undertaken to hybridize the labeled probe ITS1 with *L. bata* chromosomes. The protocol involved preparation of solutions like protease buffer, phosphate buffered saline (PBS), 1% formaldehyde, 70%, 85% and 100% ethanol, 70% formamide, post hybridization buffer 1 (2X SSC/ 0.1% NP-40) post hybridization buffer 2 (0.4X SSC/ 0.3% NP-40), 20X SSC, probe mixture. Metaphase spreads were prepared on glass slides and 'FISH' was carried out as per protocol standardized in Cytogenetic laboratory of NBFGR. The slides were screened under microscope and weak and diffuse hybridization signals were observed.

AFLP studies in *Pristolepis fasciatus*

Amplified Fragment Length Polymorphism (AFLP) is one of the important molecular tools

for characterization of fish species. *P. fasciatus* (Bleeker) species inhabits west flowing rivers of South Kerala. It has a good market value as an ornamental fish. The studies were undertaken in *P. fasciatus* (Bleeker) using commercially available AFLP kit. The primer combinations for AFLP fingerprint were E -ACG/ M-CAA, E-ACG/ ACA/ M -CAC, E -ACG/ACA/ M -CAG, E-ACA/ACG/ M -CAT, E -ACG/ACA/ACC/ M -CTA, E -ACA/ M -CTG and E -ACG/ACT/ M -CAC. Amplification products were generated in the size range of 38 to 398 base pairs. A total of 81 bands were scored with primer combination E-ACA + M-CAC and 53 bands were scored with primer combination E -ACA + M-CTG. The polymorphism was observed with primer combination E -ACG/ M-CAA, E -ACG/ACA/ M -CAC, E -ACG/ACA/ M -CAG, E -ACA/ ACG/ M -CAT, E -ACG/ACA/ACC/ M -CTA, E -ACA/ M -CTG and E -ACG/ACT/ M -CAC were 65.3%, 72.7%, 81.25%, 77.2%, 83.2%, 91.3% and 65.2%, respectively. The maximum polymorphism was observed by E -ACA/ M -CTG primer combination.

A total of 88 unique bands were observed in primer combination E -ACA/M -CTA that were used for identification of species. Thus, AFLP markers can serve as a useful tool in species-specific fingerprinting and biodiversity analysis for the management of this species.

Cytogenetic characterization of fish species from North-Eastern region

Cytogenetic studies were carried out in eight fish species, namely *Anabas testudineus, Colisa fasciatus, Osteobrama belangeri, Channa orientalis, C. punctatus, C. striatus, Rasbora rasbora* and *Clarias batrachus* collected from Manipur State.

Anabas testudineus (Bloch, 1792)

In *A. testudineus* (Bloch, 1792), popularly known as 'climbing perch', the diploid chromosome number was found to be 46. Based on the morphology, the karyotype formula was derived as 2m+ 6sm+6st+32t (FN= 54). Both silver and CMA_3 staining revealed presence of NORs on single pair of submetacentric chromosome. The C-bands were present on several chromosomes. The C-bands present on 1st sub -metacentric chromosome was flanked with the Ag-NOR site (Fig. 15).

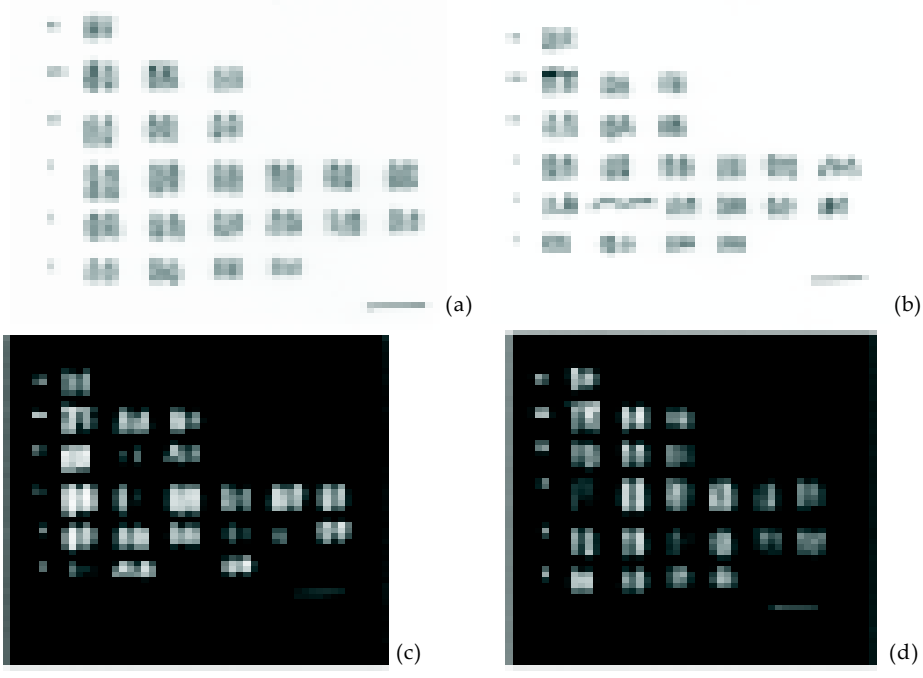
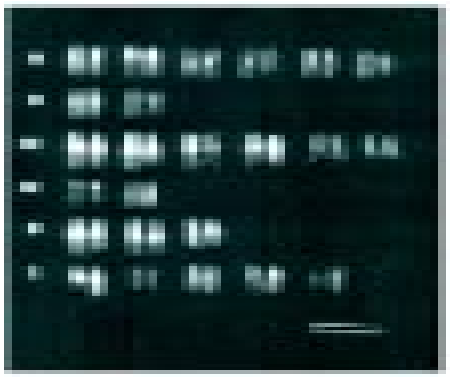


Fig. 15. Karyotypes of *Anabas testudineus* showing: (a) Giemsa staining, (b) Ag-NOR staining, (c) CMA_3 staining, and (d) C-bands.

Colisa fasciatus (Bloch & Scjneider, 1801)

Colisa fasciatus (Bloch & Scjneider, 1801), also known as 'banded gourami', was found to possess a diploid chromosome number (2N) of 48. The karyotype formula was derived as 16m+ 16sm+6st+10t (FN= 80). Silver staining revealed presence of NORs on 2 pairs of chromosome. However, the same were observed on 3 pairs of chromosomes by CMA3 staining. The C-bands were present on all the chromosomes with prominent bands on pericentromeric region of 2nd metacentric; 1st, 2nd and 4th sub-metacentric and 1st, 2nd sub-telocentric chromosomes (Fig. 16).

(a)

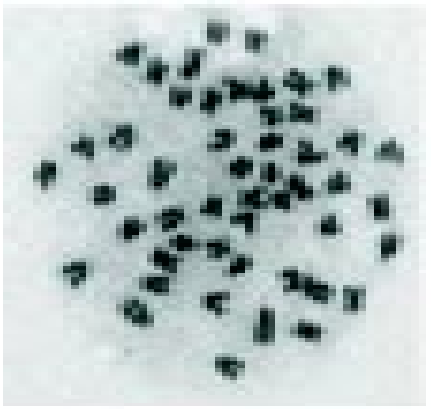


(b)

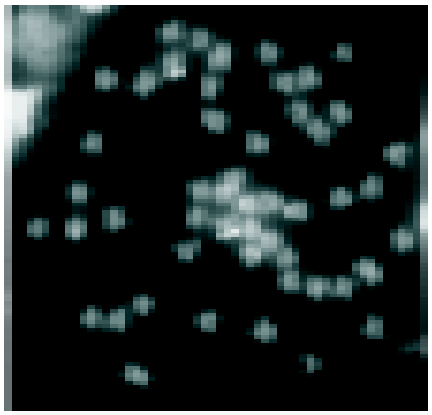
Fig. 16. Karyotypes of *Colisa fasciatus* showing (a) Giemsa staining, (b) C-bands

Osteobrama belangeri (Valenciennes, 1844)

The *O. belangeri* (Valenciennes, 1844) is a benthopelagic fish, inhabiting freshwater and occurs in rivers and lakes and attains maximum standard length of 38 cm. The species was found to possess diploid chromosome numbers of 50.



(a)



b)

Fig.17. Chromosomes of *Osteobrama belangeri* showing (a) Giemsa staining (b) CMA_3 stained NORs

Both silver and CMA_3 staining of the chromosome revealed the presence of NORs on single pair of submetacentric chromosome, whereas, the C-bands were present on many chromosomes (Fig. 17).

Channa orientalis (Bloch and Schneider, 1801)

Channa orientalis (Bloch and Schneider, 1801), popularly known as 'walking snakehead' is a broadly adapted species occurring in rivers, lakes, ponds, mountain streams and even brackish water. It can tolerate very stagnant, poorly oxygenated, turbid and very foul water.

The diploid chromosome number in this species was found to be 52. Both silver staining and banding and CMA_3 staining revealed presence of NORs on one pair of chromosomes whereas C-bands were observed on almost all chromosomes (Fig. 18).

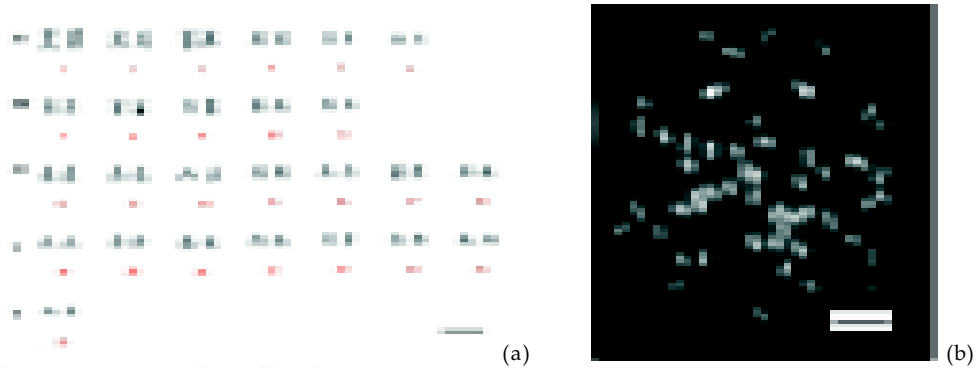


Fig. 18. Chromosomes of *Channa orientalis,* (a) Karyotype, (b) C-bands

Channa punctatus (Bloch, 1793)

In *Channa punctatus* (Bloch, 1793), known as 'spotted snakehead', the diploid chromosome number was found to be 32. The silver staining revealed presence of prominent NORs on single pair of metacentric chromosome and a pair of less prominent small NOR on another chromosome, whereas CMA_3 staining revealed presence of NORs on 4 pairs of chromosomes. The C-banding revealed presence of prominent C-bands on 7 pairs of chromosomes (Fig. 19).

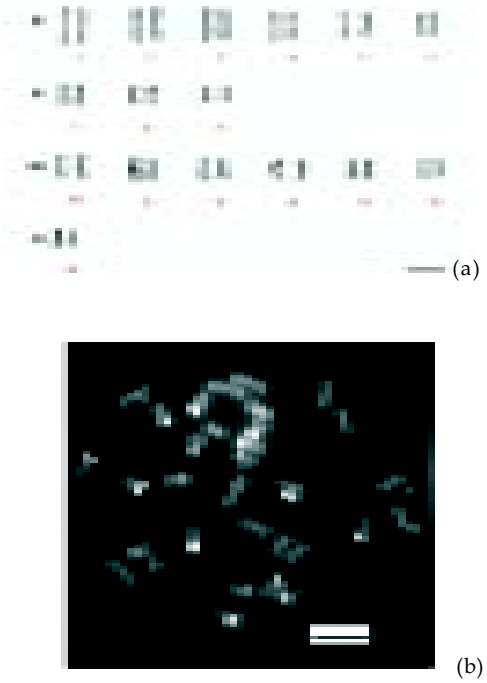


Fig.19. Chromosomes of *Channa punctatus,* (a) Karyotype, (b) C-bands.

Channa striatus (Bloch, 1793)

The diploid chromosome number (2N) in *Channa striatus* (Bloch, 1793) was found to be 40. The silver staining revealed presence of NORs on 2 pairs of chromosome whereas CMA_3 revealed presence on 3 pairs of chromosomes. The C-banding revealed presence of C-bands on many pairs including 4 pairs were prominent centromeric C-bands. (Fig. 20).

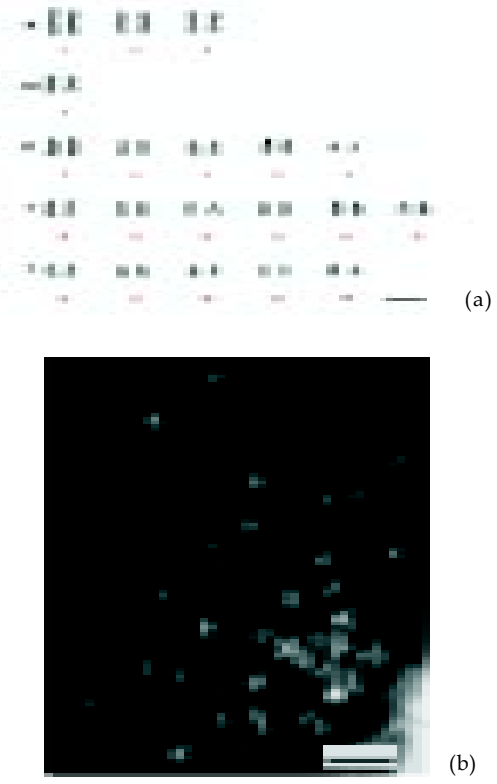


Fig. 20. Cytogenetic studies of *Channa striatus,*(a) Karyotype, (b) C-bands

Rasbora rasbora (Hamilton, 1822)

Rasbora rasbora (Hamilton, 1822) is an important aquarium fish species. In *R. rasbora,* the diploid chromosome number was found to be 48. The CMA_3 revealed presence of NORs on 6 pairs of chromosomes (Fig. 21).

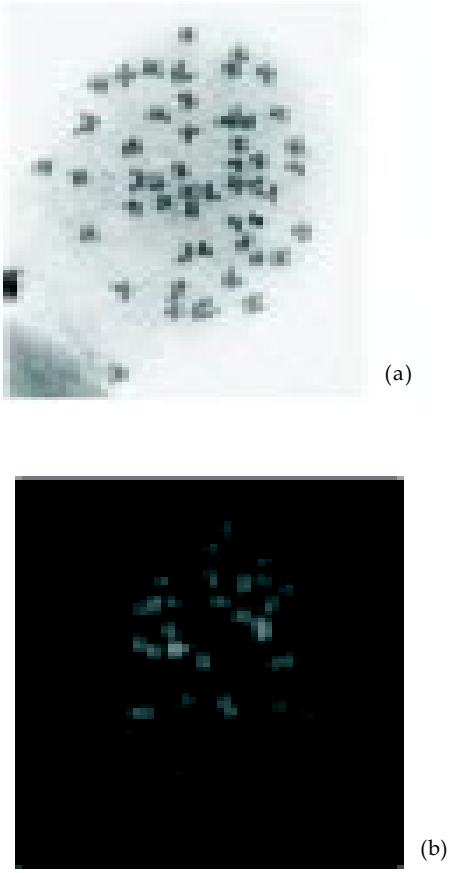


Fig. 21. Chromosomes of *R. rasbora,* (a) Giemsa staining, (b) CMA_3 stained NORs

Clarias batrachus (Linnaeus, 1758)

Clarias batrachus (Linnaeus, 1758), an important air-breathing catfish possessed diploid chromosome number of 50. The CMA_3 staining revealed presence of NORs on 7 pairs of chromosomes. The C-bands were present on several chromosomes (Fig. 22).

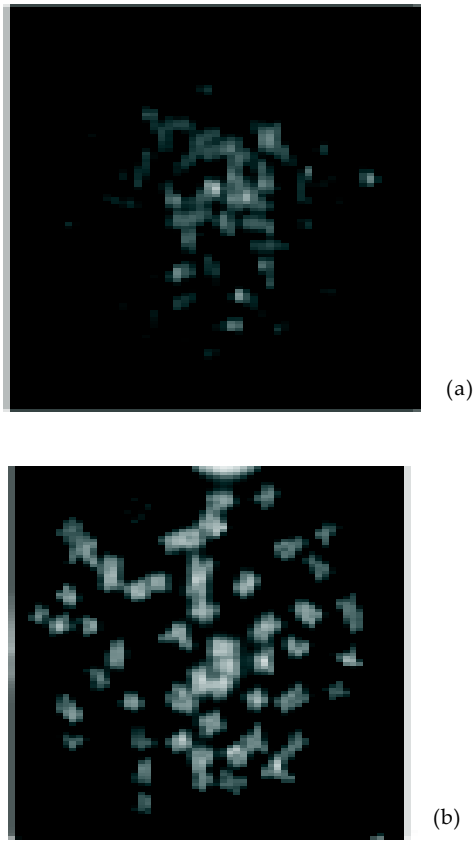


Fig. 22. Chromosomes of *C. batrachus* showing (a). C-bands (b) CMA_3 stained NORs

Comparative RAPD profiling in *Labeo* species

RAPD studies were carried out to investigate genetic variation among *L. rohita*, *L. calbasu* and a new putative species *L. rosius,* since all these species belong to *Fimbriatus* group of *Labeo* genus. Twenty OPAS (1 to 20) primers were used for RAPD studies using annealing temperature of 36^0C for DNA amplification. The RAPD band pattern obtained in *L. rohita* was almost similar to that of *L. rosius* except for OPAS 10, 13, 14 and 15 (Fig. 23). Ironically, the RAPD pattern for *L. calbasu* was entirely different from *L. rohita* and *L. rosius* indicating *L. calbasu* to be a genetically distinct species than *L. rohita* (Fig.24).

Fig. 23. Amplification in three *Labeo* spp. with OPAS 11 to 15 RAPD primers.

Lane 1-3= OPAS 11; Lane 4-6= OPAS 12; Lane 7-9= OPAS 13; Lane 10= 100 bp DNA marker; Lane 11-13= OPAS 14; Lane 14-16= OPAS 15; Lane 1, 4, 7, 11, 14= *L. rohita*; Lane 2, 5, 8, 12, 15= new putative sp. *(L. rosius)*; Lane 3, 6, 9, 13, 16= *L. calbasu*.

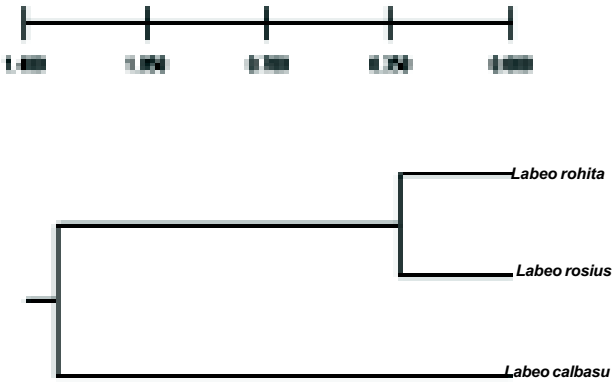


Fig. 24. Phenogram depicting Nei's genetic distance among three *Labeo* spp.

Genotoxicity studies

Genotoxicity assessment of heavy metals Arsenic trioxide and Chromium nitrate

Arsenic trioxide is mainly used in the insecticides, glass industry and pharmaceuticals whereas Chromium nitrate is commonly used in the leather industry. Both these chemicals with heavy metals are present in the industrial effluents released into natural water bodies and can pose risks to aquatic organisms living therein. The acute toxicity of these heavy metals were found to be moderate to low with 96-h LC_{50} values of 94 ppm and 740 ppm, respectively. The genotoxicity of these heavy metals were assessed in freshwater murrel, *C. punctatus* by single cell gel electrophoresis or comet assay and micronuclei test (MNT) following *in vivo* exposure to 5%, 10%, 20% and 40% concentrations of 96-h LC_{50} values. The blood samples and gill tissues from the exposed specimens were collected at different time intervals for comet assay and MNT. It was found that both the heavy metals induced DNA damage in the tissues of *C. punctatus* (Fig. 25). The heavy metals also induced higher number of micronuclei formation that indicated clastogenic effect of these chemicals (Fig. 26).

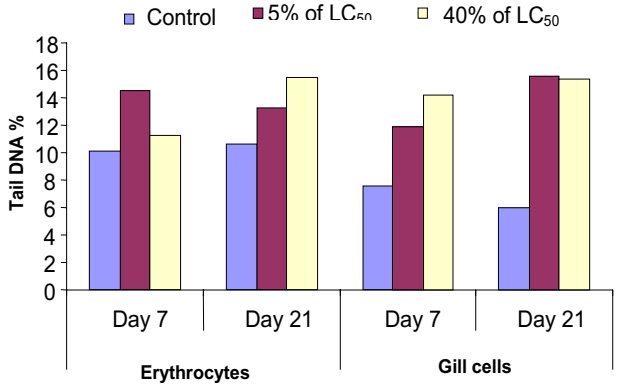


Fig. 25. DNA damage induced by Chromium Nitrate in blood and gill cells of *C. punctatus*.

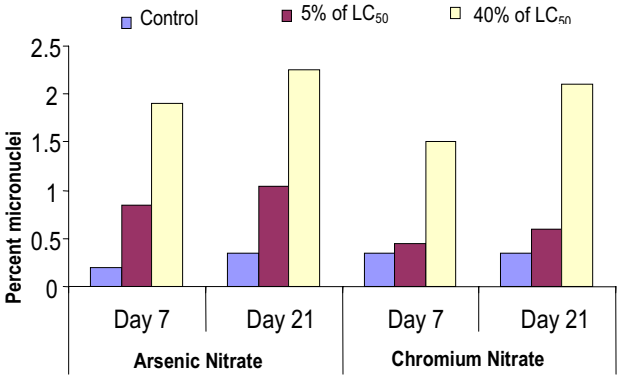


Fig. 26. Frequency of micronuclei in erythrocytes of *C. punctatus* exposed to heavy metals.

Genotoxicity effects of Chlorpyrifos

Chlorpyrifos is an organophosphate insecticide, widely used to control agricultural pests. Limited information is available about its genotoxic effects and hence, studies were undertaken to assess genotoxicity of this pesticide in freshwater murrel, *C. punctatus* using comet assay and MNT. In the beginning, acute toxicity bioassay experiments were conducted using a static system. A dose and time dependent increase in mortality rate was observed in fish specimens. The exposed fish specimens exhibited abnormal behaviour such as erratic swimming, secretion of copious amounts of mucus from whole body, loss of balance followed by loss of consciousness. The 96-h LC_{50} value for this species was determined to be 811.98 ppb, which indicated that chlorpyrifos is highly toxic to fishes and its presence in water bodies can pose threat to a wide range of aquatic fauna. Based on 96-h LC_{50} value, the safe levels of this pesticide were estimated using standard application factors. The fish specimens were exposed *in vivo* to two sub-lethal concentrations ($1/8^{th}$ and $1/12^{th}$ of 96-h LC_{50} value) of chlorpyrifos. The preliminary findings indicated that chlorpyrifos induced higher DNA damage in lymphocytes and gills in exposed specimens than that of the control (Fig.27 & 28). A higher number of micronuclei was observed (Fig. 29) in the erythrocytes of exposed specimens. The results of both the assays indicated that the pesticide can induce DNA damage in fishes.

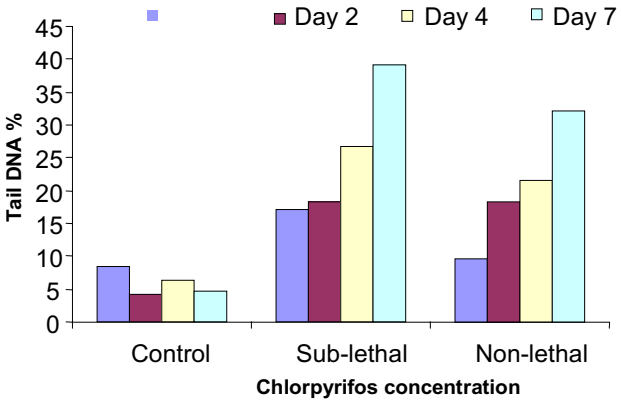


Fig. 27. Tail DNA % in gill cells of *C. punctatus* following chlorpyrifos exposure

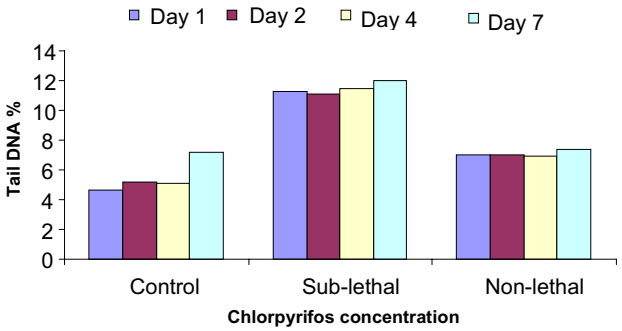


Fig. 28. Tail DNA % in lymphocytes of *C. punctatus* following chlorpyrifos exposure

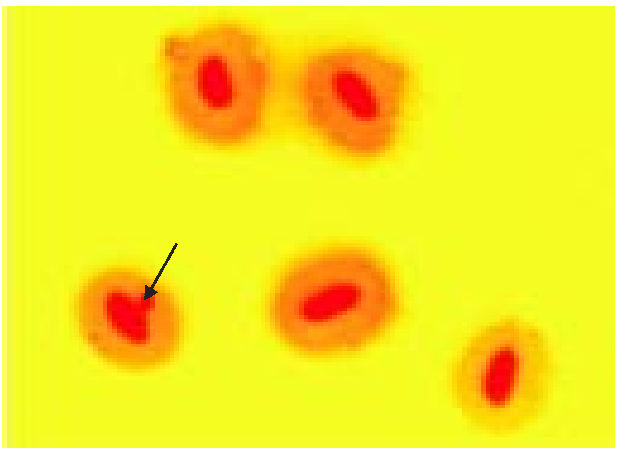


Fig. 29. Micronucleus formation (arrow) in erythrocytes of *C. punctatus*

Detection of DNA damage in fish milt

DNA damage in milt, especially in brood fish, can affect the fertility, hatchability and genetic integrity in fishes. Comet assay can be used to assess DNA damage in the sperm cells caused by pollutants, as well as, due to cryoprotectants. With a view to develop the methodology, experiments were initiated to study genotoxicity in milt collected from *L. rohita* and *C. mrigala* after exposing to a known DNA damage causing agent (positive control :100µM H_2O_2) using both neutral and alkaline versions of comet assay. In treated sperms, DNA damage was observed, while the untreated sperms were intact with less damage (Fig. 30). Thus, the technique was found to be

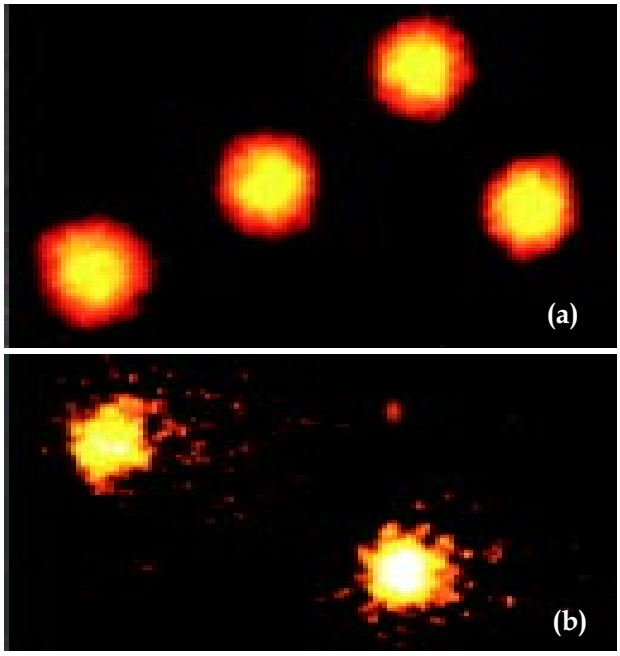


Fig. 30. Comet assay of *L. rohita* sperm cells: (a) control sperm cells, and (b) treated sperm cells showing DNA damage

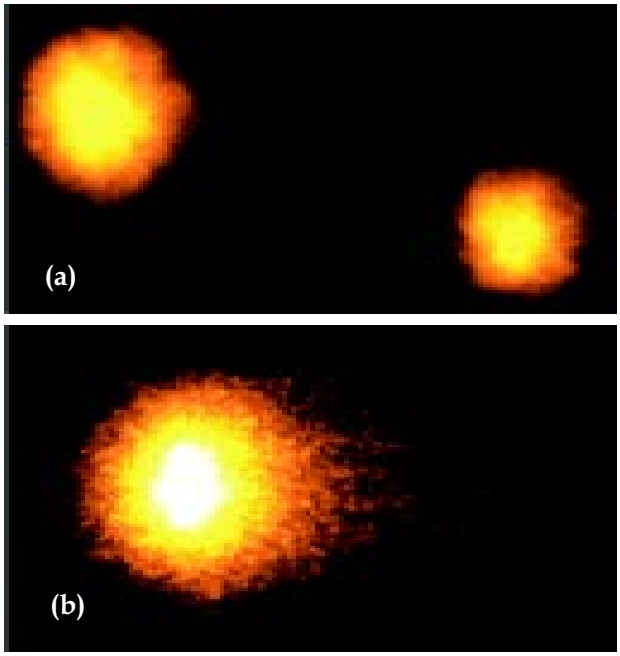


Fig. 31. Neutral comet assay of *C. punctatus* lymphocytes (a) Control, and (b) comet tail in treated lymphocytes

highly useful for assessment of quality of fish sperms especially those used for high quality seed production and selection of non- genotoxic cryoprotectant.

Neutral comet assay on fish lymphocytes

Neutral comet assay detects double stranded DNA breakages and thus, can be used for the assessment of DNA integrity in aquatic organisms exposed to a variety of environmental genotoxicants. The neutral version of comet assay is also considered to be more informative than alkaline version since, the alkaline labile sites are not expressed under neutral pH. In view of the above, trials were undertaken for utilization of neutral comet assay in fishes. The lymphocytes of *C. punctatus* were first separated by density centrifugation method and were lysed in a buffer containing 2.5M NaCl, 100mM EDTA, 10mM Tris-HCl, 5% Triton X and 10% DMSO, followed by neutralization in a solution containing 40mM Tris-HCl and l mg/ml spermine. It was observed that the comet tails were formed in treated cells (positive control; 100µM H_2O_2) whereas, untreated cells (negative control) were intact (Fig. 31). Thus, neutral comet assay can be also used as an additional biomarker for genotoxicity assessment in fishes.

5.3 *In situ* Conservation

Assessment of fish diversity and habitat in the selected stretch of river Ganga and development of a conservation model using GIS tools

One of the important components of NBFGR's mandate is developing strategies for *in-situ* conservation of native fish diversity. The detailed scientific information on the fish diversity, assemblage, occurrence and distribution along with fish habitat of the target area, are essential for undertaking conservation programme in any water body. It is reported that protected areas have the potential to be effective conservation and management tools in the protection of endangered species and habitats and safeguarding of natural freshwater ecosystem services. Interest in this direction has been growing among both the scientific community and conservation

organizations. Therefore, studies were conducted in the selected stretches of river Ganga to investigate the fish species occurrence, distribution, diversity, life history traits and aquatic habitat parameters using geographical information system tools.

Preparation of fish habitat map and arrangement of fish occurrence data

Data collected on different habitat parameters like, pH, transparency, turbidity, conductivity, TDS and DO from identified sites of the study area using Global positioning System (GPS) were arranged as point data on the extracted satellite image of the river. The fish occurrence data of the study area of river Ganga on raw image were arranged (Fig. 32). Point vector files were created for depth - wise data on fish occurrence collected through NOVMAN fish finder and GPS for monsoon and premonsoon seasons. A point vector file was created for the data on early life stages of fishes collected through GPS from different shallow areas of the river and was arranged on the classified fish occurrence map. The fish occurrence map provides information on the availability of the species with other habitat information.

Fish species diversity, abundance and richness

Based on seasonal sampling of river Ganga from Allahabad to Varanasi, a total of 60 species of fishes, belonging to 40 genera of 21 families under 6 orders, were identified (Fig. 33). The family Cyprinidae (40%) was the most dominant group followed by family Bagridae (10%) Sisoridae (5%) and Channidae (5%) (Fig. 34). The relative abundance (RA) data of the fishes showed (Table 9) higher values for some less important resident species except *E. vacha* at Allahabad site. Among exotics, *Cyprinus carpio* showed medium range of RA (2.5- 5.0%) in all the sites except Allahabad stretch, where the RA was below 1%. However, the RA of another exotic *O. mossambicus* was low (>1%) throughout the study area, except the area under the turtle sanctuary. Occurrence

Classified map of the study area showing the fish occurence points

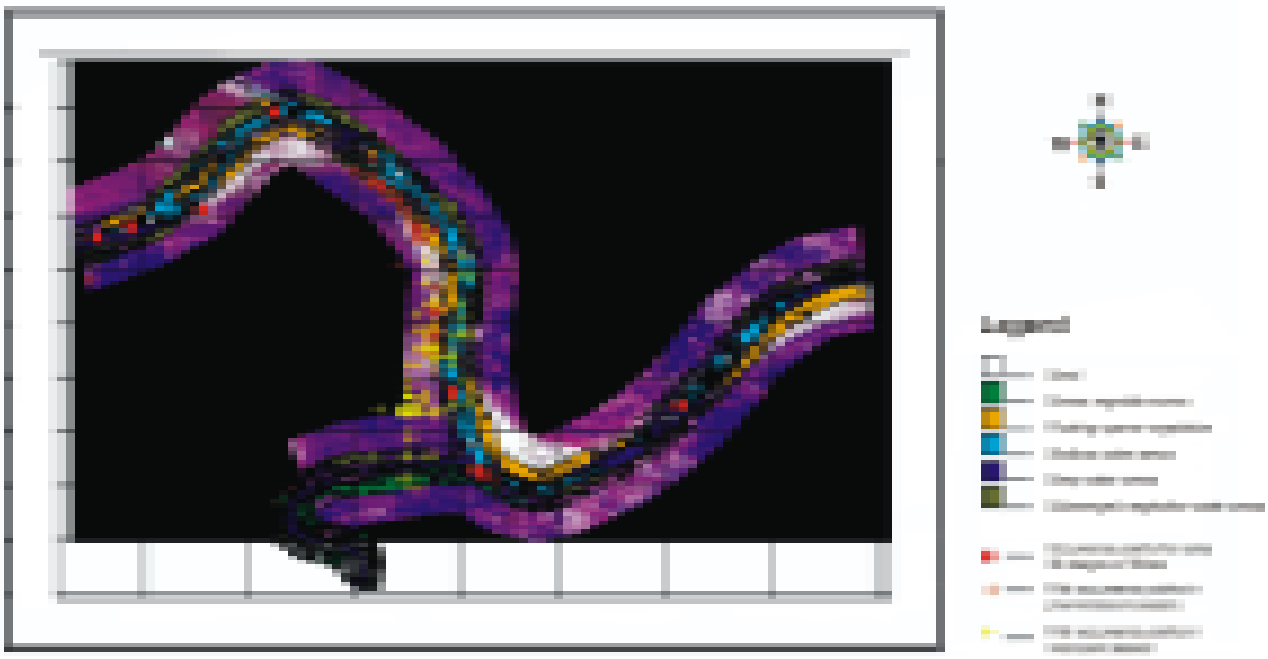


Fig. 32. Classified map of the study area indicating fish occurrence points in river Ganga

Johnius coiter

Gagata cenia, Glossogobius giuris,

Puntius sarana

Fig. 33. A few indigenous fish species collected from river Ganga

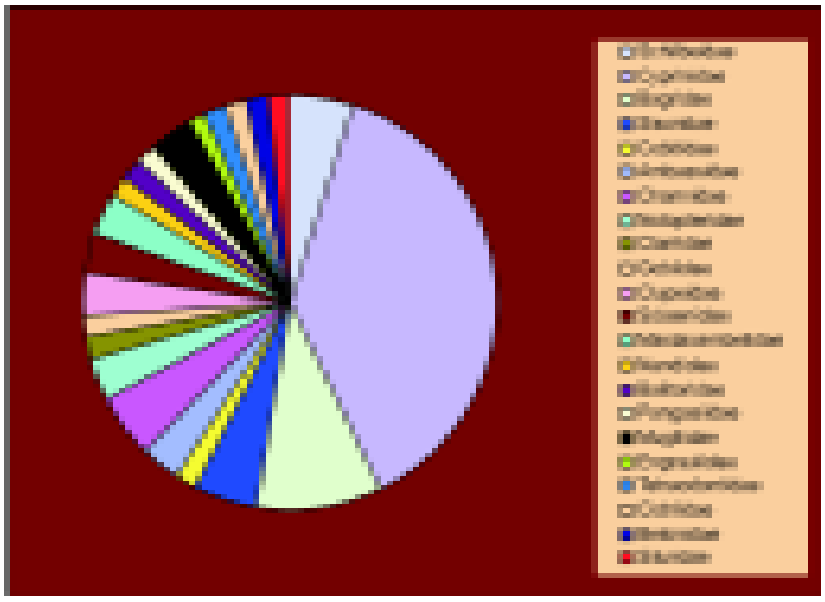


Fig.34.Taxonomic Composition (%) of fishes in selected areas of river Ganga

of fish species of high conservation importance, like *Macrognathus aral* (n =21), *Bagarius bagarius* (n=56), *Pangasius pangasius*, *Chitala chitala* in the study area of Varanasi indicates significance of protected habitat in conserving Gangetic fish diversity.

The Shannon-Weaver index was computed ($H= -\Sigma (n_i / N) \log_2 (n_i/N)$ where n_i= total number of individuals of a species; N= total number of individuals of all species) for all the sampling sites seasonally, which showed comparatively higher values in the protected areas during monsoon, indicating some effect of protected areas in the Varanasi stretch. Comparative analysis of average size range distribution of some of the selected fish in both the study area indicated little variation in total length (TL) within protected area and unprotected area, except for *A. aor, B. bagarius*, *C. garua, E. vacha* and *M. armatus*.

Fish species diversity and richness in the river Tones

A total of 48 fish species belonging to 30 genera of 18 families under 7 orders were recorded in the river Tones. The family Cyprinidae was the most dominant group followed by Bagridae, Channidae and Schilbeidae. The relative abundance and distribution of 48 species have been worked out. The data indicated lower value for commercially important and threatened species, whereas, less important species were showing high relative abundance (Table 10). The overall species RA was higher (7-16%) for *Salmostoma bacaila* and *Puntius ticto* followed by medium range (4-7%) of RA for seven species, namely, *Chela laubuca, Clupisoma garua, Gonialosa manmina, Barilius barila, P. sophore, Nemacheilus botia and Osteobrama cotio*. Comparative analysis of average size distribution of some of the selected fish did not indicate much variation in total length, in different sites except for *A. aor.*

Table 9. Mean relative abundance of selected fish species in the study area of river Ganga.

Relative abundance range (%)	Varanasi stretch		Allahabad stretch
	Protected area	Unprotected area	
10-20	*Gudusia chapra, Puntius ticto*	*Gudusia chapra,*	*Gonialosa manmina, Salmostoma bacaila*
5-10	*Salmostoma bacaila,*	*Puntius ticto, S.bacaila*	*Ailia coila, Eutropichthys vacha*
1-5	*Clupisoma garua, Puntius sophore, Chanda nama, Setipinna phasa, Ailia coila, Amblypharyngodon mola, Aorichthys aor, Chitala chitala, Cirrhinus reba, Macrognathus spp Mastacembelus armatus, Eutropichthys vacha, Cyprinus carpio*	*Clupisoma garua, Johnius coitor, Labeo calbasu, Cirrhinus reba, Mastacembelus armatus, Eutropichthys vacha, L. bata, Cyprinus carpio*	*Amblypharyngodon mola, Aorichthys aor, Barilius barila, Cirrhinus reba, Clupisoma garua, Gagata cenia, Johnius coitor, Johnius gangeticus, Labeo bata, Labeo calbasu, Macrognathus pancalus, Mastacembelus armatus, Mystus vittatus, M. seenghala, Puntius sarana, Puntius ticto,*
Below 1	*Bagarius bagarius, Cirrhinus mrigala, Pangasius pangasius, Clarius batrachus, Glyptothorax telchita, Glossogbius guiris, L.bata , Channa punctatus*	*Macrognathus aral, Bagarius bagarius, Cirrhinus mrigala,Chitala chitala, Clarius batrachus, Glyptothorax telchita, Glossogbius guiris, Ailia coila, O. mossambicus*	*Bagarius bagarius, Chagunius chagunio, Cirrhinus mrigala,Chitala chitala, Channa striatus, Chela laubuca, Gobius giuris, Labeo fimbriatus, L. rohita, Mystus cavasius, Notopterus notopterus , Cyprinus carpio, O. mossambicus*

Table 10. Specieswise variation of relative abundance in river Tones

Range of relative abundance (%)	Dominant species
7-15	*Salmostoma bacaila, Puntius ticto*
4-7	*Chela laubuca, Clupisoma garua, Gonialosa manmina, Barilius barila, Puntius sophore, Nemacheilus botia and Osteobrama cotio*
1-4	*Sicamugil cascasia, Rita rita,, Notopterus notopterus, Macrognathus pancalus, Labeo rohita, L. gonius, L. boggut, L. bata, Johnius coitor, Eutropichthys vacha, Cirrhinus reba, C. mrigala, Channa punctatus, Chanda nama, Barilius barna, Aorichthys seenghala, A. aor.*
Below 1	*Wallago attu, Tor tor, Tetrodon cutcutia, Puntius sarana, Oreochromis mossambicus, Nandus nandus, Mystus vittatus, M. cavasius, L. pangusia, L. fimbriatus, L. dyocheilus, L. calbasu, Glossogobius giuris, Gagata cenia, Cyprinus carpio, Clarias batrachus, Chitala chitala, Channa striatus, Channa marulius, Chanda ranga*

Early life stages of fishes

Shoreline larval sampling was carried out during monsoon and post-monsoon in the selected areas of river Ganga, including the turtle sanctuary area in Varanasi. The study indicated the availability of early life stages of about 26 species within sanctuary and 17 species from outside sanctuary area of the Varanasi stretch, whereas; in Allahabad stretch early life stages of 23 species were identified (Table 11). Good larval fish habitat was observed along right bank of sanctuary area, in which network of small channels served as potential spawning grounds for several freshwater fishes. Comparative abundance (mean ± SE) of the number of early life stages of important genera indicated significant variation in total numbers for *Gudusia* and *Clupisoma spp*. The study in river Tones indicated availability of early life stages of about 19 species (Table 12).

Catch Per Unit Effort (CPUE)

Catch per unit effort (Kg/hr) was calculated on the basis of experimental fishing by gill nets in different seasons. The result showed comparatively higher values of CPUE within sanctuary area compared to the outside sanctuary area throughout the season, except in Allahabad stretch in winter season. Within turtle sanctuary, it ranged from 0.39 to 0.48, whereas, in outside sanctuary area it was 0.21 to 0.40. Fish density was also counted by using NOVMAN 200 kHz portable sonar fish finder where the sensor was placed up to 1 m depth from surface and fish presence data (no.) was recorded in a transect area of 100 m^3. Overall fish availability was higher (29.33 to 51.33) at Chunarghat (Site I) with a mean of 42 ±12, as compared to other areas which may be due to presence of large deep pools (mean depth = 14.64 m during June).

Table 11. Abundance of the early life stages (number of fish per 50m ^{2}); of a few fishes in river Ganga

Genera	Near shore habitat of Sanctuary	Near shore habitat of unprotected areas (Varanasi)	Near shore habitat of unprotected areas (Allahabad)	Difference
Gudusia spp	54.2±17.5#	16.3±8.8	26.6±12.6	*
Eutropicthys spp	11.2±6.5	18.7±8.5	15.9±6.8	NS
Clupisoma spp	45±12.8	16.2±8.9	20.4±12.4	*
Macrognathus spp	11.2±5.2	18.1 ±12.6	11.7±2.6	NS
Johnius spp	12.7±6.2	16.4±8.3	9.4±16.2	NS

All figures show Mean ± SE

The results of the Tukey multiple comparison:

NS = not significant; * significant difference between the three areas at the level of p = 0.05±.

Table 12. Occurrence and distribution of early life stage of some important species in river Tones.

Site	Total species	Dominant genera	Depth range (m)	Subst-rate	Attributes of habitat			
					pH	Turbidity (NTU)	DO (ppm)	Conductivity (µS/cm)
I	16	*Salmostoma, Chanda, Puntius, Cirrhinus, Osteobrama, Chela, Labeo*	1.2-1.5	0.8	8.13	102.4	5.23	356
II	12	*Nemacheilus, Salmostoma, Chela, Clupisoma, Osteobrama, Mastacembelus, Tor*	0.98-1.4	1.5	8.41	78.3	5.74	378
III	11	*Salmostoma, Puntius, Barilius, Labeo, Tor*	1.3-1.8	4.2	8.26	73.5	6.21	327

Biological studies

In order to distinguish some important biological features of selected fishes inhabiting in protected and unprotected areas of Ganges and river Tones, fish samples were dissected. The analysis of samples of 11 selected fishes indicated comparatively higher gonadosomatic index (GSI) of fishes collected within sanctuary area, whereas, GSI was higher in the fishes of river Tones too (Fig.35 & 36). Interestingly, matured ovary of endangered *Nandus nandus* (n=5, TL=11.5 cm) was observed during the end of October while the normal period of maturity reported is from June to August. The analysis of trophic position of the fishes, collected from all the sites including river Tones, indicated dominance of carnivores, followed by omnivores and herbivores.

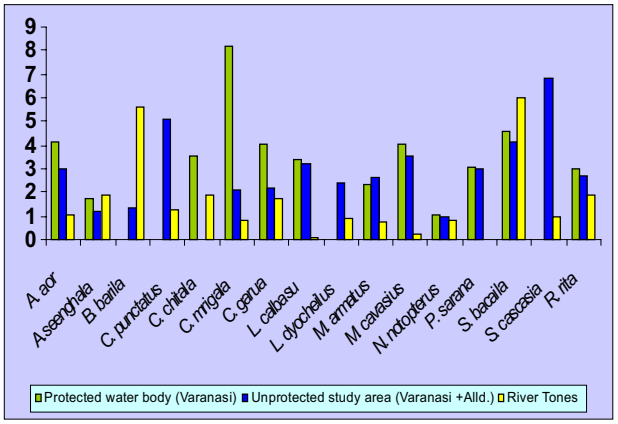


Fig. 35. Variation in GSI of some selected fish species

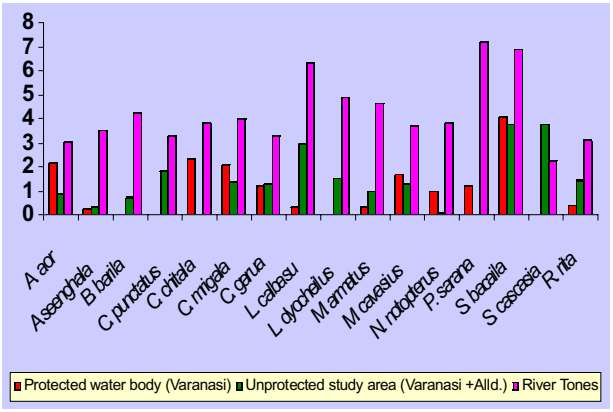


Fig. 36. Variation in GSI of some selected fish species

Fish habitat attributes

Based on the fish presence/ absence data, fish habitats were grouped into four habitat classes to determine conservation and management priorities. Water depth in the sanctuary area was considerable: averaging 6.25 m (range 5.56 – 6.4 m). Dissolved oxygen content ranged from 2.85 to 5.56 mg/l with an average of 4.65-mg/l. Current velocity varied from slow (0.5 km/hr) to swift (1.5 km/hr) with a fairly moderate average of 0.83 km/hr. Water temperature (23.4 – 30.7 °C) varied, as expected, with seasonal climate change and averaged 27.80°C. Similarly, water transparency varied seasonally and habitats from highly turbid (284.3 NTU) to quite clear (21.3 NTU) with a moderate average (101.04 NTU) were found. Water conductivity varied (204 to 624.5 µmhos/cm) with an average of 448.19 µS/cm indicating higher concentrations of dissolved materials during pre-monsoon. Total Dissolved Solids (TDS) were relatively stable (147.0 to 445.0) with an average of 309.47.

A rich diversity of microhabitats was observed in river Tones (Fig. 37). Preliminary data on fish habitat of river Tones was collected through primary survey in selected sites. Water depth varied from 4.4 – 7.5 m with an average of 6.13 m. Dissolved oxygen ranged from 4.16 to 6.2 mg/l with an average of 5.34 mg/l. Water temperature varied with climate change (22.7 – 26.4 °C) and averaged 25.02° C. Water transparency also varied seasonally and habitats from highly turbid (100.4 NTU) to quite clear (11.02 NTU) with a moderate average (46.59 cm) were found. Water conductivity varied (181 to 314 µmhos/cm) with an average of 306.88 µS/cm. Total Dissolved Solids (TDS) were relatively stable (120 to 287) with an average of 177.22. The substrate showed high diversity and ranged from 0.1 – 5.0 under code matrix indicating dominance of pebbles and cobbles.

Fig. 37. Microhabitat diversity in river Tones

Conservation threats

The following threats to fish germplasm were identified: i) discharge of untreated municipal domestic sewage in the protected areas and just below the protected area, through small drainages and also through Baruna river, ii) high load of suspended sediment in river bed iii) occasional poaching by the local people in the protected area, iv) fishing by small mesh sized net throughout the year, just below and above sanctuary. Hence, appropriate management plans need to be framed to mitigate the threats supported by stringent regulations. It is essential to establish a barrier along the edges of the sanctuary in the form of stringent regulation. There is also need to regulate farming areas around the sanctuary area of river.

The following threats to fish germplasm were identified in river Tones: i) Use of fine mesh nets (mosquito nets) by the fisherfolk during breeding season causing indiscriminate killing of brood fishes, as well as, juveniles, ii) Lifting of boulders from river beds causing serious alteration of breeding ground and substrate and iii) Soil erosion of the river banks due to poor riparian vegetation.

Status and role of temple sanctuaries in conservation of freshwater biodiversity

A study on the status and role of temple sanctuaries in conservation of freshwater biodiversity was continued in river Gomti, U.P. During the period under report 12 sites were randomly selected for detailed study in districts of Barabanki, Pratapgarh, Sultanpur, Jaunpur and Varanasi. Five additional important sites were studied during the year. Finally, a comprehensive inventory of 59 sites was prepared. These sites were identified as functional religious set ups like temples and mosque situated on the bank of river Gomti from Lucknow to its confluence point at Kaithi. Out of these, 56 sites are temples and 3 are mosques. Out of these, 4 religious set ups were newly constructed and people of these set ups were not aware of the concept of protection of aquatic resources.

Fish diversity was documented through experimental fishing near three protected sites namely, Shiv Mandir Jangleshawar Mahadev, Dhourahara, Distt. Barabanki; Dundeshwer Mahadev temple Kochhit, Distt. Sultanpur and Hanuman Temple, Gajanpur, Distt. Sultanpur. Documentation of each site was divided into 9 sections: (i) Location and description of site and temple, (ii) Social and religious activity of temple, (iii) Real prohibited status of site, (iv) Legal status of protected site, (v) Fishing pattern and stakeholders, (vi) Socio-economic profile of local fisherfolk, (vii) Trend of fish catch, (viii) Fish species diversity and (ix) Concluding remarks.

It was found that the management of all three religious sites is devoted to protect aquatic biodiversity in the water area in front of the temple, though without knowing the basic logic of conservation of biodiversity. They are doing

this service of conservation due to imposed sanctity of the religious institution. They are successfully maintaining this system, in spite of non-availability of any legal protection from the government.

Studies on fishing cooperative societies with focus on their potential for conservation of fishery resources

Studies were continued to assess the potential of selected fishing cooperative societies to utilize them for conservation of fish germplasm resources and formulate a strategy for the same. Detailed primary data were collected and analysed from three selected locations – Gobindsagar reservoir and Pong reservoir, of Himachal Pradesh and Tawa reservoir of Madhaya Pradesh. A total of 300 respondents were interviewed using a specially prepared questionnaire. Data were collected about following variables:

Profile of the fisherfolk

Profile of the fisherfolk members of the fishing cooperative societies was studied in terms of their age, education, family size, house type, major occupation, socio-economic status, socio-political participation, extension contact and cosmopoliteness. Majority of the members of the fishing cooperative societies were in the middle age category. The socio-economic status, level of extension contact and cosmopoliteness were higher among the member fisherfolk of the HP as compared to the Tawa reservoir of MP.

Awareness and involvement in Govt. schemes of fisheries development and welfare

Awareness and involvement of the members of the selected fishing cooperative societies in Govt. schemes of fisheries development and welfare was documented and analysed on three points: those not knowing anything about the scheme, having heard the name only or have availed benefits from the scheme (Table 13). Awareness and involvement of the fisherfolk members in Govt. schemes of fisheries development and welfare was higher in HP as compared to those in MP.

Opinion of the fisherfolk about the availability and condition of fishery resources and habitat availability

Opinion of the fisherfolk members was obtained about the perceived availability and condition of fishery resources in their area, during past and present and the future prospects (Table 14.).

Orientation of the fisherfolk towards conservation of fishery resources

An index was prepared to measure the orientation of the members of the fishing cooperative societies towards conservation of fishery resources. It consisted of 15 statements related to their awareness of the importance of, and interest in, fish conservation; perceived sense

Table 13. Awareness and involvement of members of the fishing cooperative societies in government schemes

Awareness and involvement in Govt. schemes	Gobindsagar Reservoir N=110	Pong Reservoir N=90	Tawa Reservoir N=100
Low	03 (2.7)	09 (10)	09 (9)
Medium	83 (75.4)	68 (75.5)	85 (85)
High	24 (21.8)	13 (14.4)	06 (06)
Mean	8.50 [12*]	7.75 [12*]	5.92 [18*]
SD	1.31	0.95	1.72

Figures in parenthesis indicate percentage

* Maximum obtainable score

Table 14. Opinion of the members with respect to the availability and condition of fishery resources

View about availability and condition of fishery resources	Gobindsagar Reservoir N=110			Pong Reservoir N=90			Tawa Reservoir N=100		
	Past	Present	Future	Past	Present	Future	Past	Present	Future
1. Abundant	83 (76)	03 (3)	0	31 (34)	0	0	33 (33)	38 (38)	10 (10)
2. Just adequate to sustain the livelihood.	19 (17)	31 (28)	13 (12)	43 (48)	17 (19)	09 (10)	64 (64)	41 (41)	19 (19)
3. Not adequate to sustain the livelihood.	08 (7)	64 (58)	63 (57)	16 (18)	57 (63)	47 (52)	03 (03)	18 (18)	51 (51)
4. Grossly inadequate and in very poor condition.	0	12 (11)	34 (31)	0	16 (18)	34 (38)	0	03 (03)	20 (20)

Figures in parenthesis indicate percentage

of responsibility and perceived sense of self-capability towards conservation. Their responses were sought on a four point rating scale and analysed (Table 15). It is clear from the data that conservation orientation of the fisherfolk members was on the higher side (mean score > 45 out of 60) with reference to all the three reservoirs. It shows that the fisherfolk are aware of the conservation issues in their areas and also perceive their responsibility towards conservation of fish germplasm resources. Further analysis of data is being done to determine and compare across different locations/ scenarios, as to what factors might affect the orientation of the members of the fishing cooperative societies towards conservation of fishery resources.

Estimation of performance of the selected societies in terms of the fishery resource enhancement and conservation measures undertaken

Performance of the identified societies, in terms of the fishery resource enhancement and conservation measures undertaken, was documented and analysed for selected locations. To achieve this, based on the pilot visits and interaction with state fisheries department and cooperative societies officials, a conservation performance index was prepared for each location/ state which consisted of all the conservation/ resource enhancement measures implemented by the state fisheries department

Table 15. Conservation orientation of the members of fishing cooperative societies

Conservation orientation	Gobindsagar Reservoir N=110	Pong Reservoir N=90	Tawa Reservoir N=100
Low	11 (10)	12 (13)	09 (09)
Medium	75 (68)	60 (67)	72 (72)
High	24 (22)	18 (20)	19 (19)
Mean	46.1 [60*]	46.01[60*]	45.60[60*]
SD	2.38	2.16	2.15
Combined SD	-----2.43----		

Figures in parenthesis indicate percentage

* Maximum obtainable score

and/or cooperative societies. The responses of the society members were documented about the frequency at which the fishermen of their society are following each of these measures. Their responses were sought on a three point frequency scale and the responses were analysed (Table 16). It is clear from the data that performance of the fishing cooperative societies in terms of the conservation measures followed, as perceived by the fisherfolk, was very high. It shows that at the selected locations, compliance to the conservation measures implemented by the state government and the fishing cooperative societies, was high.

Information was also obtained to know whether the selected societies undertake any monitoring or rule enforcement activity to implement conservation measures in their area. If yes, at what frequency? The location-wise responses were analysed (Table 17). Majority of the respondents told that their societies undertake monitoring or rule enforcement activities in their area, seasonally, to implement conservation measures.

5.4 *Ex situ* Conservation

Gene Bank

Development of sperm cryopreservation protocol for fishes of the Western Ghats

Horabagrus nigricollaris

Collection of the specimens of *Horabagrus nigricollaris* (an endemic species to the Chalakkudy river, Kerala) was made for milt cryopreservation trials from Chalakkudy River. Local tribal people were employed for collection of fishes and

Table 16. Perceived performance of the fishing cooperative societies in terms of the conservation measures followed

Perceived conservation performance	Gobindsagar Reservoir N=110	Pong Reservoir N=90	Tawa Reservoir N=100
Low	02 (2)	04 (5)	09 (09)
Medium	77 (70)	64 (71)	57 (57)
High	31 (28)	22 (24)	34 (34)
Mean	26.9 [30]*	27.0 [30]*	17.90 [21]*
SD	1.7	1.92	3.03

Figures in parenthesis indicate percentage

* Maximum obtainable score

Table 17. Conservation measures/ rules enforcement by fishing cooperative societies

Activity	Gobindsagar Reservoir N=110	Pong Reservoir N=90	Tawa Reservoir N=100
Does your society undertake any monitoring or rule enforcement activity to implement conservation measures in its area?			
Yes	92 (84)	78 (87)	93 (93)
No	18 (16)	12 (13)	07 (07)
If yes, how frequently?			
Rarely	09 (8)	12 (13.)	11 (11)
Seasonally	63 (57)	53 (59)	61 (61)
Year-round	20 (18)	13 (14)	21 (21)

Figures in parenthesis indicate percentage

collection was done using gill nets and cast nets. Specimens weighing 30-65g were kept in 1 ton tanks (half-filled with river water) with aeration and adequate hiding places for conditioning. Five samples were given ovaprim injection @ 0.4 ml/ kg body weight. After 24 hrs of injection, milt was collected in a plastic box by pressing the belly of the fin. Sperm count was in the range of 12.4 – 14.1 x 10^8 spz/ml.

Seven extenders - NBFGR 3, NBFGR 3B, NBFGR 6, NBFGR 7, NBFGR 7B, Hanks balanced salt solution (HBSS) and modified HBSS, were screened for cryopreservation protocol. Based on the motility of spermatozoa, five extenders (NBFGR 6, NBFGR 7, NBFGR 7B, HBSS and modified HBSS) were used for cryopreservation with DMSO (10%) as cryoprotectant. The ratio of milt, extender and cryoprotectant was kept as 1:3.5:0.5. Extenders HBSS and M-HBSS showed good motility scores 3 and 4, respectively, indicating that these extenders can be used in large scale milt cryopreservation of *H. nigricollaris.*

Garra surendranathanii

Garra species, popularly known as "stone suckers" or "kallotti" in local parlance, are characteristic of well-developed sucking disc or mental disc that helps these fishes to firmly attach to stones in fast flowing streams and rivers. Nineteen species of *Garra* have been described from Indian subcontinent. Of these, *Garra surendranathanii* is endemic to the rivers in Kerala part of the Western Ghats (Fig. 38). The species was described first in 1996 by Shaji, Arun and Easa and is confined to Chalakkudy, Periyar and Pampa rivers in the Kerala state. The species is consumed by the tribal people and is considered as a good table fish. *G. surendranathanii* grows to a maximum size of 25 cm. The algal browsing behaviour makes it an ideal species for freshwater aquarium. Owing to the restricted distribution and over-exploitation for aquarium trade and habitat alteration, the species was considered as "endangered" as per IUCN categorization in the Conservation Assessment and Management Plan workshop held at NBFGR, Lucknow in 1997. Trials were undertaken to cryopreserve the milt of this endangered species.

Fig. 38. *Garra surendranathanii* – an endangered species from Kerala

Specimens of *G. surendranathanii,* weighing 50-100g were kept in a glass tank for conditioning. Five male fishes were administered ovaprim injection @ 0.4 ml/ kg body weight. After 12 hrs, milt was collected by gently pressing the belly. Milt samples were evaluated for motility time, pH, spermatocrit percentage and sperm count. The spermatocrit values were in the range of 60-70%. Sperm count values were in the range of 1.43 – 12.4 x 10^8 spz/ml. Based on the motility of milt, five extenders (Table 18) were used for cryopreservation.

Ten male fishes (15-24 g) were administered ovaprim injection @ 0.4-ml/ kg body weight and after 12 hrs milt was collected by pressing the belly. Milt quantity ranged from 0.4-1.0 ml/fish. Motility was checked using river water as activator, before cryopreservation. Five extenders, screened earlier, were used for cryopreservation. DMSO (10%) was used as cryoprotectant. The ratio of milt, extender and cryoprotectant was kept as 1:3.5:0.5. Sperms preserved in all extenders with DMSO (10%) showed poor motility; hence, the trials were repeated with ethylene glycol (10%) as cryoprotectant which gave motility scores of 3 in extenders 3, 3B, & 6; and 4 in extenders 7 and 7B.

Fertility trails

Four female fishes were given ovaprim injection @ 0.4 ml/kg body weight and after 12 hrs of injection fishes were stripped for collecting eggs. Approximately, 50 eggs were taken in a plastic tray and milt from a single straw was used

Table 18. Composition of extenders used in milt cryopreservation of *Garra surendranathanii*

Chemical	Con. of Stock solution	NBFGR 3	NBFGR 3B	NBFGR 6	NBFGR 7	NBFGR 7B
NaCl	2g/10ml	375µl	375µl	365µl	375µl	375µl
KCl	1.6g/10ml	23.8µl	23.8µl	23.8µl	12.5µl	12.5µl
$CaCl_2$	600mg/10ml	-	-	48.3µl	33.4µl	33.4µl
NaHCO3	1g/10ml	200µl	200µl	750µl	20µl	20µl
Mg_2Cl2	16mg/ml	-	-	-	-	-
MgSO4	40mg/ml	-	-	-	-	50µl
NaH2PO4	41mg/ml	-	-	100µl	-	122µl
Glucose	100mg/ml	100µl	100µl	100µl	-	-
Glycine	500mg/10ml	-	-	-	-	-
Mannitol	250mg/ml	-	-	100µl	-	-
Egg yolk	-	-	200µl	-	-	-
D.D.W		9.301ml	9.101ml	8.512ml	9.559ml	9.387ml

for fertilisation. Only frozen – thawed milt in extender 7 and 7B with ethylene glycol (10%) was used for fertility trials, with fresh milt as control. After six hrs, fertilisation percentage was calculated, whereas, hatching percentage was calculated after 24 hrs (Table 19). Among all the extenders, extender 7 gave the best results with 76% fertility and 73% hatching as that of control. More fertility trials will be taken up in the next breeding season.

Breeding and sperm cryopreservation protocol of *Heteropneustes fossilis* and *Clarias batrachus*

Induced breeding and sperm cryo-preservation

Trials were undertaken for development of protocols for cryopreservation of *H. fossilis* and *Clarias batrachus* spermatozoa. The effect of different extender compositions in sperm cryopreservation was studied and hatching percentage was considered as end point. The males were treated with ovaprim @ 0.3 ml/kg body weight. After 15 hrs of incubation, males were dissected to take out testes. Testes were homogenized in 0.9 % NaCl solution. DMSO was used as cryoprotectants.

Four basic extenders HBSS, Modified HBSS, Modified HBSS with egg yolk and European catfish, were tested in this experiment with different combinations of composition. Sperm diluent was mixed with extender cryoprotectant in the ratio of 1:3.5:0.5 (sperm: extender: cryoprotectant).

Post thaw fertility success of cryofrozen sperm of *H. fossilis* and *C. batrachus*

Fertility trials were carried out with 2 days old cryopreserved sperm. In *H. fossilis*, the

Table19. Fertility and hatching percentage of *Garra surendranathanii* using milt cryopreserved in ethylene glycol (10%)

Parameters	Extender 7	Extender 7B	Control
Fertility (%)	20	16	28
Hatching (%)	10	8	14
Fertility as % of control	**71.4**	**57.1**	**-**
Hatching as % of control	**62.5**	**50**	**-**

extender M-HBSS yielded better results and showed 49.06 % hatching, whereas, control showed 51%. Other extenders HBSS, M-HBSS with egg yolk and European catfish showed 42.76 %, 37.46% and 29.47% hatching, respectively. In case of *C. batrachus* hatching, HBSS showed better result (62.09%), whereas, other extenders M-HBSS, M-HBSS with egg yolk and European catfish showed 40.9 %, 51.59 % and 46.31% hatching, respectively (Fig. 39).

Tissue Repository

A total of 871 tissue accessions were added to the tissue bank of NBFGR from 243 freshwater and marine fish species of the country. A total of 162 tissue samples belonging to 28 species were collected from Teesta and Jaldhaka rivers in North Bengal. A total of 115 tissue samples belonging to 24 species were collected from sites in the rivers Tons and Son, Madhya Pradesh. Ninety-four tissue samples belonging to 7 cold-water fish species were collected from Indus river and its tributaries Tangtse and Zanskar in Laddakh region. The tissue samples include those of blood, liver, muscle and fin clippings of the fish specimens. These were transported at –196 °C (in liquid nitrogen) to lab for long-term storage at –80 °C. Similarly, more than 500 tissue accessions were collected from 184 marine teleost species and preserved in 95% ethanol/isopropyl alcohol and the voucher specimens were preserved in alcohol.

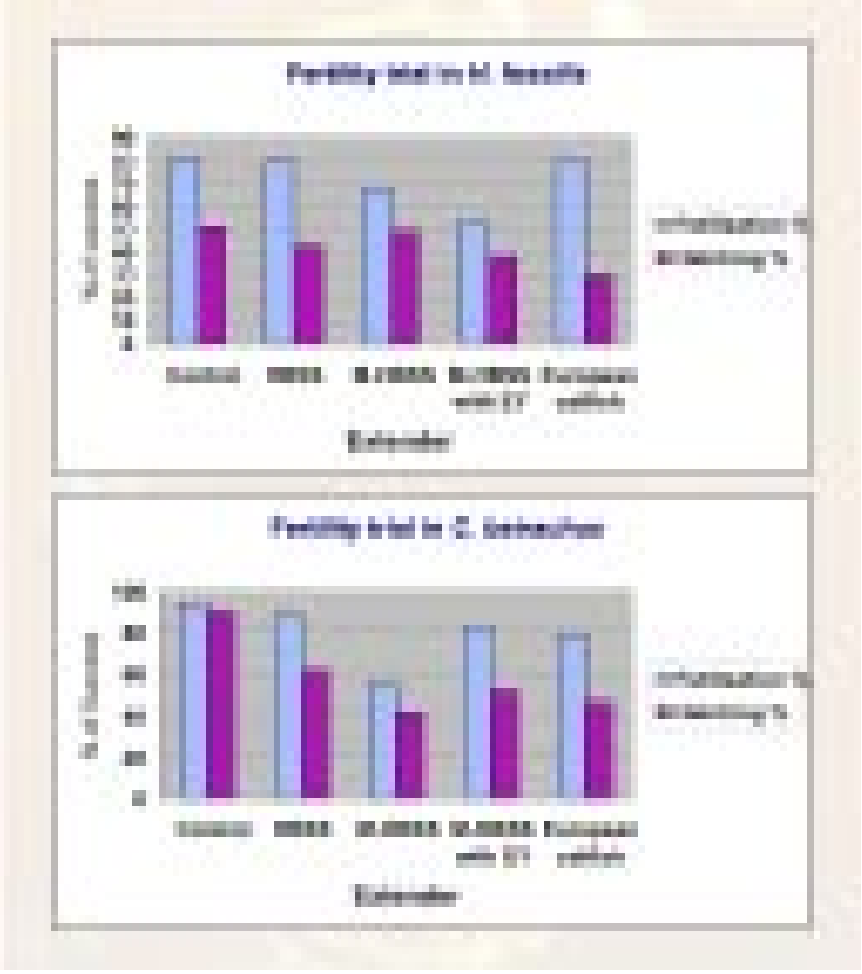


Fig. 39. Graphical representation of fertility trials in *Heteropneustes fossilis* and *Clarias batrachus*

5.5 Exotics and Quarantine

There is high influx of aquatic exotics in India and pathogens including 'parasites' also invading along with some of them are highly pathogenic like a monogenean, *Gyrodactylus salaris* and protozoans *Myxobolus, Ichthyophthirius*, trichodinids, etc., which can destroy fishery completely and cause heavy mortality. Thus, it is of utmost importance to study parasites of commercially important fishes and develop rapid and reliable molecular assays for detection and identification of fish monogeneans. In the above scenario, the NBFGR continued its research programmes in this direction.

Detection of protozoan and monogenean parasites of freshwater exotic fishes using molecular techniques

Sampling and screening of fishes and isolation and identification of parasites

Sampling of freshwater fishes, namely, *Labeo rohita, Catla catla, Cirrhinus mrigala, Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Carassius auratus, C. auratus auratus, Aristichthys nobilis, Clarias batrachus, C. gariepinus* and *Oreochromis mossambicus* was done from Aasiwan, Unnao, Hardoi, Lucknow and Allahabad.

A total of 392 fish samples were screened for isolation of monogenean and protozoan parasites (Table 20). The prevalence of parasites was highest in the *O. mossambicus* (80%) followed by *C. batrachus* (75%) (Table 20).

The intensity of parasites was very high in some samples of *L. rohita*, *C. mrigala*, and *Carassius auratus*. The monogeneans were identified on the basis of their morphological features and included *Gyrodactylus elegans* Nordman (1832) from *L. rohita*, *C. mrigala*, and *Carassius auratus*; *Dactylogyrus intermedius* Nybelin (1924) from *Cyprinus carpio* and *Carassius auratus*; *Dactylogyrus cirrhini* from *C. mrigala*; *Dactylogyrus catlaius* from *Catla catla; Dactylogyrus vastator* from *Aristichthys nobilis; Dactylogyrus* sp. from *O. mossambicus;* (Fig. 40-41) and a few monogeneans on gills of *Clarias gariepinus*.

Among protozoans, *Myxobolus* spp. were isolated from gills of *L. rohita* and *C. mrigala*; *M. clarii* from *Clarias batrachus*; and *Trichodina, Tripartiella* and *Ichthyophthirius multifilis* from *Carassius auratus* and Indian major carps. The whitish cysts carrying numerous spores were embedded in the haemopoitic tissues like, liver, spleen and kidney and were also seen in muscles. Prevalence of *Myxobolus* was highest in *Clarias batrachus* (73 %), followed by *Carassius auratus* (35%) and *L. rohita* (23%), whereas, it was lowest in *Clarias gariepinus* (15%). *Ichthyophthirius* and trichodinids were observed in most of the fishes.

Table 20. Prevalence percentage of parasites in selected freshwater fishes

S. No.	Name of fish	Number of fish screened	Prevalence percentage of parasites
1.	*Labeo rohita*	115	21
2.	*Catla catla*	35	14.3
3.	*Cirrhinus mrigala*	27	11
4.	*Cyprinus carpio*	36	20
5.	*Hypophthalmichthys molitrix*	11	18
6.	*Ctenopharyngodon idella*	64	24
7.	*Carassius auratus*	15	27
8.	*Aristichthys nobilis*	21	14
9.	*Clarias batrachus*	16	75
10.	*Clarias gariepinus*	47	17
11.	*Oreochromis mossambicus*	5	80

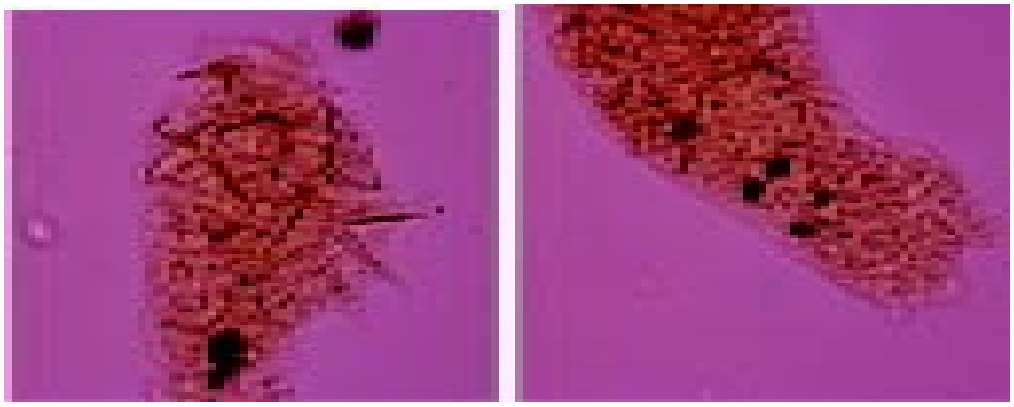


Fig. 40. ***Dactylogyrus vastator*** **isolated from bighead**

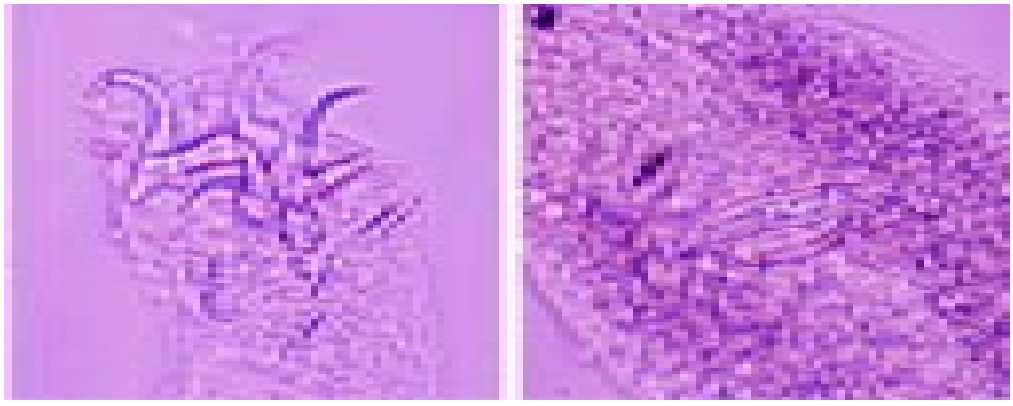


Fig. 41. ***Dactylogyrus*** **sp. isolated from** ***Orechromis mossambicus***

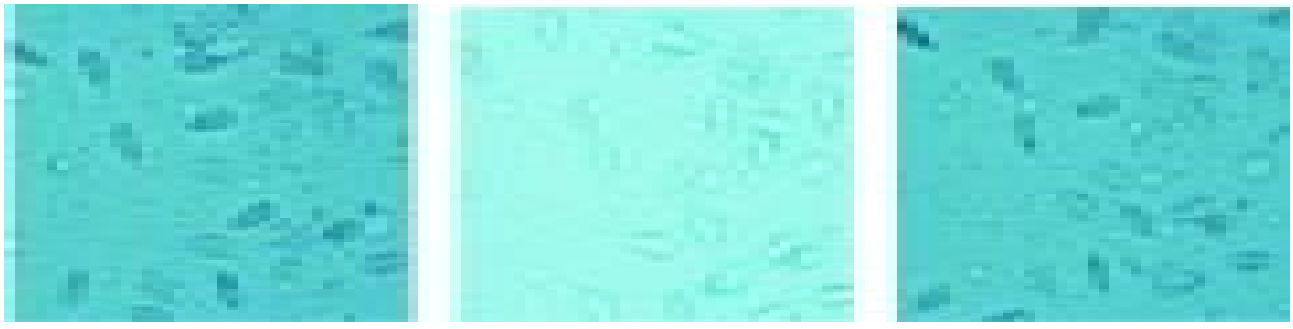


Fig. 42. ***Myxobolus*** **spores isolated from** ***Labeo rohita***

Isolation of DNA from *Myxobolus clarii and M. cerebralis*

DNA was isolated from *Myxobolus clarii* using the technique of Andree *et al* (1997). DNA was amplified using the following new primers designed from 18 small ribosomal DNA segment:

F-5′ - GCATTGGTTTACGCTGATGTAGCGA-3′

R-5′- GGCACACTACTCCAACACTGAATTTG-3′

Agarose gel electrophoresis of PCR product of 385 base pairs confirmed the *Myxobolus* species as *M. cerebralis* and PCR product of 500 base pairs as *M. clarii* (Fig. 43).

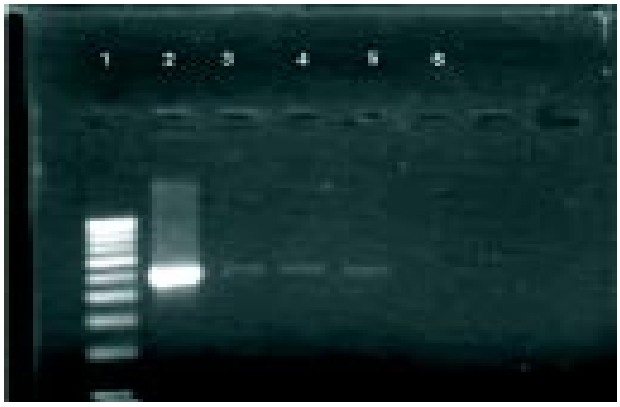


Fig. 43. PCR products of Indian and exotic *Myxobolus* species

Lane 1: 100 bp DNA ladder; Lane 2: PCR product of *Myxobolus cerebralis* DNA (485 bp); Lane 3-5: PCR product of test sample DNA of *Myxobolus clarii* (500 bp); Lane 6: Negative control

Detection and identification of *Gyrodactylus* species using molecular techniques

In order to detect and identify one indigenous and one exotic species of the monogenean *Gyrodactylus*, technique prescribed by C. O. Cunningham (1997) was followed. DNA of parasite was lysed using 7.5 µl lysis solution containing NP40, Tween 20 and proteinase K. After incubation, the lysate was used as the DNA template in PCR, without further purification. Primers for PCR were selected from the internal transcribed spacer (ITS) region and V4 region of small subunit ribosomal RNA gene, because, a lot of species-specific variation is found within the ITS region of small subunit ribosomal RNA gene. The primers used were: GSF- 5′-TTT-CCG-GTG-AAC-CT-3′ and GSR- 5′-TCC-TCC-TCC-GCT-TAG-TGA-TA-3′ (from ITS region) and 5′CTA-TTG-GAG-GGC-AGT-CT-3′ and 5′CTT-TTC-AGC-CAA-CAA-GG-3′ (from V4 region) of small subunit ribosomal RNA gene. Detection of species was done through PCR amplification of DNA, followed by its examination with the help of agarose gel electrophoresis. With the first set of primers, a 1300 base pair long PCR product was observed in agarose gels which identifies exotic species *Gyrodactylus salaris* and 1150 bp PCR product identifies indigenous species *G. elegans* (Fig. 44).

Fig. 44. Amplified PCR products of 2 species of *Gyrodactylus*

Lane 1- 500 bp molecular weight marker; Lane 2- PCR Product of *Gyrodactylus salaris* (1300bp) Lane 3- PCR Product of *G. elegans* from *L. rohita* (1150bp); Lane 4 - negative control

With second set of primers from V4 region of small subunit ribosomal RNA, only DNA of exotic species *G. salaris* got amplified and a 358 base pair long PCR product was visible in agarose gels which identifies this species (Fig. 45) but the DNA of *L. rohita* did not show any band.

Fig.45. A 358bp long PCR product from V4 region of ribosomal RNA gene of *G. salaris*

Lane.1. 100 bp molecular weight markers; Lane 2 – 5 *G. salaris* positive DNA

Targeted active surveillance of penaeids for OIE-listed viruses in selected maritime states of India

Disease outbreaks are being increasingly recognized as a significant constraint for aquaculture production and trade and are affecting economic development of the sector in many countries of the world. Disease is now considered to be the most limiting factor in the shrimp culture. In 1989, 6 viruses were known to affect penaeid shrimp, but by 1997 more than 20 viruses were identified as having affected wild stocks and commercial production. The OIE now lists seven viral diseases of shrimp in the Aquatic Animal Health Code (OIE, 2006), which are considered to be transmissible and of significant socio-economic and/or public health importance. All OIE member countries are obliged to report these diseases so that disease spread can be monitored and legislation instituted to prevent disease spread. Therefore, the NBFGR has undertaken studies for molecular detection of viral pathogens of shrimps.

During the year under report, a total of 85 shrimp samples were collected for screening of penaeid viruses namely, monodon baculovirus (MBV), yellowhead virus (YHV), taura syndrome virus (TSV) and white spot disease virus (WSDV) from Cochin, Kerala. DNA was isolated from above samples using the OIE prescribed protocols for detecting MBV and WSDV. Out of 85 samples, 15 samples were found positive for WSDV by first step PCR, whereas 22 samples turned positive by nested PCR. Nucleic acids of yellow head disease and MBV were procured from Dr Grace Lo, Taipei China, an OIE referral laboratory, to be used as positive control in PCR.

WSDV was purified from PCR positive samples using 10-50% sucrose density gradient, using standard method. A sharp band was observed and recovered at interface of 30%-40% sucrose gradient. Purified virus band was subjected to SDS-PAGE analysis for confirmation of the peptides. Five major bands of molecular weight of 28 kDa, 26 kDa, 24 kDA, 19 kDa and 15 kDa were observed in 15 % acrylamide gel (Fig. 46).

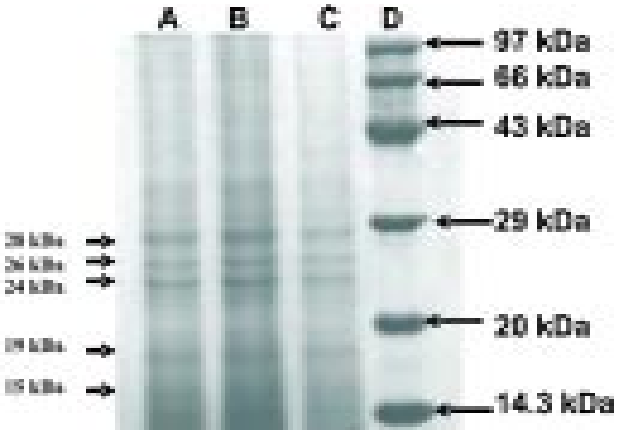


Fig. 46. SDS PAGE (15%) of purified White Spot Virus
Lane A-C-White spot virus; Lane D- Genei PMW-M marker.

Impact of exotic fish species in Uttar Pradesh with regard to fish diversity

In Uttar Pradesh (UP), number of fish species being cultured, is increasing due to the introduction of exotic fish species. They are now recognized as one of the principal threats to aquatic biodiversity. In this context, this study was continued with a view to study the impact of exotic fish species in UP with regard to fish diversity.

During the period under report, it was observed that among cultured species in UP, a few exotic fishes, namely, bighead (*Aristichthys nobilis*), Afican catfish (*Clarias gariepinus)* tilapia (both *Orechromis mossambicus* and *O. niloticus*) and *Pangasius sutchi*, had been introduced in an illegally for culture. All the exotic fishes were found to be cultivated in more than 30% of the grow-out ponds. The contribution of exotic fishes in aquaculture production was estimated to be 24.18%, 26.82%, 20.8%, 29.38% and 27.58%, respectively, in Meerut, Varanasi, Kanpur, Gorakhpur and Allahabad Divisions of UP (Fig. 47). It is to be mentioned here that the culture ponds having Thai magur were observed to have declined over the last year, due to regular awareness campaigns and regulatory action of the state fisheries department.

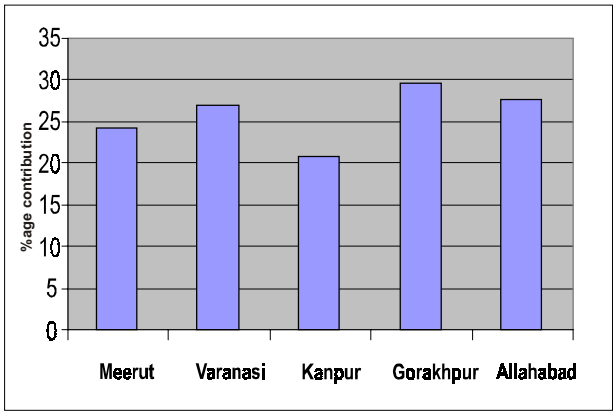


Fig. 47. Contribution of exotic fishes in total production of different divisions of UP

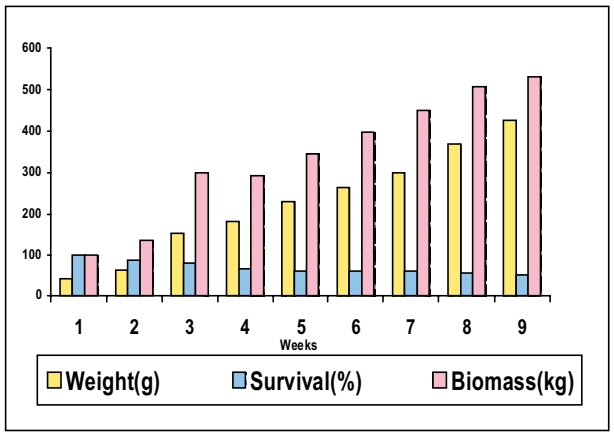


Fig. 48. Growth and mortality of African Catfish in cement cistern

The biological data on *Clarias gariepinus* and *Aristichtys nobilis* were collected with regard to food and feeding, survival, cannibalism and growth. The observations revealed that these exotic fishes had strong invasive characters. They could survive well under temperature range of 12.5 to 32.8ºC. In case of *C. gariepinus*, the average growth increase in length was 1.55 mm/day. Observations on the growth, survival and production in the out-door culture ponds was also recorded. Experimental data on the growth, survival and the production of Thai magur reared in cemented cistern of the dimension 9x3x1 m were collected for observing its performance under controlled conditions (pH 7.4-7.6, dissolved oxygen 4-6mg/l and depth of water 1 m, maintained throughout the rearing period). The fishes were maintained on supplementary feed (rice bran and groundnut oil cake in the ratio of 1:1 and fish meal added 20% the feed) to satiation. The production level for six months was observed to be 21,593 kg/ha (Fig. 48). When *Catla catla* was reared with *A. nobilis* in glass aquaria, the specific growth rate (SGR%) was depressed, whereas, the SGR% continuously increased in the case of *A. nobilis* alone (Fig. 49).

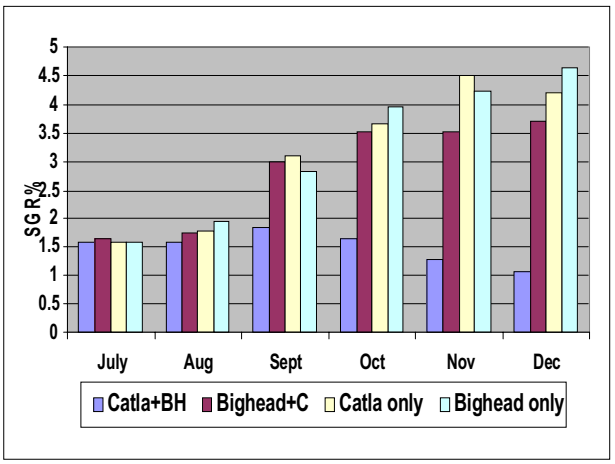


Fig. 49. Influence of bighead on SGR % of Catla reared under co-culture with bighead in aquarium conditions

Information on the catch of exotic fish species was collected from different districts along river Yamuna in Uttar Pradesh. In all the fish catches from river Yamuna, there was presence of exotic fish species namely, *Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Clarias gariepinus* and *Orechromis niloticus*. Amongst the exotic fishes, *Cyprinus carpio* was most dominating species in all the catches from all the districts under this study. It was caught to the tune of 9.5% to 50% in the size group of 280 to 300 mm in length and 350 to 1500g in weights. The maximum catch of common carp was recorded at Ferozabad (50%), followed by Etawa (40%) and Auraiya (20%). Interestingly, *C. gariepinus* was also caught to the tune of 1- 4%. At some districts, *A. nobilis* was caught from river Yamuna. The presence of *O. niloticus* was high (01-30%) at Etawa and Ferozabad.

Preparation of GIS maps for occurrences and distribution of exotics

The coverage line layer for river Yamuna and polygon layer for different districts of UP were prepared in ARC GIS 8.3 with ARC Info for analysis and map generation. Different GIS tools were applied on spatial and attribute tables, populated with presence/absence of exotic fish species and annual catch composition. Besides, local fish catch composition was segregated into different groups of these layers for reflecting the exotic fish species dynamics, compared to the local fish fauna in different segments of river Yamuna and districts, through which the river passes (Figures 50-51). Figures 52-57 show species - wise annual catches of exotic fishes in different stretches of river Yamuna at district level.

Fig.50. Presence and absence of exotic species in Yamuna river

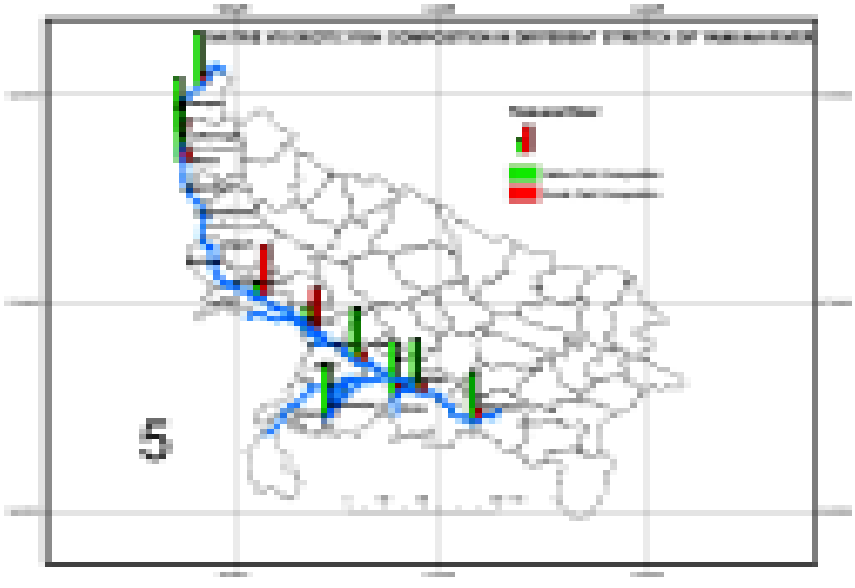


Fig.51. Native vs exotic fish composition in different stretch of Yamuna river

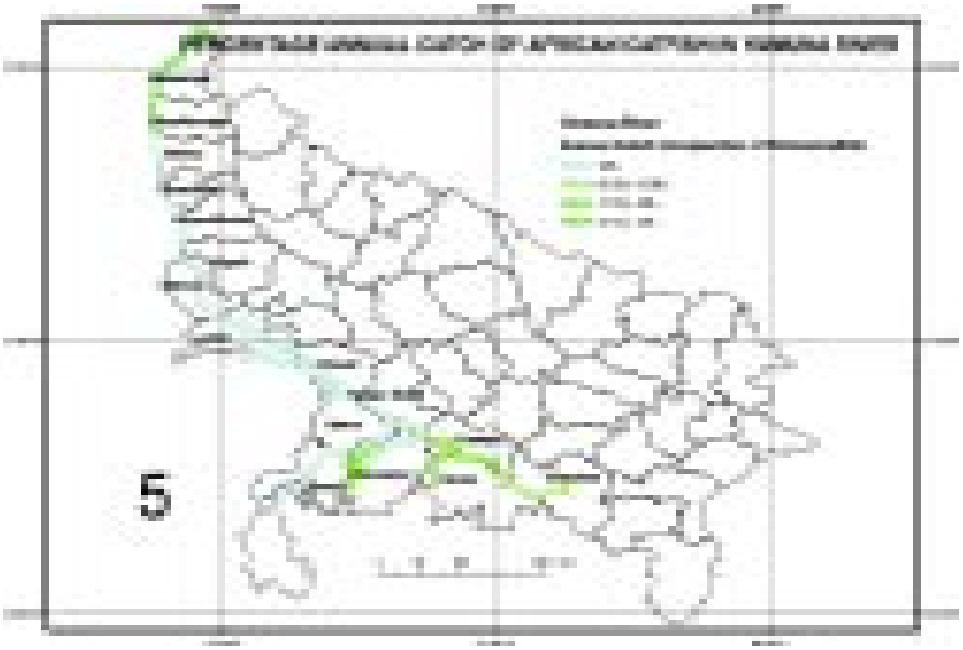


Fig. 52. Annual catch of African catfish in Yamuna river

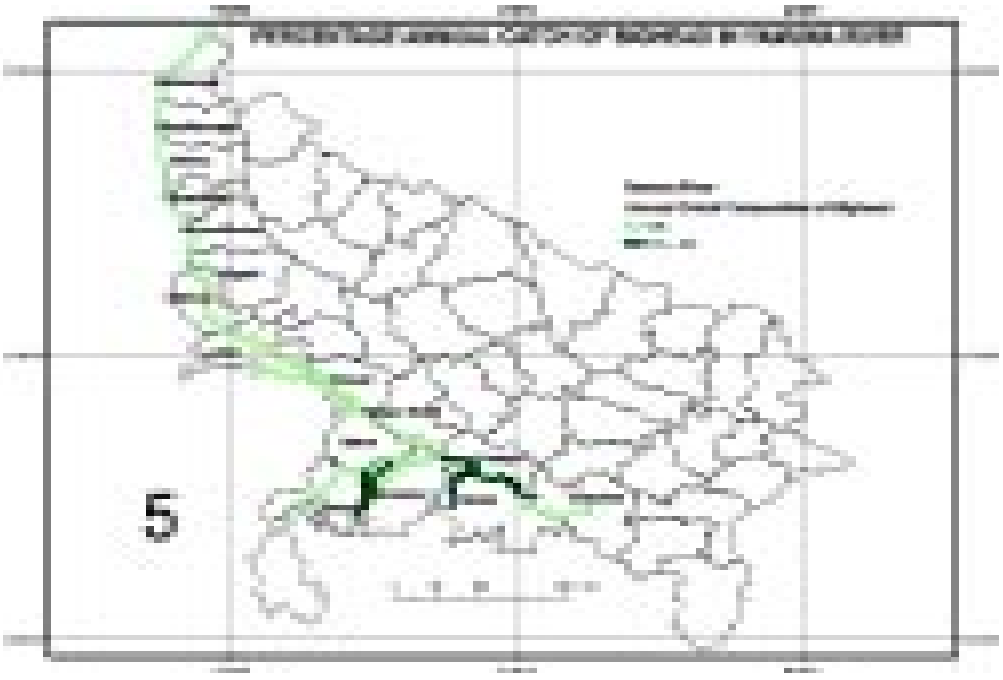


Fig. 53. Annual catch of Bighead in Yamuna river

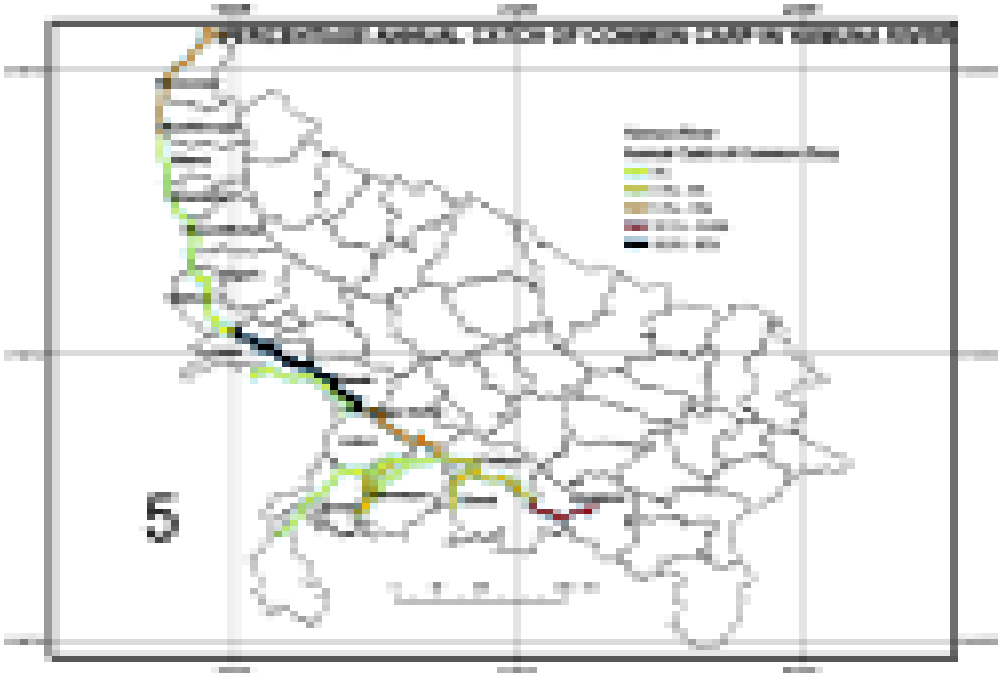


Fig. 54. Annual catch of common carp in Yamuna river

Fig. 55. Annual catch of silver carp in Yamuna river

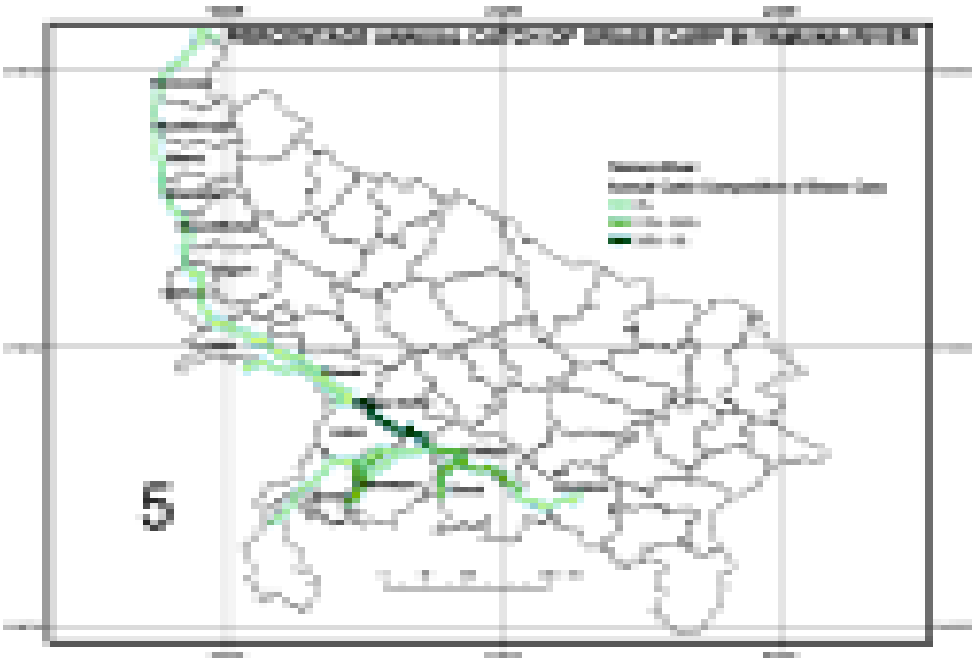


Fig. 56. Annual catch of grass carp in Yamuna river

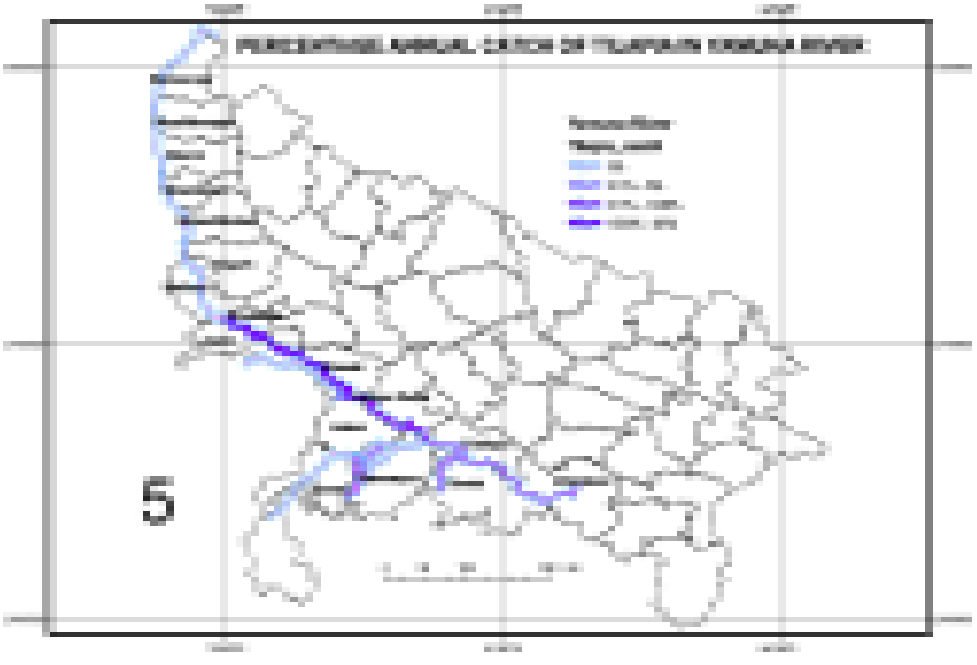


Fig. 57. Annual catch of tilapia carp in Yamuna river

EXTENSION ACTIVITIES

Mass Awareness and Advisory Services for Conservation

- The NBFGR organized a Kisan Gosthi jointly with KVK, Dariyapur, Raebareli, UP on July 29, 2006 in which Dr. P. Das, DDG (Extension), ICAR, New Delhi was the chief guest. An exhibition was also arranged by the Bureau on this occasion.
- An exhibition and awareness camp was organized by NBFGR at Feroz Gandhi Post Graduate College, Raebareli, UP on July 31, 2006 where the scientific activities of NBFGR were displayed.
- The NBFGR collaborated with Central Soil Salinity Research Institute, Lucknow Centre for initiating a new work on fish culture in saline soils at block Kashranwa, Bacchrawa, Distt. Raebareli, UP in August 2006. The Bureau also collaborated with KVK, Daryapur, Raebareli, UP for developing a demonstration pond on fish culture at the KVK campus.

Participation in Exhibitions

The NBFGR participated in the following exhibitions related to fisheries and aquatic resources during the year 2006 -2007 in different parts of the country:

- The exhibition organized on the occasion of the Inauguration of the National Fisheries Development Board at Hyderabad on Sept. 9, 2006.
- International symposium-cum-exhibition on sustainable fisheries development for food and health security at College of Fisheries, Mangalore during December, 20-21 2006.
- National Farmer's Meet organized by Indian Vegetable Research Institute, Varanasi, during January 27-28, 2007 which was inaugurated by Hon'ble Dr. Mangala Rai, Secretary, DARE and Director General, ICAR New Delhi.
- National Science Day exhibition organized by Central Institute of Medicinal & Aromatic Plants (CSIR), Lucknow, on Feb. 28, 2007.
- State level workshop-cum-exhibition on *Samanvit matasya palan* (In Hindi) organized by Uttar Pradesh State Fisheries Department on March 14, 2007 at Lucknow.

Technical lectures/ talks delivered

- Dr. Kuldeep Kumar Lal, Sr. Scientist delivered a lecture on conservation genetics for M.Sc (Wild Life) students at Wild Life Institute of India, Deheradun during April 12-14, 2006.
- Dr. A. Gopalakrishnan, Sr. Scientist delivered a lecture on "Application of Molecular markers in fishes" in an ICAR sponsored summer school at Fisheries College and Research Institute, Tuticorin, T.N in September, 2006.
- Dr. A.K. Singh, Sr. Scientist delivered an invited talk on "Biosafety and introduced fish species in India - Containment measures" in National Symposium on Biosafety Perspectives on Sept. 25, 2006 organized by Department of Zoology, Allahabad University, Allahabad during Sept 25-26, 2006.
- Dr. A. Gopalakrishnan, Sr. Scientist delivered a lecture on "DNA markers in marine biodiversity studies" in a National Seminar on Marine Biology – Advances and Prospects, on November 10, 2006 at Cochin University of Science and Technology, Kochi.
- Dr. Peyush Punia, Sr. Scientist delivered a talk on activities and achievements of the Institute in fish biotechnology and conservation on the occasion of National Science Day at CIMAP (CSIR), Lucknow on February 28, 2007.
- Dr. A.K. Singh, Sr. Scientist delivered a talk on "Diversification in fish culture" on the

occasion of the National Farmer's Meet organized by Indian Vegetable Research Institute, Varanasi, during January 27-28, 2007.

- Dr. A.K. Singh, Sr. Scientist delivered a guest lecture on "Exotic fish introductions in India: An overview" at the 9th Indian Agricultural Scientists and Farmers Congress held at Allahabad during Jan 29-30, 2007.
- Dr. P.K. Varshney, Sr. Scientist delivered a lecture on "More crop per drop- in relation to fisheries" on the occasion of National Science Day - 2007 at District Science Club, Lucknow on February 27, 2007.
- Dr. A. Gopalakrishnan, Sr. Scientist delivered a lecture on "Molecular markers: Principles and applications" in a UGC sponsored refresher course at Cochin University of Science and Technology, Kochi, March 5, 2007.
- V.S. Basheer, Scientist (SS) delivered a lecture on "Cryopreservation of fish gametes" in a UGC sponsored refresher course at Cochin University of Science and Technology, Kochi, March 5, 2007.
- Dr. P.K. Varshney, Sr. Scientist delivered a lecture on "Integrated fish farming" in a Workshop organized by the UP State Fisheries Department at Lucknow on March 14, 2007.

Visits by students and farmers

The following batches of students and farmers visited different laboratories and fish farm of the Institute during this period:

- Thirteen students of M. Sc. (Zoology, Ecology and Environment) from Cotton College, Guwahati along with one faculty member visited the Institute on May 5, 2006.
- A group of 13 students of B. Tech (Biotech.) Ist year from ACS Informatics, Lucknow visited NBFGR on June 2, 2006.
- Fifty progressive farmers from Krishi Vigyan Kendra, Ujwa, Delhi on March 01, 2007.
- Eleven trainees of Jammu & Kashmir State Fisheries undergoing training at NBFGR Unit, Chinhat, Lucknow on March 07, 2007.
- Twenty-five students of M.Sc. Zoology along with the faculty members from T.D College, Jaunpur, U.P on March 28, 2007.

Fig. 58 : Dr. Dilip Kumar, Director, CIFE, Mumbai and Prof. Mohan Joseph Modayil, Director, CMFRI, Cochin visiting NBFGR stall at College of Fisheries, Mangalore

AWARDS AND RECOGNITION

- The Institute was awarded with the 'Best Annual Report Award – 2003-04' by the Indian Council of Agricultural Research, New Delhi.
- Dr. W.S Lakra, Director was honoured with the Gold Medal of the Indian Academy of Environmental Sciences.
- Dr. A.K. Singh, Sr. Scientist was awarded S. Z. Quasim Medal 2007, by the Bioved Research and Communication Centre, Allahabad at the 9th Indian Agricultural Scientists and Farmers Congress during Jan 29-30, 2007.
- The Bureau was awarded an appreciation letter by the *Nagar Rajbhasha Karayanvayan Samiti* for organizing a workshop in Hindi. Dr. L.K Tyagi, Scientist (SS) and Hindi Officer received this appreciation letter on behalf of the Director and staff of the Institute on February 26, 2007 at Central Drug Research Institute, Lucknow.
- Dr. A. Gopalakrishnan, Sr. Scientist was nominated as a Member, Faculty of Environmental Sciences, Cochin University of Science and Technology (CUSAT), Kochi.
- Dr. A. Gopalakrishnan, Sr. Scientist was nominated as a Member, Board of Studies, Faculty of Environmental Sciences, CUSAT, Kochi.
- Dr. A. Gopalakrishnan, Sr. Scientist was nominated as a Member, Board of Studies, Faculty of Industrial Fisheries, CUSAT, Kochi.

HUMAN RESOURCE DEVELOPMENT

Trainings Organized

Symposium-cum-Training Programme on 'Fish Biotechnology'

The Institute organized a Symposium-cum-Training Programme on Fish Biotechnology, during November 7-15, 2006, exclusively aimed at capacity building of young researchers from North-Eastern States of India, for the first time. A total number of 14 participants, representing the states of Manipur, Assam, Tripura, Arunachal Pradesh and Meghalaya attended the programme. Dr. P.K. Seth, Former Director, ITRC and Executive Officer, Botech Park, Lucknow inaugurated the programme. Dr. R.K. Tuli, Director, NBRI, Lucknow and Dr. R.D. Ward, Senior Principal Scientist, Marine Research, CSIRO, Hobbart, Australia were Guests of Honour on this occassion. The distinguished guests addressed the participants (Fig. 59). The training was aimed at exposing young researchers to advanced techniques of biotechnology including Comet assay, FISH, AFLP, Microsatellite, Allozyme analysis and Molecular disease diagnosis. A series of lectures were arranged by the eminent scientists from Department of Biotechnology, New Delhi; Centre for Cellular and Molecular Biology, Hyderabad; National Institute of Immunology, New Delhi; College of Fisheries, Mangalore and Central Institute of Fisheries Education, Mumbai.

Fig. 59. Dr. R.D. Ward, Senior Principal Scientist, CSIRO, Hobart, Australia addressing the participants

Dr. W.S. Lakra, Director, NBFGR informed that the rapid progress made by the Bureau in molecular genetics and biotechnology work has led to the initiation of a new area of research on DNA Barcoding of Indian marine fish species, for the first time in South Asia. The eight-day training programme concluded with the award of certificates to the participants by Dr. S.A.H. Abidi, Former Member, ASRB, New Delhi who appreciated the efforts of NBFGR in popularizing biotechnology in the remote and difficult areas of the country which happens to be one of the biodiversity hotspots too (Fig. 60).

Fig. 60. Dr. S.A.H. Abidi, Former Member, ASRB (on the dais), chairing the Valedictory Function and Dr. W.S Lakra addressing the participants.

Workshop-cum-Training programme on 'Fish Culture and Inland Fisheries'

A workshop-cum-training programme on Fish Culture and Inland Fisheries was organized by NBFGR, Lucknow during December 21-22, 2006. The programme was inaugurated by Shri P.K Jha, Secretary, Fisheries, U.P. whereas Shri Bihari Swaroop, Director, Fisheries, U.P; Shri. G.K. Tandon, Special Secretary (Fy.), U.P; Shri. R.B Verma, Former Managing Director, U.P Fish Development Corporation and Prof. C.S Singh, Former Dean (Fy.), Pantnagar also graced the occasion (Fig. 61). The workshop was aimed at strengthening technical expertise and manpower for enhancing fish production in the state of U.P. The workshop was sponsored by the National Fisheries Development Board, Hyderabad. Invited experts and NBFGR scientists trained the participants on various aspects related to fish culture and management including, aquaculture techniques, composite fish culture, fish nutrition, culture of air-breathing fishes, fish disease management, etc. A large number of officers of the UP State Fisheries Department and progressive fish farmers of the state participated in the program and were benefited by the technical advices related to fish culture and inland fisheries. On this occasion, a book "Matsya Palan Darshika" (in Hindi) was released. An exhibition on the modern approaches to fish farming was also arranged for the officials and fish farmers.

Fig. 61. Shri P.K. Jha (in centre) Secretary, Fisheries , U.P. chairing a session

Training on 'Basic Tools in Molecular Biology Research'

The NBFGR organized a training programme on "Basic Tools in Molecular Biology Research" during February 5-9, 2007. The participants were exposed to the baseline theoretical, as well as, practical insights in various types of tools used in molecular biology research. The training included DNA extraction from different tissues, restriction digestion of DNA, polymerase chain reaction, DNA sequencing, etc. A total of 9 participants belonging to different research organizations/ universities/ national institutes of India, participated in the programme.

Training on 'Genotoxicity Biomarkers in Fishes'

A training programme on "Genotoxicity Biomarkers in Fishes " was organized during February 15-21, 2007. Dr. D.P Singh, Dean and Head, Department of Environmental Science, BBA Central University, Lucknow inaugurated the programme. The participants were given hands on training on chromosomal aberration test, sister chromatid exchanges, micronuclei detection, and the single cell gel electrophoresis or comet assay for genotoxicity assessment in aquatic organisms including fishes. Invited lectures from eminent scientists of premier organizations/ universities were also organized during the training. A total of 20 participants from different research organizations/ universities/ national institutes of the country participated in this course.

Training on 'Fish Disease Reporting System' for State Fisheries Officers.

The Institute organized a training programme on "Fish Disease Reporting System", sponsored by DAHDF, Ministry of Agriculture, Govt. of India, for State Fisheries Officers during March 7-9, 2007. A total number of 21 fisheries officers from ten states including, Andhra Pradesh, West

Bengal, Punjab, Nagaland, Haryana, Uttrakhand, Rajasthan, Madhya Pradesh, Chattisgarh and Uttar Pradesh participated in this training programme. Dr. P.V. Dehadrai, former DDG (Fy.), ICAR, New Delhi inaugurated the programme. The main objective of this training was to create awareness among state fisheries officers on OIE and NACA listed diseases. The training focused on level one diagnosis, collection and dispatch of samples and familiarization with modern disease diagnostic techniques. Besides the internal resource persons, leading experts from other institutions gave a series of invited lectures during the training. Shri. M. Dwivedi, Special Secretery, U.P State Fisheries was the Chief Guest of the Valedictory function whereas, Smt. Anita Mishra, Director, U.P State Fisheries was the Guest of Honour.

Training on "Molecular Markers and Genetic Diversity Analysis"

A training programme on "Molecular Markers and Genetic Diversity Analysis" was conducted from March 12-21, 2007. A total number of 18 participants representing leading national institutes and universities of 11 states of the country participated in the programme. The training course was inaugurated by Dr. S.P.S. Ahlawat, Director, IVRI, Izatnagar, Bareilly UP (Fig. 62). The participants were given hands on training on molecular techniques such as DNA isolation, genomic library construction, RAPD, allozymes, microsatellites, genotyping, mitochondrial haplotyping, sequencing and statistical tools for genetic diversity analysis.

Fig. 62 : Dr. S.P.S. Ahlawat, Director,IVRI, delivering inaugural address during Training on Molecular Markers

Training on 'DNA Marker Technologies: Principles and Applications' at NBFGR Cochin Unit, Kochi

A training programme on "DNA Marker Technologies: Principles and Applications" was organized at NBFGR Cochin Unit during February 21- March 03, 2007. Altogether 21 participants from various universities, research institutes, colleges and fish processing industry attended the course. The training was aimed to impart theoretical and practical knowledge on various classes of DNA based markers and on the recent developments in the field, with an ultimate goal to develop trained manpower in the field of DNA fingerprinting. The training programme was inaugurated by Mr. G. Mohan Kumar, I.A.S., Chairman, Marine Products Export Development Authority, Kochi whereas Prof. Mohan Joseph Modayil, Director, CMFRI, Cochin presided over the function (Fig. 63 & 64). In the valedictory function, the Chief Guest, Dr. K. Gopakumar, Vice Chancellor, IFCR – York

Fig. 63 : Shri G. Mohan Kumar, Chairman, MPEDA, Kochi inaugurating the training programme on DNA Marker Technologies at NBFGR Cochin Unit.

Fig. 64 : The participants having hands-on practice during a training programme at NBFGR Cochin Unit

College, Toronto, Canada and Former Deputy Director General (Fisheries), ICAR, New Delhi distributed certificates to the participants.

Lectures organized

A series of invited guest lectures by following leading experts were organized at the Institute:

- Dr. T. R. Rao, Former Director, School of Environmental Sciences, Delhi on Biotic Invasions on Sept. 16, 2006.
- Dr. P. Das, Former Director, NBFGR on Challenging experiences of exotic fish introductions on Sept. 16, 2006.
- Dr. N. Sarangi, Director, CIFA, Bhubaneswar on Exotic fishes and biodiversity on Sept. 16, 2006.
- Dr. R.K. Khetarpal, Principal Scientist and Head, Quarantine Division, NBPGR, New Delhi on the Role of quarantine in regulating the introductions of exotic flora and fauna on Sept. 16, 2006.
- Dr. Madhumita Mukherjee, Joint Director Fisheries, Government of West Bengal on Exotic fishes in ornamental fish industries and as food fish in West Bengal on Sept. 16, 2006.
- Dr. A.D Diwan, ADG (Marine Fy.) ICAR, New Delhi on "Nano-technology and its applications in fisheries" on February 10, 2007.
- Dr. Yogeshwer Shukla, Scientist E, Industrial Toxicology Research Centre, Lucknow on "Mutagenic and Carcinogenec risk with environmental carcinogens" on February 17, 2007.
- Dr. Neeraj Sinha, Senior Assistant Director, Division of Toxicology, Central Drug Research Institute, Lucknow on "Clinical Cytogenetics" on February 19, 2007.
- Shri Prabodh Kumar Trivedi, Plant Gene Expression Lab, National Botanical Research Institute, Lucknow on "Molecular basis of detoxification of heavy metals by aquatic plants" on February 20, 2007.
- Dr. S.V.S Rana, Professor and Head, Department of Zoology, CCS University, Meerut on "Biomarkers in health and disease" on February 21, 2007.
- Dr. Suraksha Agarwal, Head, Department of Genetics, SGPGI, Lucknow on Genetic Diversity in Human Populations on March 13, 2007.
- Dr. Balvinder Singh, Scientist C, Bioinformatic Centre, Institute of Microbial Technology, Chandigarh on "Bioinformatic Tools in Molecular Genetics" on March 16, 2007.
- Dr. J.L Karihaloo, Project Coordinator, Asia-Pacific Consortium on Agricultural Biotechnology, National Agricultural Science Centre, New Delhi on "Agricultural Biotechnology Research in Asia: Status and Priorities" on March 17, 2007.
- Dr. S.K Jain, Professor, Department of Biotechnology, Faculty of Science, Jamia Hamdard University, New Delhi on "Advances in Functional Genomics" on March 17, 2007.
- Dr. Neeta Sehgal, Reader, Department of

Zoology, University of Dehli on "Advances in Molecular Endocrinology" on March 19, 2007.

- Dr. Rajinder Singh Sagwan, Scientist E, Central Institute of Medicinal and Aromatic Plants, Lucknow on "Genetic Diversity in Medicinal and Aromatic Plants" on March 20, 2007.
- Dr. A.K Singh, Principal Scientist & Head, Germplasm Conservation Divison, National Bureau of Plant Genetic Resources, New Delhi on "Registration of Germplasm and Genetic Stocks: Status and Opportunities" on March 20, 2007.
- Prof. Sandeep Malhotra, Department of Zoology, Allahabad University on "Diseases of aquatic animals: Modern approach to diagnostic and prophylaxis".
- Prof. Nirupama Agarwal, Head, Department of Zoology, Lucknow University on "Parasitic diseases of finfishes in India: Symptoms, diagnosis and treatment".

LINKAGES

The NBFGR worked in collaboration with the following international and national organizations and agencies, during the period under report.

National Organizations/Agencies

ICAR Institutes

- Central Institute of Freshwater Aquaculture, Bhubaneswar, Orissa.
- Central Inland Fisheries Research Institute, Barrackpore, West Bengal.
- Central Marine Fisheries Research Institute, Cochin, Kerala.
- Central Institute of Brackishwater Aquaculture, Chennai, T.N.
- Central Institute of Fisheries Education, Mumbai, Maharastra.
- National Research Centre on Coldwater Fisheries, Bhimtal, Nainital.
- National Bureau of Animal Genetic Resources, Karnal.
- National Bureau of Soil Survey and Land Use Planning, Nagpur.
- ICAR Complex for NEH Region, Barapani, Shillong, Meghalaya.
- ICAR Center for Sikkim, Tadong, Gangtok, Sikkim.

International Organizations/Agencies

- The WorldFish Centre, Penang, Malaysia.
- Network of Aquaculture Centers in Asia Pacific (NACA), Bangkok, Thailand.
- CSIRO Marine and Atmospheric Research, Hobart, Australia
- Institute of Biodiversity, University of Guelph, Canada

Universities and Colleges

- Cochin University of Science and Technology, Cochin.
- College of Fisheries, Kerala Agriculture University, Panangal, Cochin, Kerala.
- College of Fisheries, G.B. Pant University of Agriculture & Technology, Pantnagar, U.P.
- Centre for Aquaculture Resource & Extension (CARE), St. Xavier College, Palayamkottai, T.N.
- Paramakalyani Centre for Environmental Sciences Maranmarian Sundaranas University, Alwarkinichi, T.N.
- Manonmaniam Sundaradanar University, Tirunelveli, Tamil Nadu.
- Regional Agricultural Research Station, Kerala Agricultural University, Kumarakom, Kottayam, Kerala.
- School of Industrial Fisheries, Cochin University of Science & Technology, Cochin.
- School of Life Sciences, NEHU, Shillong, Meghalaya.
- Department of Zoology, Guwahati University, Guwahati, Assam.
- School of Life Sciences, Dibrugarh University, Dibrugarh, Assam.
- Department of Life Sciences, Manipur University, Manipur.
- Department of Life Sciences, Assam University, Silchar, Assam.
- College of Fisheries, Assam Agriculture University, Assam.
- School of Life Sciences, Arunachal University, Itanagar, Arunachal Pradesh.
- College of Fisheries, Central Agriculture University, Lambuchara, Agartala, Tripura.
- Delhi University, Delhi

- HNB Grahwal University, Srinagar, Garhwal, Uttrakhand

Central Ministries/ Departments

- Ministry of Environment and Forests, New Delhi.
- Ministry of Agriculture, New Delhi.
- Ministry of Commerce, New Delhi.
- Department of Biotechnology,
- Department of Science and Technology, New Delhi

State Ministries/ Departments

- Department of Fisheries, Govt. of UP, Lucknow.
- Department of Fisheries, Govt. of Himachal Pradesh, Bilaspur.
- Department of Fisheries, Govt. of Kerala.
- Department of Fisheries, Govt. of Punjab.
- Department of Fisheries, Govt. of MP, Bhopal
- Department of Fisheries, Govt. of Assam, Guwahati.
- Department of Fisheries, Govt. of Meghalaya, Shillong.
- Department of Fisheries, Govt. of Arunachal Pradesh, Itanagar.
- Department of Fisheries, Govt. of Tripura, Agartala.
- Department of Fisheries, Govt. of Nagaland, Kohima.
- Department of Fisheries, Govt. of Manipur, Imphal.
- Department of Fisheries, Govt. of Sikkim, Gangtok.
- Department of Fisheries, Govt. of Mizoram, Aizwal.
- Department of Forest, Govt. of UP., Lucknow
- Assam Fisheries Development Corporation Ltd., Guwahati
- Zoological Survey of India, Dehradun.
- National Informatics Centre, Delhi and Lucknow.
- UP Remote Sensing Application Centre, Lucknow.

Non Government Organisations/ Professional Societies

- Several NGOs working in the North Eastern Region of India.
- Aquatic Biodiversity Conservation Society, Lucknow.

Other Organisations

- National Institute of Oceanography, Panaji, Goa.
- Central Drug Research Institute, Lucknow.
- Central Institute of Medicinal and Aromatic Plants, Lucknow
- Kerala Forest Research Institute, Trichur, Kerala.
- Indian Institute of Remote Sensing, Dehradun.
- Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow.
- Marine Products Export Development Authority, Cochin.
- Department of Limnology, Barkatullah University, Bhopal.
- North Eastern Council, Shillong, Meghalaya.
- Industrial Toxicology Research Centre, Lucknow.
- Centre for Cellular Molecular Biology, Hyderabad.
- Wildlife Institute of India, Dehradun.
- Fisheries Survey of India, Mumbai

WORKSHOPS/ SYMPOSIA ORGANISED

Workshop on Freshwater Fish Diversity of Hill States of Northern India: Conservation and Management for Sustainable Fisheries

The NBFGR organized a Regional Workshop in Hindi on *"Mithajal Matsya Vividhta: Uttari Bharat Ke Parbatiya Rajyon Me Tikaoo Matsiyki Hetu Sanrakshan Evam Prabandhan"* during April 24-25, 2006. The main objective of the workshop was to discuss the state-wise status of the freshwater fish diversity in the hill states of northern India namely, Uttaranchal, Himachal Pradesh and Jammu & Kashmir and to plan a strategy for sustainable development and conservation of freshwater fish diversity of these states. A total of 70 participants from universities, fisheries research institutes, state fisheries departments and the ICAR participated in the workshop. Prof S.P. Singh, Vice Chancellor, HNB Garhwal University, Srinagar, Uttaranchal inaugurated the workshop whereas Dr. S. Ayyappan, DDG (Fy.), ICAR presided over the inaugural function (Fig. 65). Dr. P.V. Dehdrai, Former DDG (Fy.), ICAR; Prof. M.Y. Kamal, Former Vice Chancellor, Sher-e-Kashmir University of Agriculture and Technology, Srinagar, J&K and Prof. H.R. Singh, Former Vice Chancellor, Allahabad University, Allahabad were other dignitaries on the dais.

Fig. 65. Prof. S.P. Singh, Vice Chancellor, HNB Garhwal University, Srinagar, delivering the inaugural address

Workshop on Fish Germplasm Exploration, Cataloguing and Conservation for North Eastern Region: New Initiatives

The NBFGR, Lucknow, in collaboration with ICAR Complex for NEH Region, Barapani, organized a Workshop on "Fish Germplasm

Fig. 66. A view of the concluding session of the Workshop organised by NBFGR at Barapani, Meghalaya

Exploration, Cataloguing and Conservation for North Eastern Region: New Initiatives" during May 5-6, 2006 at Barapani, Meghalaya. Major thrust areas of the workshop were: fish germplasm explorations, molecular characterization for genetic diversity of prioritized fish species, phylogeny, systematics and resolving taxonomic conflicts, gene banking, exploration of aquatic microbial diversity of north-eastern India, documentation of indigenous knowledge & policy issues related to fisheries in north- eastern region. Dr. P. Das, Former Director, NBFGR was the Chief Guest of the inaugural function. Dr. W.S. Lakra, Director, NBFGR, Lucknow gave an overview of NBFGR research activities. Dr. K.M. Bujarbaruah, Director, ICAR Complex for NEH Region, Barapani chaired the inaugural function. Dr. E.G. Silas, Former Vice-Chancellor, Kerala Agricultural University and Former Director, CMFRI, Cochin chaired a technical session during the workshop (Fig. 66). About 100 participants from different universities, institutes, organizations and government departments of north-eastern region actively participated in the workshop.

National Workshop on Fish Introductions in India

The Institute organized a National Workshop on "Fish Introductions in India: Status, Challenges and Potentials - a Public Private Partnership" during Sept 16-17, 2006. A total number of 60 invited experts from ICAR Institutes; State Agricultural Universities; MPEDA; Coastal Aquaculture Authority; Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and several aquaculturists and entrepreneurs participated in the workshop. Among the distinguished personalities included Dr. S. Ayyappan, DDG (Fy.), ICAR; Prof. K.V. Devraj, Former Vice-Chancellor, University of Agricultural Sciences, Dharwad; Dr. P.V. Dehadrai, Former DDG (Fy.), ICAR; Dr. M.Y. Kamal, Former Vice-Chancellor, Sher-E-Kashmir University of Agriculture and Technology, Srinagar and Dr. P. Das, Former Director, NBFGR, Lucknow (Fig. 67).

Fig. 67. Inaugural function of the National Workshop on Fish Introductions in India

Workshop on Conservation Assessment of Freshwater Fish Diversity for Central India

The Bureau organized a Regional Workshop on "Conservation Assessment of Freshwater Fish Diversity for Central India (CAFF 2006)" at CIAE, Bhopal on Nov. 25, 2006. The major objective of the workshop was to assess the status of fish diversity of three states of central India; Madhya Pradesh, Rajasthan and Chattishgarh and suggest effective strategies for conservation and management of endangered and threatened fish species of theses regions. Dr. Mahesh Sharma, Director General, Madhya Pradesh Council of Science and Technology, Bhopal was the Chief Guest on this occasion. Dr. S.N. Diwedi, Former Additional Secretary, Govt. of India; Dr. P.V. Dehadrai, Former Deputy Director General (Fisheries), ICAR, New Delhi and Dr. G.P. Dubey, Fishery Consultant and Former Director, Fisheries, MP also graced the occasion (Fig 68).

Fig. 68. A view of the inaugural function of the Workshop on conservation Assessment of Freshwater Fish Diversity for Central India.

The technical sessions consisted of lead presentations from the representatives of the three states and leading experts of the universities. In the second phase of the workshop, state-wise group discussions were held on identified issues. In the concluding session, action points were finalized. A total of 200 participants including leading professors from universities; eminent fisheries scientists from research institutes; officers of the state fisheries departments from Madhya Pradesh, Chhatisgarh and Rajasthan; and Zoological Survey of India; representatives from State Biodiversity Boards; and Non Governmental Organizations attended the workshop.

Awareness Programmes on Exotic Fishes in India

The NBFGR organized two awareness programmes on Exotic Fishes in India on July 24, 2006 and July 25, 2006 at CIBA, Chennai and CIFE, Mumbai, respectively. During these programmes NBFGR scientists gave presentations on different aspects concerned with exotic fishes. A large number of scientists, aquaculturists and entrepreneurs participated in these programmes. Two publications entitled "Fish Introductions and Quarantine: Indian Perspective" and "Field Guide for OIE and FAO/NACA Listed Aquatic Animal Diseases" were also released on this occasion.

IMPORTANT MEETINGS

Staff Research Council (SRC) Meetings

The Annual Staff Research Council meeting of the Bureau for the year 2006-07 was held during April 22-23, 2006. Dr. W.S. Lakra, Director chaired the meeting. Dr. S. Ayyappan, DDG (Fy.), ICAR chaired the meeting on 23.04.06 and reviewed the progress of on-going projects and gave valuable suggestions for improving the research programmes and output.

The Annual Staff Research Council meeting of the Institute for the year 2007-08 was organized on March 30-31, 2007 under the chairmanship of Dr. W.S. Lakra, Director (Fig 69). In his introductory remarks, Dr. Lakra stressed that the SRC meeting provides a good opportunity for SWOT analysis to refine and reorient research programmes through open discussions. He, while complementing the scientists of the Institute for having several externally funded projects ongoing, at present, also advised scientists to submit more project proposals for externally funding. All the on-going projects were critically reviewed for the programme made in 2006-07 and suggestions were given for their improvement. Five new project proposals were also presented by the scientists. Each new project presentation was followed by a detailed discussion and refinements/ modifications suggested therein.

Fig. 69. A view of the SRC Meeting

Research Advisory Committee (RAC) Meeting

The Research Advisory Committee meeting of NBFGR for the year 2006-07 was conducted during Feb. 09-10, 2007 under the chairmanship of Dr. E.G Silas, former Vice-Chancellor, Kerala Agricultural University (Fig. 70).

The following members of the RAC and NBFGR staff attended the meeting:

Fig. 70. Dr. E.G. Silas, former Vice Chancellor, Kerala Agricultural University chairing the RAC Meeting

Dr. E.G Silas, Former Vice-Chancellor, Kerala Agricultural University	Chairman
Dr. A.D. Diwan, ADG (Marine Fy.) ICAR, New Delhi	Member
Dr. P. Das, Former Director, NBFGR, Lucknow	Member
Prof. T.R. Rao, Former Director, School of Environmental Sciences Delhi University, Delhi,	Member
Dr. B.C. Panda, Former Professor and Head, Biophysics Division, IARI, New Delhi,	Member
Mr. R.R. Tripathi,	Member
Mr. Kameshwar,	Member
Dr. W.S. Lakra, Director, NBFGR,	Member
Dr. R. Soundararajan, Principal Scientist, NBFGR,	Member – Secretary
All Scientists and technical staff, NBFGR,	Invitee

Dr. Lakra expressed his appreciation and gratitude to the RAC Chairman and members for their continued guidance and support in planning and executing Bureau's research programmes. He pointed out that the Bureau is in the threshold of opening up to new frontiers of research with XI Plan period to be initiated from April, 2007. The Chairman, Dr. E.G. Silas in his introductory remarks, emphasized the importance of quality of the outputs. The RAC members also went through the Action Taken Report on the recommendations of the previous RAC meeting and expressed their happiness that most of the recommendations have been addressed to effectively. Dr. Lakra made a presentation on the overall research achievements of the Bureau, as well as, the initiatives and collaborative research taken up with the participation of other institutions. The Chairman appreciated the achievements from the last year's programmes

and congratulated Dr. Lakra and scientists for the same. Subsequently, there were presentations on the progress of work during the year 2006-07 by the respective Head of Divisions/ Section in-charge/ PI of the projects.

After the project's presentation, there was a discussion on XI Plan proposals. The discussion was focused on the following research thrust areas:

1. Cataloguing and Classification of Fish Genetic Resources;
2. Conservation and Management of Fish Genetic Resources;
3. Development of molecular markers, their application in documentation of natural genetic diversity and genome research; and
4. Disease diagnostics, risk assessment and quarantine of exotic aquatic species.

The corrections and refinement suggested by RAC were incorporated in the proposed programmes and infrastructure. The following general recommendations were also made by the RAC on XI Plan Proposals/ EFC of NBFGR:

1. Central Instrumentation / Training Facility with required equipments has to be created.
2. Scientific and technical manpower has to be strengthened along with appropriate ratio of other staff.
3. Strengthening the NBFGR Cochin Unit with adequate facilities and manpower and upgrading it as a full-fledged center.
4. A brain storming session may be arranged with the participation of renowned experts to facilitate the refining of XI Five year Plan proposals / EFC for the Bureau.
5. Linkages with other organizations/ institutes are to be strengthed to share the resources, facilities and data.
6. Team work should be encouraged among different Divisions of the Bureau, on targeted/ prioritised research programmes.
7. Students form abroad should be attracted for getting training from the Bureau by making NBFGR globally recognized for excellence.
8. Good hostel facilities have to be created for visiting students and faculty members.

PUBLICATIONS

Research papers

Gopalakrishnan, A., P.M. Abdul Muneer, K.K. Musammilu, K.K. Lal, D. Kapoor and V. Mohindra, 2006.

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LIST OF PROJECTS

Institutional Projects

1. Fish Biodiversity database of India. *D. Kapoor, A. Gopalakrishnan, A. K. Pathak, K.V. Singh, R. Dayal, S. K. Paul and Reeta Chaturvedi.*
2. Development of database on Marine ornamental and shell-fishes of Indian waters. *R. Soundararajan, Rehana Abidi, V.S. Basheer, A. K. Pathak, M.S. Verma* and *K.V. Singh.*
3. Genotoxic studies of selected piscicides and xenobiotics in fishes using molecular assays. *N. S. Nagpure, Ravindra Kumar, Poonam J. Singh* and *S.K. Srivastava.*
4. Detection of protozoan and monogenean parasites of freshwater exotic fishes using molecular techniques. *Rehana Abidi, G. Rathore, Neeraj Sood* and *T.R. Swaminathan.*
5. Invasive impact of exotic fish species in Uttar Pradesh with regard to fish biodiversity. *A.K. Singh and A.K. Pathak.*
6. Assessment of fish biodiversity and habitat in the selected stretch of river Ganga (Varanasi and Allahabad) and development of a conservation model using GIS tools. *U.K. Sarkar, S.P. Singh, A. K. Pathak, L.K. Tyagi, S.M. Srivastava, S.K. Paul* and *Reeta Chaturvedi.*
7. Status and role of temple sanctuaries in river Gomti towards developing policies for conservation and sustainable production. *S.P. Singh, L.K. Tyagi. S.M. Srivastava, Amar Pal* and *S.K. Paul.*
8. Studies on fishing cooperative societies with focus on their potential for conservation of fishery resources. *L.K. Tyagi, S.P. Singh, S.M. Srivastava, Amar Pal* and *S.K. Paul.*
9. Cryopreservation protocols and germplasm accession development for prioritized freshwater fishes. *V.S. Basheer, D. Noble (CMFRI, Cochin)* and *A. Gopalakrishnan.*
10. Development and utilization of fish gene banking techniques for cryopreservation of prioritized fish species. *Peyush Punia, K.K. Lal, V. Mohindra, Neeraj Sood, Rajiv Kr. Singh* and *M.S. Verma.*
11. Genetic divergence studies in marine finfish and shellfish species. *A. Gopalakrishnan, P. Jayashankar (CMFRI, Cochin)* and *V.S. Basheer.*
12. Development of molecular markers and genetic divergence studies in Indian Catfishes. *V. Mohindra, K.K. Lal, Peyush Punia, and Rajiv Kr. Singh.*
13. Development of species-specific molecular markers for florescence *in-situ* hybridization in selected fish species. *Ravindra Kumar, N.S. Nagpure, B. Kushwaha, Poonam J. Singh* and *S.K. Srivastava*
14. Barcoding of Indian marine fishes. *W.S. Lakra, M.S. Verma, A. Gopalakrishnan, K.K. Lal, V. Mohindra, K.V. Singh* and *Akhilesh Kumar Mishra.*
15. Targeted active surveillance of penaeids for OIE-listed viruses in selected maritime states of India – *Neeraj Sood, T.R. Swaminathan* and *G. Rathore.*
16. Development of cell line from *Epinephelus* sp.. *T.R. Swaminathan, G. Rathore* and *Neeraj Sood.*
17. Network Project on Germplasm Exploration, Cataloguing and Conservation of Fish and Shellfish Resources of India.
18. New initiative in fish germplasm conservation exploration, cataloguing and conservation for North East region.

Externally funded Projects

1. Harmful Algal Blooms in the Indian EEZ. Genetic Characterization of *Trichodesmium* spp. from Indian waters. *A. Gopalakrishnan*

and *V.S. Basheer* /Funded by Ministry of Earth Sciences, Govt. of India.

2. Technology development for cryopreservation of embryonic stem cells in Indian catfishes, *Clarias batrachus* and *Heteropneustes fossilis. K.K. Lal* and *Peyush Punia*/Funded under APCESS- ICAR.
3. Database on taxonomy and distribution of freshwater fishes of India-UP. *D. Kapoor, R.K. Tyagi* (CIFRI, Allahabad), *A.K. Pathak* and *R. Dayal* / Funded under APCESS- ICAR.
4. Development of molecular markers for fluorescence *in-situ* hybridization in genus Tor. *Ravindra Kumar, N.S. Nagpure* and *B. Kushwaha/* Funded by DBT, Govt. of India.
5. Isolation and characterization of *Flavobacterium* spp from fish and aquatic environmental samples. *G. Rathore/* Funded by ICAR.
6. Studies on association of viral infections in diseases of cultured freshwater carps by immunological and molecular techniques. *G. Rathore and T. Raja Swaminathan/*Funded by DBT, Govt. of India.
7. Transcriptome analysis of *Clarias batrachus* spleen: Analysis of genes in immune function and type I markers. *V. Mohindra* / Funded by DBT, Govt. of India.

PARTICIPATION IN SEMINARS/ SYMPOSIA/ WORKSHOPS/ TRAININGS/ MEETINGS

Abroad

- Dr. W.S. Lakra, Director attended an International Symposium on "Genetics in Aquaculture IX", at Montpellier, France during June 27-July 1, 2006 and chaired a technical session.
- Dr. W.S. Lakra, Director participated in the XII Animal Science Congress 2006 held at Busan, Korea during Sep. 18-22, 2006 as a lead Speaker for Aquaculture.
- Mrs. Poonam Jayant Singh, Scientist (SS) and Nodal Officer for IPR & Patents, NBFGR attended a Summer School on Intellectual Property at World Intellectual Property Organization, Geneva, Switzerland during July 3-14, 2006.
- Dr. T. Raja Swaminathan, Scientist (SS) attended a FAO/DA- BFAR/ NACA-workshop on "Information requirements for maintaining aquatic animal biosecurity" at Cebu City, Philippines during February 14-18, 2007.

In India

- Dr. W.S. Lakra, Director attended the meeting of the Directors of ICAR Fisheries Research Institutes at NRCCW, Bhimtal from April 15-16, 2006.
- Dr. W.S. Lakra, Director and Dr. Peyush Punia, Sr. Scientist attended the Mahseer Writeshop at Lonavala organized by CIFE, Mumbai and Tata Power Company during June 17-19, 2006.
- Dr. W.S. Lakra, Director attended the XI plan meeting for Inland Aquaculture and Fisheries at CIFRI, Barrackpore during Aug. 21-22, 2006.
- Dr. W.S. Lakra, Director attended the XVIII meeting of the ICAR Regional Committee No. IV at ICAR Research Complex for Eastern Region, WALMI complex, Patna during Sept. 1-2, 2006.
- Dr. W.S. Lakra, Director attended the International Symposium on "Current Issues in Zoology and Environment Sciences" at Department of Zoology, DDU, Gorakhpur, UP, on Nov. 11, 2006.
- Dr. W.S. Lakra, Director attended the Director's Conference at NASC Complex, Pusa, New Delhi during Nov. 3-4, 2006.
- Dr. W.S. Lakra, Director attended the Agricultural Summit 2006 - Reforms for Empowering the Farmer at Vigyan Bhawan, New Delhi during Oct. 18-19, 2006.
- Dr. W.S. Lakra, Director; Dr. A.K. Singh, Sr. Scientist and Dr. U.K. Sarkar, Scientist (SS) attended the Advisory Committee Meeting of Department of Science and Technology on Animal Sciences at SV University, Tirupati during July 21-22, 2006.
- Dr. W.S. Lakra, Director; Dr. L.K. Tyagi Scientist (SS) and Dr. S.K. Srivastava, T-6 attended the inaugural function of the National Fisheries Development Board at Hyderabad on Sept. 9, 2006.
- Dr. W. S. Lakra, Director attended the 12th

meeting of the National Committee on Introduction of Exotic Aquatic Species on January 19, 2007 at DAHDF, MOA, New Delhi.

- Dr. W. S. Lakra, Director attended the Mega Seed Project meeting of ICAR on March 01, 2007 at NASC, New Delhi.
- Dr. W. S. Lakra, Director attended the 6th meeting of the Bioscience sub-group of ICAR-CABI Work Plan Committee, New Delhi on March 08, 2007.
- Dr. Kuldeep Kumar Lal, Sr. Scientist attended a meeting on Seed production in Agricultural Crops and Fisheries at CIFA, Bhubaneswar during April 6-7, 2006.
- Shri Ashish Srivastava, Assistant Finance & Account Officer attended a training programme on "Purchase policy and procedures in government departments" organized by Center for Training and Social Research, New Delhi at Hotel Jaypee Siddharth, New Delhi during April 19-21, 2006.
- Dr. Kuldeep Kumar Lal, Sr. Scientist participated in Institute Management Committee meeting of CIFA Bhubaneswar on May 26, 2006.
- Dr. A.K. Singh, Sr. Scientist participated in the Brainstorming session on Reclamation of saline soil through fisheries and horticulture, organized by CSSRI, Karnal at UPCAR, Lucknow on June 26, 2006.
- Shri Ashish Srivastava, Assistant Finance & Account Officer and Shri Tej Singh Seepal, Sr. Clerk attended a training programme on "IT Sensitization for Finance Officers / Officials" at Division of Computer Applications, IASRI, New Delhi during June 26-30, 2006.
- Shri A.K. Pathak, Scientist (Sr. Scale) attended a workshop on "People's Biodiversity Register" and expert committee meeting on "Developing the Biodiversity" organized by National Biodiversity Authority, Chennai at Anna University, Chennai during June 22-23, 2006.
- Shri V.S. Basheer, Scientist (SS) attended a Summer School on "Recent Advances in Seed production and Growout Technologies for Marine finfish and Shellfish" during August 7-27, 2006 at Regional Centre of CMFRI, Mandapam.
- Dr. Gaurav Rathore, Scientist (SS) attended a meeting on preparation of Vision 2020 document at New Delhi on August 28-29, 2006.
- Shri Satyavir Chaudhari, Library Assistant (T-II-3) attended a National Convention and Seminar on Library Legislation and Development at CDRI, Lucknow during August 12-13, 2006.
- Dr. A.K. Singh and Dr. Ravindra Kumar, Sr. Scientists participated in the Task Force meeting of the Department of Biotechnology at New Delhi on Sept 4, 2006.
- Shri Rajesh Dayal T-6 and Shri S.M. Srivastava T-6, attended a Summer School on "Advanced Fish Taxonomical Methods for Fisheries Professionals at Fisheries College and Research Institute, Tuticorin, T.N. during Sept. 4-26, 2006.
- Shri R.C.P. Sinha, Stenographer attended two training programmes on Improving effectiveness of PA/PS and office personnel and Interpersonal relations and effective communication for office/ organizational growth organized by national Institute of

man management and Advancement, New Delhi at Goa during Sept.26- 30, 2006.

- Dr. A. Gopalakrishnan, Dr. K.K. Lal, Dr. P.P. Srivastava, Sr. Scientists and Dr. Gaurav Rathore, Scientist (SS) attended a meeting convened by Dr. S. Ayyappan, DDG (Fy.), ICAR to discuss the priorities in Biotechnology Research in Fisheries and Aquaculture during the XI plan at NRC on Coldwater Fisheries, Bhimtal during September 22-23, 2006.
- Dr. A.K. Singh, Sr. Scientist participated and presented a paper in the National Seminar on Peri-Urban Agriculture for Improved Livelihood Development Opportunities organized by Krishi evam Gramin vikas Sewa Samiti and U.P. Council of Agricultural Research at Lucknow.
- Dr. A.K. Singh, Sr. Scientist and Dr. Gaurav Rathore, Scientist (SS) attended and delivered invited talks in a National Symposium on Biosafety Perspectives held at Allahabad University, Allahabad on September 25, 2006.
- Shri Ram Sakal , Jr. Stenographer attended a Technical Workshop on Effective Private Secretaries/ PAs and Office Staff organized by the Institute of Socio-economic research and Action, New Delhi at The Connaught Hotel, New Delhi during October 12-14,2006.
- Dr. T. Raja Swaminathan, Scientist attended an export consultation to consider Risks and benefits of introduction of *Litopenaeus vannamei* in India organized by Coastal Aquaculture Authority of India at Chennai on October 26, 2006.
- Dr. T. Raja Swaminathan, Scientist attended a training programme on "Application of PCR for improved shrimp health management in the Asian region" during October 23-27, 2006 organized by NACA, MPEDA, ACIAR and CIBA at CIBA, Chennai.
- Dr. A. Gopalakrishnan, Sr. Scientist participated in the 7th Asia pacific Marine Biotechnology Conference during 2-5 November 2006 organized by National Institute of Oceanography, Goa, India.
- Dr. Gaurav Rathore, Scientist (SS) attended a training programme on "Genome analysis techniques in farm animals: Cloning, chracterization and *in vitro* expression of gene and identification of genetic markers for economic traits" during Nov. 21- Dec. 11, 2006 at Dept. of Animal Genetics, IVRI, Izatnagar.
- Dr. Neeraj Sood, Scientist (SS) attended a training programme on "Molecular diagnostics and animal tissue culture techniques" during November 2-22, 2006 at Dept. of Animal Biotechnology, College of Veterinary Sciences, CCS Haryana Agriculture University, Hissar.
- Shri Rajesh Dayal, T-6, attended a training programme on "Tools and Languages for Database Development" at Biotechnology park, Lucknow during Nov. 9-10, 2006.
- Dr. L.K. Tyagi, Scientist (SS) and Shri Amar Pal, Technical Officer participated in a National Workshop on Natural Resources and Local Communities at Itarsi, MP during Nov. 18-20, 2006.
- Dr. T. Raja Swaminathan, Scientist (SS) attended a discussion meeting on setting up a National Agenda towards Biosecurity at National Institute of Advanced Studies, Bangalore during November 23-24, 2006

organized by M.S. Swaminathan Research Foundation, Chennai and National Institute of Advanced Sciences, Bangalore.

- Shri P. Lal, AAO attended a residential workshop on Right to Information Act, 2005 at Gurgaon during Dec. 20-21,2006.
- Shri V.S. Basheer Scientist (SS) participated in the International Symposium-cum-exhibition on sustainable fisheries development for food and health security during 20-21 December 2006 organised at College of Fisheries, Mangalore.
- Shri Gulab Chandra, T-2 attended a training programme on "Supervisory Development" at Foremen Training Institute, Jamshedpur during January 08-12, 2007.
- Dr. A. Gopalakrishnan, Sr. Scientist participated in the Symposium on Enhancing skills for research and development in marine fisheries during February 5-7, 2007 organised at Central Marine Fisheries Research Institute, Kochi.
- Dr. U.K Sarkar, Sr. Scientist and Shri A.K. Pathak, Scientist (SS) attended a training programme on "Application of remote sensing in agriculture and allied sciences research" at Remote Sensing Application Centre (RSAC), Lucknow during February 19-25, 2007.
- Dr. L.K Tyagi, Scientist (SS) and Hindi Officer attended half-yearly meeting of the Nagar Rajbhasha Karayawahan Samiti at Central Drug Research Institute (CSIR), Lucknow on February 26, 2007.
- Dr. U.K Sarkar, Sr. Scientist attended a Consultation workshop of the MOEF Animal and Plant Committee for development of criteria for inclusion of flora & fauna in the schedules of the Indian Wildlife (Protection) Act, 1972, held at Wildlife Institute of India, Dehradun, during March 19-20, 2007.

LIBRARY AND INFORMATION SERVICES

The NBFGR Library and Documentation Unit acts as a repository of literature and information and provides latest information in the field of fish diversity conservation, fish genetics, fisheries and related aspects.

Resource Development

The library added a total of 443 documents, including 351 books, 237 serials and 50 annual reports, during the period under report. At present, the library has a total collection of 4924 books, 1654 bound volumes of journals, 2537 serials and 2261 reprints. The library subscribed to 31 international current journals and 51 Indian current journals. In addition to these, 44 current journals were received on gratis/ exchange basis. The library also subscribed to 77 electronic journals of Blackwell Publishing, related to Agriculture, Plant Sciences, Fisheries, Aquaculture and Ecology. The total expenditure incurred by the library during the year under report was Rs. 15, 13,826/-.

Library Automation

The various activities of library have been computerized using LIBSYS: Library Automation Software. The record of books, journals, maps, etc., was entered in the database. Barcoding of books, periodicals, maps for automated circulation is under active process.

Readers and Reference Services

A total of 7975 documents were borrowed and 1200 users consulted 7975 documents in the library. A total of 200 scientists, professors and research scholars from different institutions of the country consulted the NBFGR library. The references from different databases using Internet were searched and arranged to suit the requirements of users by using the 'Reference Manager' and 'Biblioscape: Research Information Manager' software.

Technical Reports and Reprography Services

Technical reports on the progress and research activities of the Bureau were compiled and sent to various agencies. This unit also attended to Questionnaires on Bureau's infrastructure and other facilities. Review and research papers and abstracts of the Director and scientists were communicated to various journals and symposia, seminars and conferences for presentation and publication. The unit provided technical support to bring out departmental publications. The bio-data of scientists is also maintained and updated in this unit. The Section continued active reprography services. Comb binding, spiral binding, electro-data binding and lamination facilities for departmental reports were provided.

Exchange Services

The Library continued exchange relationship and resource sharing with 68 leading National and International Research Institutes and Development organizations. To keep abreast of the activities of the Bureau, the library sent the NBFGR Annual Report 2005-2006 to Universities, State Fisheries Departments, FFDA, Entrepreneurs and Fish Farmers.

Institute Publications

The following Institute publications were brought out by the library:

1. Kshetriya Karyashala "Meetha Jal Matsya Vividhata: Uttari Bharat ke parvatiya rajyon mein tikaoo matsyiki hetu sanrakshan evam prabandhan", April, 24-25, 2006 (Abstract Book in Hindi).
2. Fish Introductions and Quarantine: Indian Perspective/ by *W.S. Lakra, R. Abidi, A.K. Singh, N. Sood, G. Rathore and T. Raja Swaminathan.*
3. Field Guide for OIE and FAO/NACA Listed Aquatic Animal Diseases/ by *T. Raja Swaminathan, R. Abidi and W.S. Lakra.*
4. Matsya Palan Darshika (Hindi)/ *W.S. Lakra and A.K. Singh.*
5. NBFGR Newsletter, Vol. 4(1), Jan-June, 2006.
6. NBFGR Newsletter, Vol. 4(2), July-December, 2006.
7. NBFGR Annual Report, 2005-06.

OTHER IMPORTANT ACTIVITIES

Aquatic Biodiversity Conservation Society (ABCS) launched

A professional society, named "Aquatic Biodiversity Conservation Society (ABCS)", was formed at the NBFGR. Dr. Mangala Rai, Secretary, DARE and Director General, ICAR, Govt. of India has kindly consented to be the Patron of the Society, whereas, Dr. S. Ayyappan, Dy. Director General (Fy.) as Co-Patron. The society was formally launched at NBFGR, Lucknow on April 24, 2006 by Dr. S. Ayyappan, Dy. Director General (Fy.), ICAR, New Delhi (Fig. 71). Dr. W.S. Lakra, Director, NBFGR is the Founder President of the Society. The ABCS is a culmination of a long felt desire to bring all those who have keen interest and been involved with the conservation of aquatic biodiversity, under one umbrella for sharing the knowledge and expertise. The society intends to focus on all aspects of conservation of aquatic biodiversity and its sustainable use for the present, as well as, future generations. The ABCS has its headquarters at National Bureau of Fish Genetic Resources, Lucknow.

Fig. 71. Dr. S. Ayyappan, DDG (Fy.) ICAR releasing the brochure of ABCS

NBFGR signed MoUs with HNB Garhwal University and Lucknow University

A Memorandum of Understanding (MoU) was signed between NBFGR, Lucknow and HNB Garhwal University, Srinagar, Garhwal, Uttarakhand on April 24, 2006 in the presence of Prof. S.P. Singh, Vice Chancellor, HNB Garhwal Univesity, Srinagar, Garhwal; Dr. S. Ayyappan, DDG (Fy.), ICAR and Dr. W.S. Lakra, Director, NBFGR and other important dignitaries. Similarly, the Institute also signed a MoU with the Department of Zoology, Lucknow University, Lucknow. The primary objective of these MoUs is to develop and share expertise and facilities at mutually agreeable terms and conditions.

Hindi Day and Hindi Pakhwada organized

A function was organized on Sept.14, 2006 to celebrate the Hindi Day (Fig. 72). The Institute also observed a Hindi Pakhwada during Sept.15-29, 2006 during which 6 Hindi competitions were organized among the staff of the institute, to promote the use of Hindi in official work. Shri Subhash Chandra, Library Assistant (T-4) won the prize for the Best Hindi Competitor – 2006. Dr. W.S. Lakra, Director, NBFGR distributed certificates and prizes to all the winners of these competitions.

Fig. 72. A view of the Hindi Day function

CIFE, Chinhat Centre merged with NBFGR, Lucknow

The assets and farm facilities, along with twenty two staff members of the Chinhat, Lucknow Centre of the Central Institute of Fisheries Education, Mumbai were transferred to the Bureau w.e.f. February 21, 2007.

New Infrastructure/Facilities

- The Institute procured and installed a new digital EPBAX system and fishing rafts which were inaugurated by Dr. S. Ayyappan, DDG (Fy.), ICAR, New Delhi on April 23, 2006. The DDG (Fy.) also inaugurated the newly furnished and strengthened Technical Cell in the administration block and a Badminton Court near the residential block. In addition, the DDG (Fy.) planted a tree and released the riverine seed of some freshwater species to be kept in the gene bank. On this occasion, the DDG(Fy.) also addressed the scientists and other staff of the Institute (Fig. 73 & 74).

Fig. 73. Dr. S. Ayyappan, DDG (Fy.), ICAR, New Delhi planting a tree at NBFGR campus

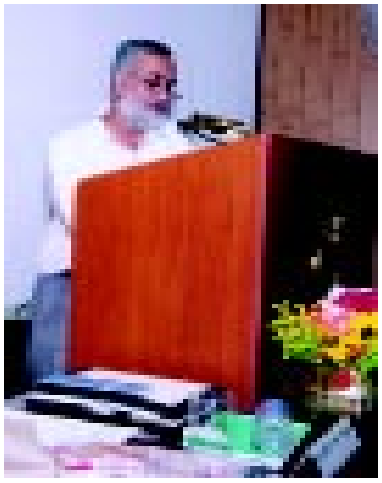

Fig. 74. Dr. S. Ayyappan, DDG (Fy.), ICAR, New Delhi addressing the sceintists and staff of NBFGR

- A new DNA Barcoding and Training Lab was established in the laboratory block of the Institute which was inaugurated by Dr. S. Ayyappan, Deputy Director General (Fy.), ICAR, New Delhi on September 16, 2006 (Fig. 75).

Fig. 75. Dr. S. Ayyappan, DDG (Fy.), ICAR, New Delhi inaugurating the new DNA barcoding Lab

- The Institute celebrated the Independence Day and the Republic Day on August 15, 2006 and January 26, 2007, respectively. A flag

hoisting ceremony was observed on both the occasions. Dr. W.S. Lakra, Director hoisted the National Flag in the presence of other staff members of the Bureau (Fig. 76). On the Independence Day, a cultural programme was also organized; whereas, a series of sports events were organized for the staff and their family members on the Republic Day. Dr. W.S. Lakra, Director distributed prizes to the winners (Fig. 77).

- A Vigilance Week was organized at NBFGR during Nov 6-10, 2006.
- A Communal Harmony Week was also celebrated at NBFGR during 14-20 Nov 2006.

Fig. 76. Dr. W.S. Lakra, Director, NBFGR addressing the staff members on the Republic Day

Fig. 77. Dr. W.S. Lakra, Director, NBFGR distributing prize to Dr. T. Raja Swaminathan, Scientist (SS) during sports events organized on Republic Day

DISTINGUISHED VISITORS

The following distinguished personalities visited the Bureau and its Cochin Unit during the year 2006-07:

NBFGR H.Q., Lucknow

- Dr. S. Ayyappan, Deputy Director General (Fy.), ICAR, New Delhi. *
- Dr. Robert D. Ward, Senior Principal Scientist, CSIRO Marine and Atmospheric Research, Hobart, Tasmania, Australia. *
- Dr. S.A.H. Abidi, Former Member, Agricultural Scientist's Recruitment Board, ICAR, New Delhi
- Prof. K.V. Devraj, Former Vice-Chancellor, University of Agricultural Sciences, Dharwad.
- Dr. P.V. Dehadrai, Former DDG (Fy.), ICAR, New Delhi
- Dr. E.G. Silas, Former Vice Chancellor, Kerala Agricultural University, Trichur and Chairman, RAC, NBFGR. *
- Dr. S.D. Tripathi, Former Director, Central Institute of Fisheries Education, Mumbai
- Dr. M.Y. Kamal, Former Vice-Chancellor, Sher-E-Kashmir University of Agriculture and Technology, Srinagar.
- Dr. N.K. Tyagi, Member, Agricultural Scientist's Recruitment Board, ICAR, New Delhi.

Fig. 78. Dr. N.K. Tyagi, Member, Agricultural Scientist's Recruitment Board, ICAR, New Delhi visiting laboratories of the Institute

- Dr. Dilip Kumar, Director, Central Institute of Fisheries Education, Mumbai.
- Dr. S.P.S. Ahalawat, Director, Indian Veterinary Research Institute, Izatnagar, Bareilly.
- Prof. H.R. Singh, Former Vice-Chancellor, Allahabad University, Allahabad.
- Dr. P. Das, Former Director, NBFGR, Lucknow
- Dr. A.D. Diwan, Assistant Director General (Marine Fy.) ICAR, New Delhi. *
- Prof. Sher Ali, National Institute of Immunology, New Delhi.
- Dr. R.C. Srivastava, Director, CARI, Port Blair.
- Shri P.K. Jha, IAS, Secretary, Fisheries, Govt. of U.P.
- Shri. G. K. Tandon, Special Secretary (Fy.), U.P.
- Shri Bihari Swaroop, Director, Fisheries, UP.
- Shri. R.B. Verma, Former Managing Director, U.P Fish Development Corporation.
- Dr. George John, Adviser, Department of Biotechnology, Govt. of India, New Delhi. *
- Dr. B.C. Panda, Former Professor and Head, Biophysics Division, IARI, New Delhi
- Prof. T.R. Rao, Former Director, School of Environmental Sciences, Delhi University, Delhi.
- Dr. B.N. Pandey, Bhabha Atomic Research Centre, Mumbai.
- Dr. D.P. Singh, Dean and Head of the Department, Environmental Science, BBR Ambedkar University, Lucknow.
- Shri M. Dwivedi, Special Secretary, Fisheries, Govt. of U.P. Lucknow.

- Smt. Anita Mishra, Director, Uttar Pradesh State Fisheries Department, Lucknow.
- Dr. G. Choudhary, Professor and Head, Department of Gastroenterology, Sanjay Gandhi Post Graduate Institute, Lucknow.
- Prof. Sandeep Malhotra, Department of Zoology, Allahabad University, Allahabad.
- Prof. Nirupama Agarwal, Head, Department of Zoology, Lucknow University.

NBFGR Cochin Unit

- Dr. Jesse H. Ausbel, Programme Director, Alfred P. Sloan Foundation, New York, USA.

Fig. 79. Dr. Jesse H. Ausubell, Program Director Alfred P. Sloan Foundation, New York, U.S.A. discussing with Scientist and Research fellows at NBFGR Cochin Unit

- Shri G. Mohan Kumar, Chairman, Marine Products Export Development Authority, Kochi.

Fig. 80. Dr. Robert D. Ward, Senior Principal Scientist, Marine Research, CSIRO, Hobart, Tasmania, Australia discussing with Dr. A. Gopalakrishnan, OIC, NBFGR Cochin Unit

- Prof. Mohan Joseph Modayil, Director, CMFRI, Cochin.
- Dr. K. Gopakumar, Vice Chancellor, IFCR – York College, Toronto, Canada and Former Deputy Director General (Fisheries), ICAR, New Delhi.
- Prof. (Dr.) M. Chandrasekaran, Department of Biotechnology, Cochin University of Science and Technology (CUSAT), Kochi.
- Dr. P.S.B.R. James, Former Asst. Director General (Marine Fisheries), ICAR, New Delhi and Former Director, CMFRI, Kochi.
- Dr. D. Chandra Mohan, Former Deputy Director, NIO, Goa
- Prof. (Dr.) A. V. Saramma, Head, School of Marine Sciences, Cochin University of Science & Technology, Kochi.

* Also v*isited NBFGR Unit at Cochin*

LIST OF PERSONNEL

Research Management

	Dr. W. S. Lakra	-	Director

Scientific Staff

1.	Dr. R. Soundararajan	-	Principal Scientist
2.	Dr. D. Kapoor	-	Principal Scientist
3.	Dr. (Mrs) Rehana Abidi	-	Sr. Scientist
4.	Dr. S. P. Singh	-	Sr. Scientist
5.	Dr. A. Gopalakrishnan	-	Sr. Scientist (NBFGR Cochin Unit)
6.	Dr. A. K. Singh	-	Sr. Scientist
7.	Dr. N S. Nagpure	-	Sr. Scientist
8.	Dr. Kuldeep Kumar Lal	-	Sr. Scientist
9.	Dr. (Mrs) Vindhya Mohindra	-	Sr. Scientist
10.	Dr. Peyush Punia	-	Sr. Scientist
11.	Dr. Ravindra Kumar	-	Sr. Scientist
12.	Dr. U. K. Sarkar	-	Sr. Scientist
13.	Dr. P. P. Srivastava	-	Sr. Scientist
14.	Dr. P. K. Varshney	-	Sr. Scientist
15.	Shri Sanjeev Kr. Srivastava	-	Scientist (Sr. Scale)
16.	Shri V. S. Basheer	-	Scientist (Sr. Scale) (NBFGR Cochin Unit)
17.	Dr. Basdeo Kushwaha	-	Scientist (Sr. Scale)
18.	Dr. Gaurav Rathore	-	Scientist (Sr. Scale)
19.	Dr. Neeraj Sood	-	Scientist (Sr. Scale)
20.	Mrs. Poonam Jayant Singh	-	Scientist (Sr. Scale)
21.	Dr. Lalit Kumar Tyagi	-	Scientist (Sr. Scale)
22.	Shri Ajay Kumar Pathak	-	Scientist (Sr. Scale)
23.	Shri Rajeev Kumar Singh	-	Scientist (Sr. Scale)
24.	Shri Mahendra Singh Verma	-	Scientist (Sr. Scale)
25.	Dr. T. Rajaswaminathan	-	Scientist (Sr. Scale)
26.	Shri Karan Veer Singh	-	Scientist (Sr. Scale)
27.	Mrs Divya P.R.	-	Scientist

Technical Staff

1.	Shri Rajesh Dayal	-	Field Officer (T-6)
2.	Shri S. M. Srivastava	-	Field Officer (T-6)
3.	Shri R. S. Patiyal	-	Farm Manager (T-6)
4.	Shri A. K. Mishra	-	Electrical Foreman (T-6)
5.	Shri Amar Pal	-	Technical Officer (T-6)
6.	Dr. S. K. Srivastava	-	Sr. Lab Technician (T-6)
7.	Shri Babu Ram	-	Farm Engineering Asst. (T-6)
8.	Shri A. K. Yadav	-	T-6
9.	Shri S. P. Singh	-	T-6
10.	Shri Ajay Kumar Singh	-	Field Surveyor (T-5)
11.	Shri S. K. Paul	-	Field Surveyor (T-5)
12.	Shri Mohd. Gyas	-	Driver (T-5)
13.	Mrs. R. Chaturvedi	-	Computer Operator (T-4)
14.	Shri R. Sah	-	Lab. Technician (T-4)
15.	Shri Subhash Chandra	-	Library Asst. (T-4)
16.	Shri A. Kr. Mishra	-	Lab. Technician (T-4)
17.	Shri S. K. Upadhyay	-	T-4
18.	Shri Ravi Kumar	-	Sr. Computer Operator (T-4)
19.	Shri Amit Singh Bisht	-	T-4
20.	Shri Satyavir Chaudhary	-	Senior Library Asst. (T-3)
21.	Shri B. K Rao	-	Sample Sorter (T-II-3)
22.	Shri R. K. Shukla	-	Sample Sorter (T-II-3)
23.	Shri Ved Prakash	-	Library Attendant (T-II-3)
24.	Shri Samarjeet Singh	-	Driver (T-I-3)
25.	Shri S. K. Singh	-	T-II-3
26.	Shri Om Prakash	-	Driver (T-I-3)
27.	Shri B. N. Pathak	-	Gestetner Operator (T-3)
28.	Shri Madan Lal	-	Farm Technician (T-2)
29.	Shri Raj Bahadur	-	Lab. Technician (T-2)
30.	Shri Gulab Chandra	-	Electrician (T-2)
31.	Shri K. K Singh	-	Jr. Field Asst. (T-2)
32.	Shri Rajesh Kumar	-	Laboratory Asst. (T-2)
33.	Shri Sree Ram	-	Laboratory Asst. (T-2)
34.	Shri Om Prakash	-	Driver (T-2)
35.	Shri P. C. Jaiswar	-	T-2
36.	Shri Ram Bharose	-	T-2

Administrative Staff

1.	Shri Ashish Srivastava	-	Asst. Finance & Accounts Officer
2.	Shri Panchoo Lal	-	Asst. Administrative Officer
3.	Shri R. C. P. Sinha	-	Personal Assistant
4.	Shri Jogendra Singh	-	Assistant
5.	Shri Navin Kumar	-	Assistant
6.	Shri Tej Singh Seepal	-	Assistant
7.	Shri P. K. Awasthi	-	Sr. Clerk
8.	Smt. Kaneez Fatima	-	Sr. Clerk
9.	Shri Swapan Debnath	-	Sr. Clerk
10.	Shri S. N. Srivastava	-	Sr. Clerk
11.	Mrs. Mamta Chakraborty	-	Jr. Stenographer
12.	Shri Ram Sakal	-	Jr. Stenographer
13.	Shri P.C. Verma	-	Jr. Clerk
14.	Shri Vinay Kumar Srivastava	-	Jr. Clerk
15.	Shri Sreelal Prasad	-	Jr. Clerk
16.	Shri S. K. Singh	-	Jr. Clerk
17.	Shri Sajivan Lal	-	Jr. Clerk
18.	Shri Ram Baran	-	Jr. Clerk

Supporting Staff

1.	Shri Narain	-	SSG-IV
2.	Shri Laxman Prasad	-	SSG-IV
3.	Shri D. Shyam Deo	-	SSG-IV
4.	Shri Anil Kumar	-	Lab. Attendant, SSG-III
5.	Shri Indrajit Singh	-	Messenger, SSG-III
6.	Shri Prahalad Kumar	-	Lab. Attendant, SSG-III
7.	Shri Chhote Lal	-	Fisherman, SSG-III
8.	Shri Dinesh	-	Lab. Attendant, SSG-II
9.	Shri Ram Lakhan	-	SSG-II
10.	Shri Dash Raj	-	SSG-II
11.	Shri B. Babu Bajpai	-	Lab. Attendant, SSG-II
12.	Shri Rajan Kumar Malhotra	-	Lab. Attendant, SSG-II
13.	Shri A. Kr Awasthi	-	Lab. Attendant, SSG-II
14.	Shri Sidhnath	-	Fieldman, SSG-II
15.	Shri Sunit Kumar	-	SSG-I
16.	Shri J. N. Tiwari	-	SSG-I
17.	Shri Mahesh Chandra	-	SSG-I
18.	Shri Anwar	-	SSG-I
19.	Shri Ashok Kumar	-	Lab. Attendant, SSG-I
20.	Smt. Sabita Kumari	-	SSG-I

Staff Welfare Activities

Institute Joint Staff Council

The Institute Joint Staff Council with the members mentioned below, was operative at the Bureau during the period under report and considered the matters of common interest.

Official side:

1.	Dr. (Mrs) Rehana Abidi Senior Scientist	-	Member
2.	Dr. N. S. Nagpure, Senior Scientist	-	Member
3.	Dr. Gaurav Rathore, Scientist (Senior Scale)	-	Member
4.	Sh. S. M. Srivastava, T-6	-	Member
5.	Sh. Ashish Srivastava, AF& AO	-	Member
6.	Sh. P. Lal, Asst. Adm. Officer	-	Member

Staff side:

1.	Sh. K. K Singh, T-2	-	Secretary
2.	Sh. S. V. Chaudhary, T-3	-	Member
3.	Sh. S. N. Srivastava, Jr. Clerk	-	Member representative of CJSC
4.	Sh. R.C.P. Sinha, P.A. to Director	-	Member
5.	Shi. Dukhi Shyam Deo, SSG-III	-	Member
6.	Sh. Ashok Kumar, SSG-I	-	Member

Women's Cell

The Women's Cell has been constituted at NBFGR, Lucknow with the following members:

1.	Dr. (Mrs) Rehana Abidi Senior Scientist	-	Head of the Cell
2.	Dr. (Mrs.) V. Mohindra Senior Scietntist	-	Member Secretary
3.	Mrs. Reeta Chaturvedi T-4	-	Member
4.	Mrs. Mamta Chakraborty Jr. Stenographer	-	Member
5.	Shri Anil Kumar SSG-III	-	Member

APPENDIX-I

NBFGR Cochin Unit

A Research Unit of the Bureau is functioning in the campus of Central Marine Fisheries Institute (CMFRI), Cochin, Kerala. This unit is carrying out research activities pertaining to genetic characterization, conservation and cataloguing of the vast fish genetic resources of marine and brackishwater ecosystems of the country, as well as, of endemic freshwater fish species from the Western Ghats – the megabiodiversity 'hotspot'.

Address : **Scientist–in-Charge**
NBFGR Cochin Unit
CMFRI Campus
Post Box No. 1603
Ernakulam North P.O.
Kochi – 682 018, Kerala.
Telefax : 0484-2395570
E-mail : nbfgrcochin@vsnl.net
nbfgrcochin@eth.net

APPENDIX-II

Aquaculture Research & Training Unit, Chinhat

An Aquaculture Research & Training Unit of the Bureau is functioning at Chinhat, Lucknow. This unit is carrying out human resource development activities including practical training programmes and fishery advisory services pertaining to fish culture, induced breeding, quality fish seed production, hatchery management and nursery pond management.

Address : **Scientist–in-Charge**
NBFGR Aquaculture Research & Training Unit
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