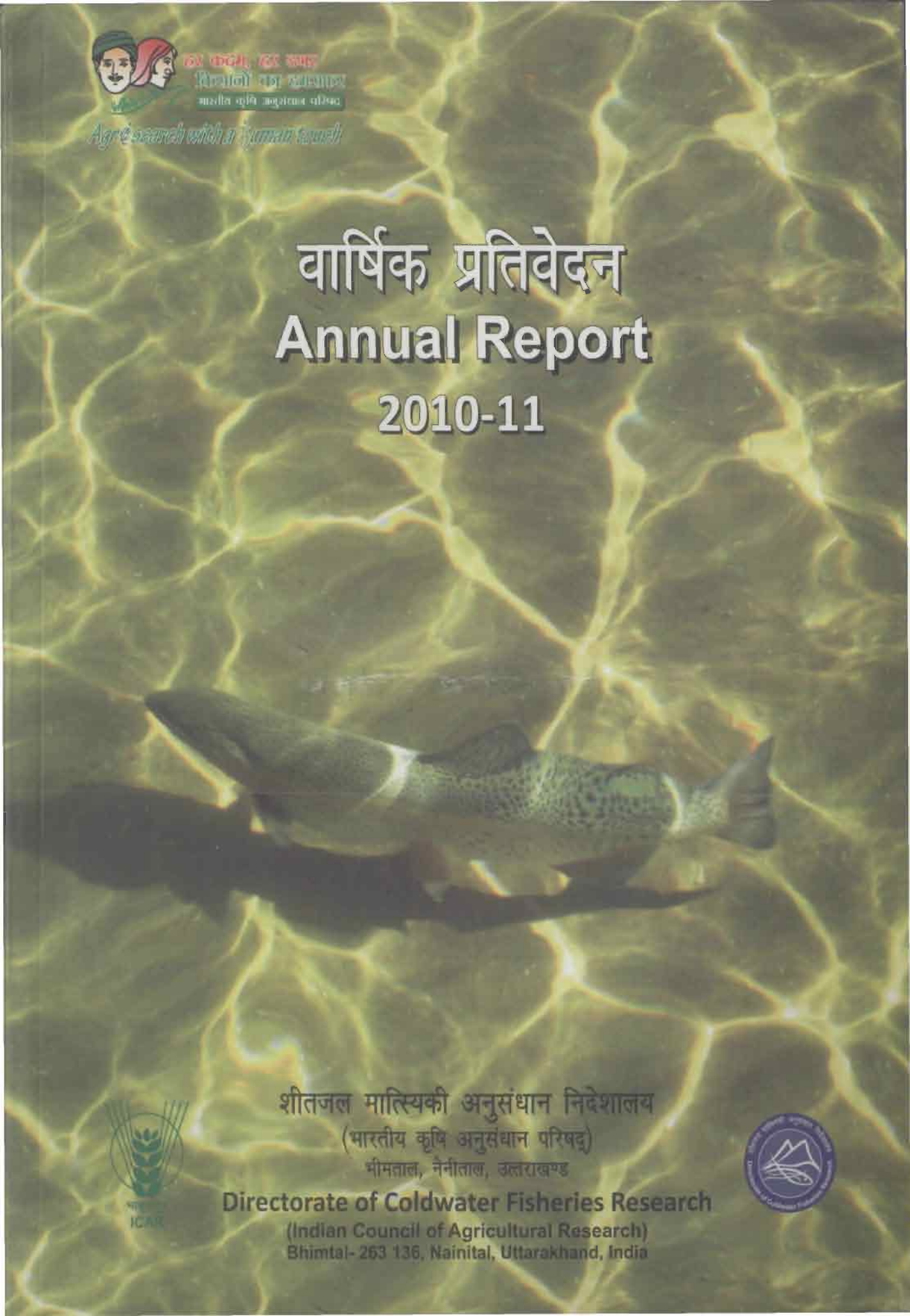

वार्षिक प्रतिवेदन
Annual Report
2010-11

शीतजल मात्स्यिकी अनुसंधान निदेशालय
(भारतीय कृषि अनुसंधान परिषद्)
भीमताल, नैनीताल, उत्तराखण्ड

Directorate of Coldwater Fisheries Research
(Indian Council of Agricultural Research)
Bhimtal- 263 136, Nainital, Uttarakhand, India

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agri search with a human touch

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A view of rainbow trout
(Photo by Dr. S. Ali)

Back Cover
Ladhya stream near Chalthi, Champawat
(*Photo by Dr. A. Barat*)

PREFACE

The vast aquatic resources in the forms of streams, lakes, rivers and natural and manmade reservoirs in the hill region of the country provide immense potential for the development of fisheries and fish based eco-tourism in the country. The major challenge in the coldwater sector is to increase production and sustainable utilization of aquatic resources as well as upliftment of the socio-economic status of the people, while preserving the fragile ecosystem. Fisheries in the hill region provide employment opportunity as well as nutritional security in the form of fish protein. In order to fulfill the objective of developing situation and need specific technologies for the benefit of hill community, the Directorate of Coldwater Fisheries Research has successfully completed three years working in a collaborative mode with the five hill states and other fisheries institutes. The resource mapping is an utmost requirement for assessing its health and potential utilization. The effort has been made using modern tools of Geoinformatics to develop a Decision Support System for aquaculture site selection. Species and system diversification is the need of the hour to augment the fish production from coldwater region. Sincere efforts are on to bring more number of cultivable species in the culture system by developing a package of practice. The polytank technology for fish culture in mid altitude region has been successfully tested and disseminated to the farmers which is giving a satisfactory return. Expansion of trout farming in the potential areas of the country particularly Arunachal Pradesh and Sikkim has been explored and necessary support from the Directorate is being provided.

Keeping the seriousness of the disease problem in view the Directorate has set up Fish Health Management laboratory to develop protocols for disease monitoring and management in the coldwater sector of the country. The biotechnological approach for the characterization of species and development of molecular markers is underway. I would like to emphasize that we as a team of DCFR is fully committed to virtually actualizing the path of success and setting up milestone in coldwater fisheries development of the country. During the year we have developed linkages with different ICAR institutes and state agriculture universities in the areas of research and transfer of technologies. The well equipped laboratories of the Directorate is attracting students and research scholars from different parts of the country to carry out research activities. The externally funded projects from NAIP (ICAR), Department of Biotechnology, Department of Science and Technology, New Delhi has further provided impetus to the research activities to the DCFR.

During the year we have successfully conducted several training programmes and farmer based extension activities. Scientists from the Directorate also participated in several national training, workshops, seminars and received awards and honours. It was the constant efforts of scientists and all staff members of this Directorate that made possible for such progress and achievements. The continuous support, guidance and encouragement received from Dr. S. Ayyappan, Secretary DARE & Director General, ICAR. The encouragement received from Dr. B. Meenakumari, DDG (Fisheries), Dr. S.D. Singh, ADG (Inland Fisheries), ICAR are recorded with sincere thanks and gratitude.

Thanks are also due to Dr. A. Barat, Sr. Scientist, and Dr. S. Ali, Scientist for bringing out the annual report. The efforts made by Dr. R. S. Patiyal Sr. Scientist and Sh. Amit Joshi, Technical Officer for Hindi version of the report and other assistance rendered by Smt. Susheela Tewari, PS to Director is also recorded with appreciation.

(P.C. MAHANTA)
DIRECTOR

Date: 01 June 2011

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सारांश

शीतजल मात्स्यिकी अनुसंधान निदेशालय ने गत वर्ष 2010–2011 में निदेशालय द्वारा वित्त पोषित चार प्रोजेक्ट, पाँच हिमालय राज्य हेतु एक आउटरीच एक्टिविटी, आई.सी.ए.आर. के अर्न्तगत आने वाले विभिन्न मत्स्य संस्थानों के साथ तीन आउटरीच कार्यक्रम तथा तीन वाहय सहायतार्थ योजनाओं में सफलतापूर्वक शोध संचालित किये, इसके साथ–साथ तीन संस्थागत योजनाओं को भी पूर्ण किया। फेलासोसोमेगी मिरर कार्प तथा रोफ्सा स्केली कार्प, जेनेटेकली इम्प्रोभ्ड प्रजाति को चम्पा–1 तथा चम्पा–2 के नाम से अंगीकरण किया गया जिनका दो वर्ष बाद सफलतापूर्वक प्रजनन कराया गया। प्रजनित चम्पा–1 तथा चम्पा–2 के अंगुलिकाओं को विभिन्न हिमालय राज्य अरूणाचल प्रदेश, सिक्किम, आई.सी.ए.आर.काम्पलेक्स उत्तर पूर्वी क्षेत्र को वितरित किये गये। ताकि विभिन्न पर्यावरणीय प्रक्षेत्र में इसके वृद्धि का अवलोकन किया जा सके। जलव्ययक (Water Budgeting) शोध योजना के तहत चम्पावत मत्स्य फार्म में सीपेज तथा वाष्पीकरण के कारण जल व्यय लगभग 10 प्रतिशत पाया गया। चम्पावत मत्स्य फार्म में उपलब्ध मत्स्य सम्पदा (Biomas) ट्राउट के ब्रूडर एवं अंगुलिकाओं तथा पालिटैन्क में रखी गयी कार्प तथा अंगुलिकाओं हेतु जल की आवश्यक मात्रा को मापा गया और पाया कि 5 LPS जल की मात्रा ट्राउट मछलियों हेतु चाहिए जबकि कार्प हेतु 1 LPS जल की खपत है।

निदेशालय में चलायी जा रही परियोजना ''परफारमैन्स ऑफ चोकलेट महाशीर'' के तहत *नीयोलिसोचिलस हेक्सागोनोलेपिस* के जीरा तथा अंगुलिकाओं के बर्षद्धि दर के डाटा को संग्रहित किया गया जिसमें प्रारम्भिक अनुपातिक लम्बाई एवं भार 28.1 तथा 0.21 ग्राम रहा। सम्पूर्ण रूप से 605 दिनों में वर्षद्धि लम्बाई तथा भार के हिसाब से 82.9 एम.एम तथा 14.6 ग्राम रहा। शीतजल क्षेत्र की मछलियों में पायी जाने वाली विभिन्न बिमारियों के खोज हेतु शुरूआत में सिक्किम, अरूणाचल प्रदेश तथा उत्तराखण्ड के विभिन्न क्षेत्रों में भ्रमण कर अवलोकन किया गया। सिक्किम के याकसुम एवं उतरेय फार्म के 10 प्रतिशत रेनवो ट्राउट में घाव मत्स्य के पष्ठ भाग तथा गल्फड़ा में पाये गये। दिसम्बर महीने में निदेशालय के तालाब में पाले गये 2 प्रतिशत महाशीर के अंगुलिकाओं तथा बूड स्टॉक के आँखों में बिमारी पायी गयी। इन बिमारियो के पहचान हेतु अध्ययन किया गया जिसमें *सैपरोलेगनिया पैरासाईटिग* तथा *सैपरोलेगनिया डिक्लिना* नामक फंजाई की पहचान की गई। *सैपरोलेगनिया* नामक फंजाई का स्रोत सरसों की खली तथा लैमन ग्रास निश्चित किया गया। कई समस्याओं के बावजूद आउटरीच एक्टिविटी के अर्न्तगत चल रहे शोध परियोजना ''सस्टेनेवल यूटीलाईजेशन ऑफ माउनटेन फिशरी रीसोर्स'' में अच्छी प्रगति हुई है। जम्मू एवं कश्मीर तथा सिक्किम में मात्स्यिकी संसाधन जानकारी हेतु दौरा किया गया। ट्राउट के ब्रूड बैंक स्थापना हेतु अरूणाचल प्रदेश में ट्राउट का ब्रीडिग किया गया। आउटरीच एक्टिविटी ''फिश जेनेटिक स्टाक'' के तहत *टार प्यूटीटौरा* (महाशीर) के 287 सैम्पल हिमाचल प्रदेश के वैजनाथ, पालमपुर एवं जोगिन्दर नगर और अरूणाचल प्रदेश के भालुकपुंग, उत्तराखण्ड के रामनगर, महाराष्ट्र के लोनावाला तथा जम्मू और कश्मीर के तीन स्थानों अची, जाझरकाँटी एवं वसोली से संरक्षित किये गये जिनका ट्रस नेटवर्क तथा मालिक्यूलर मारकर Cytb-ATPase जीन का प्रयोग कर विश्लेषण किया गया।

''आउटरीच एक्टिविटी आन फिशफीड इनवेस्टीगेशन'' के अर्न्तगत गोल्डन महाशीर के लारवी का पाचन एन्जाईम स्तर के विश्लेषण से लारवा पाचन क्रिया के विकास तथा शंसलेषित भोजन के विकास हेतु एक मार्ग प्रशस्त किया। लिपिड के एक समान स्तर 14 प्रतिशत तथा प्रोटीन के तीन स्तर 45, 50 एवं 35% के संयोजन से फीड (फ्लोटिंग पैलेट के रूप में) तैयार किया गया। एक अन्य आउटरीच एक्टिविटी के तहत शीतजल में विभिन्न मछलियों में खाद्य पदार्थो की पहचान की गयी। कार्य पूर्ण हो चुके प्रोजेक्ट ''डेवलपमैन्ट ऑफ जी.आई.एस. बेसड डिसीजन सपोर्ट सिस्टम फॉर एक्वाकल्चर इन सेलेक्टेड कोल्डवाटर रीजन'' के तहत मात्स्यिकी के संदर्भ में जियोइनफार्मेटिक्स एवं डीसीजन सपोर्ट सिस्टम जैसे जुडे सवालो को रेखांकित करने का प्रयास किया गया। वर्तमान अध्ययन में कुमायूँ के क्षेत्र में मात्स्यिकी हेतु जी.आई.एस. सम्बन्धी डिसीजन सपोर्ट सिस्टम को विकसित किया। प्रोजेक्ट ''माडलिग ऑफ लैन्थ वेट रिलेशनशिप एण्ड ग्रोथ पैर्टन ऑफ सेलेक्टेड इम्पोरटैन्ट कोल्ड वाटर फिश स्पेसिज'' के अर्न्तगत कोसी नदी में पायी जाने वाली महाशीर के लैन्थ वेट रिलेशन को विभिन्न स्टेटिकल मॉडल द्वारा रेखांकित किया गया।

एक अन्य प्रोजेक्ट जिसकी कार्य अवधि समाप्त हो गयी "जैनेटिक करेक्टराइजेशन एण्ड पापूलेशन स्ट्रक्चर एनालेसिस ऑफ कोल्ड वाटर फिशरिज" के अर्न्तगत पॉपजीन (POPGENE) साफ्टवेयर के उपयोग द्वारा फायलोजैनेटिक ट्री बनाया गया जिसमें दो समान्तर समूह पाया गया जिसमें *टार पूटीटोरा* के साथ *साइजोथोरेक्स रिचर्डसोनी* तथा *गारा स्पेसिज* के साथ *बैरेलियस वैन्डेलेसिस* था। गणितीय मध्यमान के UPGEM विधि द्वारा फाईलोजनेटिक ट्री का निर्माण किया गया। डाटा संग्रह नी एवं ली (1978) के अनुसार किया गया। RAPD पीसीआर ऐसे तथा mt DNA 12S rRNA सिक्वेन्स के प्रयोग से जेनेटिक दूरी का ऑकलन किया गया। निर्धारित mt DNA 12S rRNA सिक्वेन्स और RAPD पीसीआर विश्लेषण उचित साधन हो सकते हैं जिससे मौलिक्यूलर सिस्टेमैटिक्स और 12S rRNA ट्री के निमार्ण के स्थिति को फैमली स्तर तक निर्धारित करने हेतु वर्तमान अध्ययन आगे यह मार्ग दर्शाता है कि सर्वभौम प्राईमर अधिक संख्या में mt DNA जीन एवं RAPD प्राईमर मछलियों के प्रजाति स्तर तक मौलिक्यूलर सिस्टेमैटिक को निश्चित रूप प्रदान करते हैं।

वाहय पोषित प्रोजेक्ट "डेवलोपमेन्ट एण्ड करेक्टराईजेशन ऑफ माइक्रोसैटेलाईट मार्कर्स इन *साइजोथोरेक्स रीचार्डसोनी*" के अर्न्तगत स्नाट्राउट के पारशियल जीनोमिक लाईब्रेरी से 57 माइक्रोसेटेलाईट मार्कर विकसित किये गये। 57 मार्कर में से अब तक *साइजोथोरेक्स रीचर्डसोनी* के विभिन्न प्रजातियों में से 27 लोसाई को सफलतापूर्वक सत्यापित किया गया है। इनमें उच्च पोलीमार्फिकता पायी गई है जिसका उपयोग पापूलेशन जेनेटिक्स एनालेसिस एवं जेनेटिक वेरियेविलिटी अध्ययन में किया जाता है। डी.वी.टी प्रायोजित दूसरे प्रोजेक्ट में FB–2सेल से काजेटिव एजेन्ट वाईरस को चिन्हित करने का प्रयास किया गया जिसमें साईटोपैथिक प्रभाव पाया गया।

डी.वी.टी प्रायोजित पोस्ट डाक्टरल प्रोजेक्ट के अर्न्तगत क्लासिकल RAPD का प्रयोग कर पूर्वोत्तर भारत में पायी जाने वाली वैगेरिट कैटफिश (जीनस मिसटस सकापोली) का फायलोजेनी एवं जैव विविधता का ऑकलन किया गया। डेन्डोग्राम यह दर्शाता है कि *एम.रूफेसैन्स* और *मिसटस* जैनेटिकली समीपता लिये हुए है, जबकि ये मछलियां अलग–अलग प्रजाति की हैं। इनकी समीपता इन्डेक्स वैल्यू 0.444 है। इस अध्ययन का परिणाम यह दर्शाता है कि *एम. मोनटोनस, एम. वलीकरी* के साथ जनेटिकली समीपता लिये हुए है। Cyto-b ATPase 6/8 एवं COII जीन सिक्वेन्स का प्रयोग करते हुये *साईजोथोरेक्स रीचर्डसोनी* के जनसंख्या कुमाऊँ के विभिन्न क्षेत्र से पहचान की गयी। यह कार्य डी.एस.टी. प्रयोजित प्रोजेक्ट "जीनोम स्केल माइनिंग ऑफ *एस. रीचार्डसोनी* फिश स्पेसिज फॉर फारमुलेशन ऑफ ब्रीडिग प्रोग्राम" के अर्न्तगत किया गया।

NAIP (कम्पोनेन्ट–4) प्रोजेक्ट "वायो प्रोस्पेक्टिंग ऑफ जीन एण्ड एलैल माइनिग फार एवायोटिक स्ट्रैस टोलेरेन्स–कोल्ड टोलेरेन्स " के तहत मुख्य उपलब्धियां इस तरह रहीं हैं **(एक)** हिमालय क्षेत्र के विभिन्न ऊँचाई के भू भागो से क्षेत्रीय विभिन्नता युक्त *साइजोथोरेक्स* प्रजाति की प्राप्ति। **(दो)** विभिन्न तापमान के लिए फिजियोलोजिकल एवं वायोकैमिकल पैरामीटर्स को स्थापित किया गया। एलानिन एमिनो ट्रांसफरेज (ALaAt) एवं एस्प्रेटेड एमिनो ट्रांसफरेज के बड़े हुए क्रिया और लिवर के सैम्पल में एमीनो ट्रांसफरेज (As PAT) में ग्लिसरोल जमाव हेतु सम्भावित कार्बनस्रोत दर्शाता है। जो कि जाड़ो में शीततापमान को हतोत्साहित करता है। **(तीन)** AFP टाईप III द्वारा निर्मित एक प्राइमर को युग्म पीसीआर के माध्यम से 285 bp तक वृद्धि दिखाता है। जिसको NCBI जीन बैंक मे काल्पनिक प्रोटीन के रूप में प्रस्तुत किया गया है। **(चार)** NAD से जुड़े GPDH जीन को विश्वास किया जाता है कि *साइजोथोरेक्स* को शीतजल से अनुकूलनता हेतु ग्लिसरोल का जमाव करता है। *साइजोथोरेक्स* के यकृत GPDH cDNA का सफलतापूर्वक एम्पलिफाई किया गया तथा क्लोनिंग एवं सिक्वेनसिंग को सुनिश्चित किया। **(पाँच)** *साइजोथोरेक्स रीचर्डसोनी* के ब्रेन टिश्यू का प्रयोग कर 1200 क्लोन का c DNA लाईब्रेरी तैयार किया गया।

NAIP (कम्पोनेन्ट–3) प्रोजेक्ट "इन्हैन्समैन्ट ऑफ लिबलीहूड सिक्यूरिटी थ्रो ससटेनेवल फार्मिंग सिस्टम एण्ड रिलेटिड फार्म इण्टरप्राजेज इन नार्थ–वेस्ट हिमालय" के तहत बहुउद्देशीय फिश कल्चर मॉडल तैयार किया जिसमें पाली युक्त सिंचाई टैंक का प्रयोग किया गया। तालाब में चायनीज तथा कामन कार्प डाली गई जिसका 2 प्रतिशत वाडी वेट के अनुसार राईस पालिश तथा सरसों की खली दिया गया। तुलनात्मक रूप से पॉली टैंक मे 0.7kg/m^3 जबकि कच्चा मिट्टी तालाब में 0.12–0.36 kg/m^3 वृद्धि दर पायी गयी।

निदेशालयों ने एन.एफ.डी.बी. प्रायोजित प्रशिक्षण कार्यक्रम "थ्री प्रोगड़ फिश फार्मिंग टेक्नोलोजी फार हिल रीजन" को 19–23 अक्टूबर 2010 में तथा राजीव गाँधी यूनीवर्सिटी ईटानगर अरूणाचल प्रदेश के सहयोग से ईटानगर दो प्रशिक्षण कार्यक्रम को सफलतापूर्वक संचालित किया। राष्ट्रीय स्तर पर "ब्रिडिग इनक्यूवेशन एण्ड रीयरिंग ऑफ रेनबो ट्राउट" मॉडल प्रशिक्षण कार्यक्रम डी.सी.एफ.आर भीमताल में दिनांक 27 दिसम्बर 2011 से 3 जनवरी 2011 तक आयोजित की गई। इस प्रशिक्षण कार्यक्रम को डिपार्टमैन्ट ऑफ एग्रीकल्चर एण्ड कूपरेशन मिनिस्ट्री ऑफ एग्रीकल्चर, निदेशालय, नई दिल्ली द्वारा प्रायोजित किया गया। शीतजल निदेशालय ने 26 अप्रैल 2010 को विश्व बौद्धिक सम्पदा अधिकार दिवस, 5 जून को विश्व पर्यावरण दिवस मनाया, जिसमें हिन्दी के माध्यम से पर्यावरण सूचना के आदान प्रदान पर बल दिया गया। इसी क्रम मे शीतजल निदेशालय ने दो दिवसीय "नेशनल कनसल्टेशन ऑफ वायोडाईवर्सिटी ऑफ हाई अल्टीटयूड एक्वाटिक रीर्सोस कन्जर्वेशन एण्ड यूटीलाईजेशन" संदर्भ में 29–30 सितम्बर का सेमिनार आयोजित किया जिसमें विभिन्न विशेषक एवं स्टेक होल्डर ने सहभागिता की।

विभिन्न शोध क्रियाकलापों के साथ–साथ निदेशालय ने किसानों से सम्बन्धित विभिन्न प्रशिक्षण कार्यक्रम, आर.ए.सी, आई.आर.सी, आई.एम.सी, आई.जे.एस.सी की बैठकें लगातार आयोजित की। निदेशालय के वैज्ञानिको ने विभिन्न सेमिनार, सिमपोजियम तथा आई.सी.ए.आर जोनल स्पोर्ट में भाग लिया तथा राष्ट्रीय दिवस एवं राष्ट्रीय साम्प्रदायिक सौहार्द्ध दिवस को उत्साह के साथ मनाया।

EXECUTIVE SUMMARY

Directorate of Coldwater Fisheries Research during the year 2010-11 has successfully conducted research activities with four institute's ongoing projects, an outreach activity with five hill states as partners, three outreach programs with different fisheries institutes under Fisheries Division (ICAR), three externally funded projects and also successfully completed three institutional projects. Apart from this, genetically improved strain of Felsosomogy mirror carp and Ropsa scaly carp which was released as Champa 1 and Champa 2 respectively, were successfully bred after two years of its transplantation and rearing at DCFR's Experimental Field Station, Champawat and the fingerlings were supplied to different hill states particularly Dept. of Fisheries of Arunachal Pradesh, Sikkim and ICAR Research Complex for NE region, Barapani to evaluate the growth performance in different eco-climatic condition. In an innovative program of water budgeting at Experimental Field Station, Champawat, water loss was measured almost 10% due to the seepage and evaporation. On the basis of fish biomass, water requirement of broodstock of trout, growing trout fingerlings and exotic carps in polyculture system was measured. It was observed that 5 lps water is required for trout stock and 1 lps is required for growing carps.

The details of the growth performance of fry and fingerlings of *Neolissochilus hexagonolepis* were recorded under the project on performance of Chocolate Mahseer. The initial average length and weight was 28.1 mm and 0.21 gm respectively. The gross increment in length and weight was observed about 82.9 mm and 14.6gm respectively after a culture period of 605 days.

Surveys were conducted in the states of Sikkim, Arunachal Pradesh and Uttarakhand for surveillance of occurrence of infectious diseases in cold-water aquaculture. In fish farms of Yaksum and Uttray in Sikkim, lesions over the dorsal body surface and opercular regions were observed in 10% of rainbow trout stock. During the month of December, two per cent (2%) of advance fingerlings as well as brood stock of Mahseer are observed with eyes disease in rearing ponds of the Directorate. An attempt was made to isolate the pathogenic fungus from water, body tissue of Mahseer and trout and pathogenic fungi was identified as *Saprolegnia parasitica* and *Saprolegnia diclina*. The growth of *Saprolegnia* was found to be inhibited by use of extract of kali sarson and lemon grass.

Address by Dr. P.C. Mahanta Director during Asia-Pacific Aquaculture 2011 at Kochi

The project entitled "Sustainable utilization of Mountain Fishery Resources" under Outreach activity had progressed well even after financial constraints. The survey of fishery resources was made in J&K and Sikkim. Trout breeding was done in Arunachal Pradesh to develop brood stock. Under Outreach Activity-Fish Genetic Stock, 287 samples of Mahseer (*Tor putitora*) from Baijnath-Palampur and Jogindernager (Himachal Pradesh), Bhalukpong (Arunachal Pradesh-Assam), Ramnagar (Uttarakhand), Lonavala (Maharashtra), and three locations, Anji, Jhajharkoti, Basoli (J&K), were analyzed using Truss network and molecular markers like Cyt b and ATPase gene. Under outreach activity on Fish Feed investigation on digestive

Release of fish seed in DCFR ponds by the Director during RAC meeting

enzyme profile of golden mahseer larvae was made which provided an insight on the development of the larvae digestive functions in order to obtain essential data for the formulation of a compound diet adapted to larvae. Grow-out feeds (Floating pellets) were formulated with 3 levels of protein (45, 40 & 35%) with uniform lipid level of 14%. In another outreach activity- Nutrient Profiling and Evaluation of Fish as a Dietary component had detected nutrient content of different coldwater fishes.

Under completed projects entitled "Development of GIS based decision support system for aquaculture in selected coldwater region", an attempt has been made to put forward issues of Geoinformatics, Decision Support System (DSS) with regard to application in fisheries. The present study encapsulates the GIS based decision support system meant for aquaculture in the Kumaon region of Uttarakhand.

In another completed project entitled, "Modelling of Length-Weight Relationship and Growth Pattern of Selected Important Coldwater Fish Species", it was tried to draw length-weight relationship of *Tor putitora* from wild aquatic environment of Kosi River, using different statistical models.

The completed project entitled "Genetic Characterization & Population Structure analysis of Coldwater fishes" constructed phylogenetic tree using POPGENE software package, which showed two common clusters consisting of *Tor putitora* with *S. richardsonii* and *Garra* species with *Barilius bendelisis* by forming a separate cluster. The phylogenetic tree was constructed using UPGMA method of arithmetic mean. The data was generated based on Nei and Li (1978) genetic distance using RAPD-PCR assay and mtDNA 12S rRNA sequences. The targeted mtDNA 12S rRNA sequences and RAPD-PCR analysis could be a valuable tool for establishing the status of molecular systematics and phylogenetic tree construction even at the subfamily level. The present study further suggests that the universal primers for more numbers of mtDNA genes as well as with more numbers of RAPD primers may provide accurate assessment of molecular systematic of fish species even at the species level.

Under the externally funded projects like

Visit of Students at DCFR

"Development and Characterization of microsatellite markers in *S. richardsonii*" developed 57 microsatellite markers from a partial genomic library of Indian Snow Trout. Among 57 markers, so far 27 loci were successfully validated in different populations of ***S. richardsonii***. They were also found to be highly polymorphic and usable for population genetic analysis and genetic variability studies.

In another DBT sponsored projects it was tried to isolate the causative agent in BF2 cells. Virus isolation was attempted from a number of field samples and cytopathic effects were also observed.

DBT sponsored post doctoral project revealed the diversity and phylogeny of Bagrid catfishes of the genus *Mystus* Scopoli of northeast India using classical and RAPD. The dendogram had showed that *M. rufescens* is genetically closer to *Mystus sp.* (an undescribed species) with high similarity index value of .444, even though both are resolved as distinct species. The result of this study also showed that *M. montanus* is genetically more similar with *M. bleekeri* and both are under a same cluster.

The DST funded project, "Genome Scale Mining of *S. richardsonii* fish species for formulation of selective breeding Programm" also tried to identify different populations of *Schizothorax richardsonii* from Kumaon Himalayas using Cyt b, ATPase 6/8 and COII gene sequences.

Under NAIP (Component-4) project, "Bioprospecting of Gene and allele mining for abiotic stress tolerance-Cold tolerance", the salient achievements were, **i)** location specific availability of different *Schizothorax sp.* at different altitudes of Himalayan regions, **ii)** Physiological and biochemical parameters were established under different temperatures, the increased activities of alanine amino transferase (AlaAT) and aspartate amino transferase (AspAT) in the liver samples showed the possible carbon source of glycerol accumulation to depress the cold temperature during the winter months in addition to activities of Glycerol phosphate dehydrogenase through Dihydroxy acetone phosphate (DHAP), iii) One primer pair designed from AFP type III revealed an amplicon of about 285bp through PCR. The amplicon was sequenced and submitted to the NCBI Genbank as hypothetical protein, iv) NAD linked GPDH gene, presumed to be responsible for cold acclimation process in association with Glycerol accumulation in *S. richardsonii*, was successfully amplified in liver cDNA of *S. richardsonii*, and confirmed by cloning and sequencing, v) a cDNA library consisted of 1200 clones was developed using brain tissue of *S. richardsonii*.

Scientist interacting with farmers from Afghanistan

In another NAIP (Component-3) entitled, "Enhancement of Livelihood Security through Sustainable Farming System and related farm Enterprises in North-West Himalaya" where the major achievements were through the multi-tier model for fish culture in which the poly-cum irrigation tanks were used. The ponds were stocked with Chinese carps and Common carp and were

fed with rice polish and mustard oil cake @ 2% of body weight. The significant production was achieved in polytank of 0.7 kg/ m^3 of water in comparison to 0.12-0.36 kg / m^3 in earthen ponds.

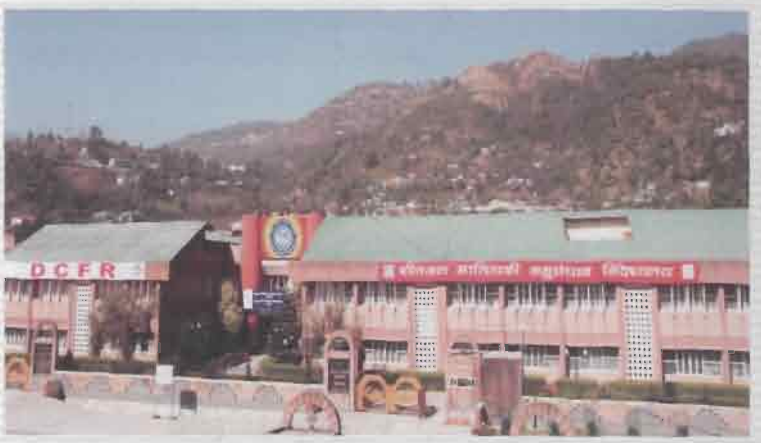
The directorate has also successfully conducted two training programmes. The NFDB Sponsored training programme on "Three pronged fish farming technologies for hill regions" was conducted during 19-23 October 2010, in collaboration with Rajiv Gandhi University (RGU) at Itanagar, Arunachal Pradesh. A national level model training course on "Breeding, Incubation and Rearing of Rainbow Trout" was organized by DCFR, Bhimtal From 27th December 2010 to 3rd January 2011 sponsored by Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, New Delhi. The directorate has also celebrated World Intellectual Property Day on 26th April. A Hindi workshop was also organized on 5th June on the occasion of World Environment Day with an objective to popularize Hindi typing software and dissemination of information on the environment. The directorate has organized two days "National Consultation on Biodiversity of High Altitude Aquatic Resources, Conservation & Utilization" during 29-30 September. The seminar was attended by various experts and stakeholders. International Women's Day was celebrated on 8th March 2010.

Other than research activities the Directorate had also organized several other farmers related training programmes, meetings, like RAC, IRC, Institute Management Committee, IJSC and official language. The Directorate had also participated in several seminars, symposium, ICAR Zonal sports and celebrated various events like national days and sprit of communal harmony.

Exhibition of Scientific books at DCFR

INTRODUCTION

About one-fifth of the land surface of the world is covered by mountains, which are home to one-tenth of the world's population, and provide livelihood to some of the poorest communities in the world. The hill fishery resources have a great potential in generating rural income and providing food security to the economically underprivileged population residing in Indian uplands. To utilize the available resources and opportunities in the coldwater fisheries sector the involvement of Indian Council of Agricultural Research in this sector started during late sixties which, subsequently culminated in the creation of National Research Center on Coldwater Fisheries as an independent Research Center on 24 September 1987 during the VII Five Year Plan. This is the only national facility in the country to take up the research investigation on capture and culture aspects with a focus on exotic and indigenous coldwater fish species. Since its inception, the NRCCWF in spite of constraints in terms of manpower and infrastructure has made significant contribution for proper appraisal of coldwater fishery resources and evolve suitable technologies to propagate important coldwater fish species in hills.



Keeping in view the ever expanding activities of NRCCWF and the greater potential of coldwater fisheries in different Himalayan states, in a significant decision during the XI plan, it has been made a **Directorate of Coldwater Fisheries Research (DCFR)**, to develop location, situation and system specific technologies by utilizing and augmenting resources in all the **Himalayan states from Jammu & Kashmir to Arunachal Pradesh**.

The DCFR is on its glorious path of virtually actualizing its vision by imparting boon of quality research in sustainable coldwater fisheries production, management and conservation.

Location

The headquarters of DCFR is located at Bhimtal at an altitude of 1470 masl in the district of Nainital of Uttarakhand state. It is about 25 km away from the famous tourist place of Nainital. The nearest railway station is Kathgodam, which is about 280 km from Delhi. The nearest airport is Indira Gandhi International Airport, New Delhi. The experimental field station of the Institute at Chirapani in Champawat district of Uttarakhand State is about 150 km from Bhimtal.

This Directorate is now emerging as the nodal facility in the country where research investigations are under taken both on capture and culture aspects with a focus on exotic and Coldwater species.

Management

A high powered Research Advisory Committee (RAC) guides this Directorate in the research in thrust areas and on new initiatives. The RAC also evaluates and monitors the progress of research activities of this Directorate. The Management Committee (IMC) constituted and mandated by Indian Council of Agricultural Research under the

Chairmanship of the Director, supervises various management aspects of this Institute. A number of Internal committees such as Institute Research Council (IRC), Official Language Committee and Institute Joint Staff Council (IJSC) are in place of decentralized management.

Mandate

- To conduct basic, strategic and applied research in coldwater fisheries and aquaculture
- To develop stock management models and culture technologies for major coldwater fish species
- To create awareness and provide training and consultancy

Organizational set-up

Infrastructure

Building and Farm

The Institute is now functioning from its own new complex constructed at Bhimtal Industrial area. The main building has various facilities such as library, laboratories, ARIS cell, aquarium and auditorium. A pilot scale mahseer seed production unit is also operating at Bhimtal on the land belonging to State Fisheries Department, Uttarakhand, which in addition to the mahseer hatchery houses, a laboratory which provides back up facilities to seed production activities of the directorate. The directorate has an experimental fish farm facility at Chhirapani in Champawat district of Uttarakhand State which has trout hatchery, cemented raceways for nursery and brood stock rearing and few circular iron tanks for conducting yard trials on various culture aspects of the indigenous and exotic fish species.

Support Services

Project Implementation and Monitoring Cell

A separate cell called the **Project Implementation and Monitoring Cell (PME)** monitors the implementation and progress of research project programmes being conducted by the Directorate. This cell biannually organizes the meeting of Institute Research Council (IRC) to evaluate the progress made in each research project and accordingly approves the work programmes for the current year. The new proposals are also approved by the IRC after thorough evaluation of the objectives, practical utility, manpower support and financial involvement. The cell is also responsible for maintaining records of project reports through RPF system.

Auditorium facility of the Directorate

Technical Cell

The technical cell has given the responsibilities of dealing with all technical matters within and outside matters of the ICAR system. The cell takes care of the training programmes, deputation, participation of scientists in seminars, symposia, workshop, meetings etc. and organizing conferences.

Library Section

The library of the Directorate subscribes about 19 foreign and 11 Indian Journals during the year. The current holding of the library includes more than 2000 books and 3000 other publications. It provides services to the scientists and other staff members of the institute apart from scholars, researchers, students and other local organizations interested in scientific literature on coldwater fisheries and other allied subjects. The library also provided facilities to access free online download of publications, articles of many international journals through www.cera.jccc.in. The library section is further continuing its efforts in collection, processing and disseminating scientific/ technical information to the potential users.

Visit of Director DWSR, Jabalpur

ARIS Cell

The ARIS Cell of this Directorate has so far provided the facilities for Internet through VSAT, scanning, printing to the Scientists and other staff members. Acted as Network Administrator, monitored the LAN connectivity of around 50 computers at this Directorate. The Internet facilities were provided to all scientists, Library & Director cell, ARIS Cell and also at VIP rooms in Guesthouse. In ARIS Cell computer and Internet facilities were provided to other research scholars and M.Sc./Ph.d. students working under various project/programmes. Administrative cases for LAN, VSAT Internet connectivity at institute were processed from time to time.As per instructions of ICAR to upgrade the internet connectivity in each institute, processed the proposal with ICAR/ERNET for 2Mbps bandwidth connectivity at this organization. Another proposal for setup a new VSAT internet connectivity at Experimental Fish Farm & Field Centre of this Institute at Champawat was processed as the old NIC connectivity is going to be obsolete. The proposal is put up to ERNET India for better connectivity at our center.

The website of this institute is being updated from time to time as per instructions of the ICAR and under the AGROWEB project. The site contains the information about manpower, institute mandate, project programmes and achievements, tenders & job announcements etc. The DCFR's website has been uploaded with the new domain name http://

Demonstration of ARIS activities to students

www.dcfr.res.in. After hosting the website on DCFR's name, it is easier to update regularly. The website is being updated with content management system for better usability as per the suggestions of AGROWEB project. The major achievements of the Directorate, the technology generated, consultancy services were incorporated in the site. Further, the ongoing and forthcoming training programmes, seminar/symposia conducted by the institute, recruitments, tender notice has been reflected in the website. The Directorate's website finds a place in the Indian Council of Agricultural Research (ICAR) website with the address: http://www.dcfr.res.in. The mail & messaging solutions, (mail server) maintained at this Directorate for smooth information communication via email. Individual user ids and passwords for new scientists and officers were allotted from time to time for proper use of the mail server at this organization.

Laboratory Facilities

The Directorate has well equipped laboratories of Fish Nutrition, Environmental Fish Biology & Nutrient Profiling, Molecular Genetics, Fish Health Management (Diagnostic Virology Laboratory & Diagnostic Bacteriology Laboratory). A Geoinformatics Laboratory is under the process of setting up to conduct research on Remote sensing and GIS application in coldwater fisheries. In addition to these there is a Wet laboratory facility equipped with flow through troughs for setting up physiological experiments and nutrition trials for coldwater fishes. One Feed mill also installed at the main campus of Institute to meet routine requirements of fish feeds.

Extension Wing

The extension wing carries out the various extension activities of the institute such as transfer of technology programmes, organizing the exhibitions, training programmes and other activities related to farmers.

ITMU

The Directorate has constituted Institute Technology Management Unit (ITMU). It is responsible for providing information about ICAR guidelines on IPR issues. Trainings to

Dr.L.M.S. Palni, Director GBPHIED, Kosi Katarmal, Almora addressing during IPR Day

the concerned scientists have also been given regarding IPR issues. The ITMU Cell observes World Intellectual Property Day on 26th April. The ITMC has been constituted under the chairmanship of Director for dealing with patents and other intellectual property rights to recognize technologies developed at the Institute and their safe transfer.

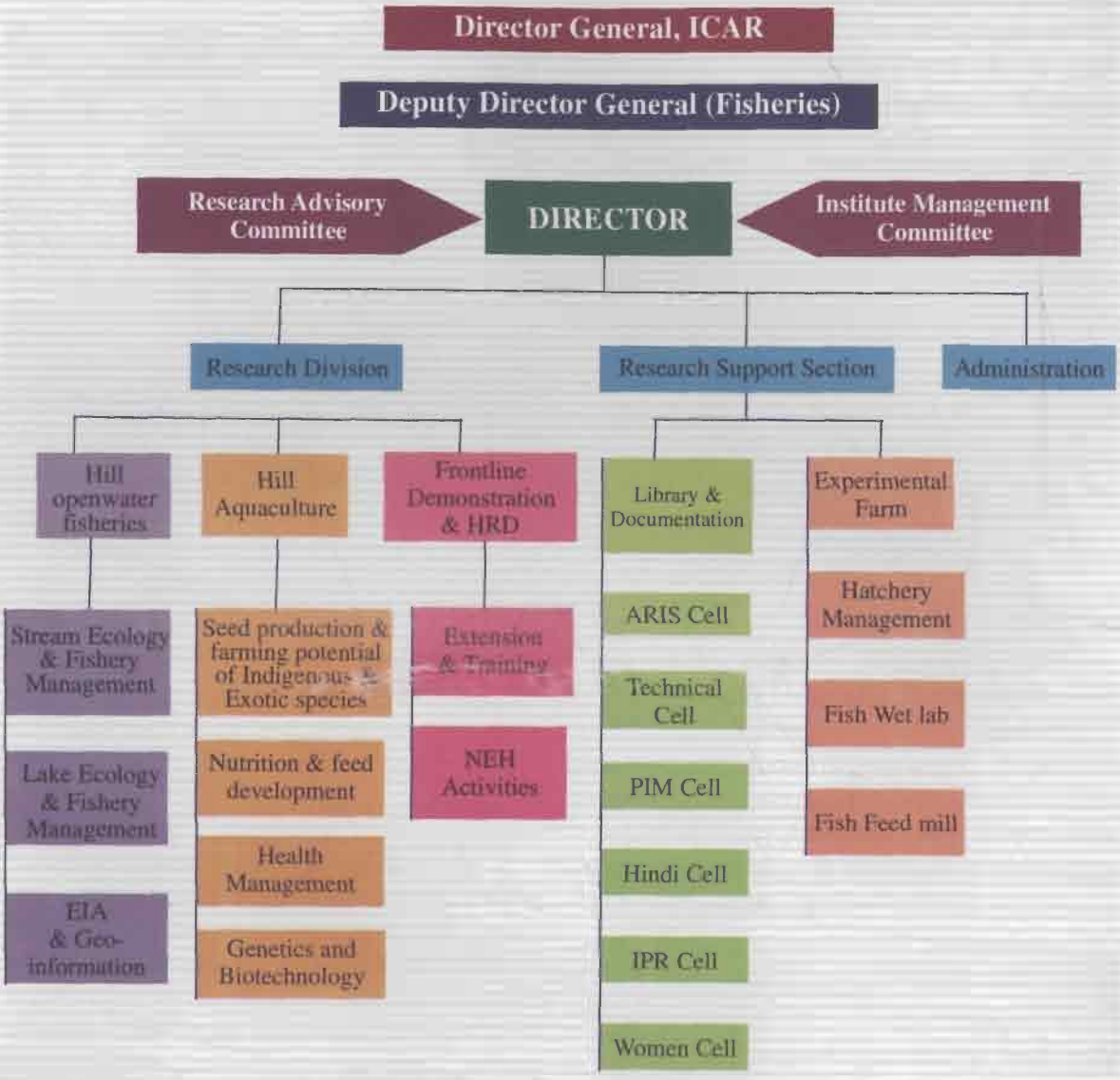
Academic Council

The academic council was constituted under the chairmanship of the Director. It is responsible to arrange administrative facilities to Ph.D. scholars and Postgraduate students from different Universities and State Agricultural Universities under MoU with the institute to carry out the dissertation work. The Academic council also looks for national and international linkages with repute educational institutes and universities.

Staff strength (As on 31.03.2011)

Category	Sanctioned	Filled	Vacant
Director (RMP)	01	01	-
Scientific	30	15	15
Technical	14	13	01
Administrative	12	11	01
Supporting	15	13	02
Total	**72**	**53**	**19**

ORGANOGRAM

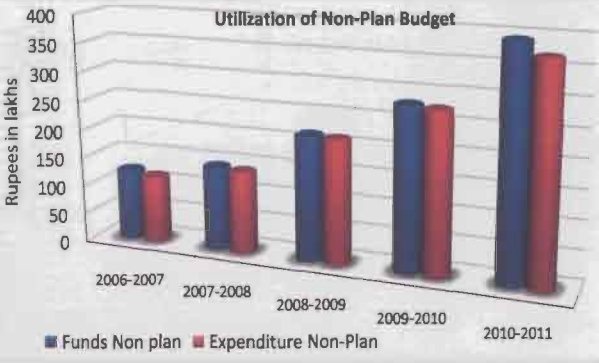

Director General, ICAR
Deputy Director General (Fisheries)
Research Advisory Committee
DIRECTOR
Institute Management Committee
Research Division
Research Support Section
Administration
Hill openwater fisheries
Hill Aquaculture
Frontline Demonstration & HRD
Library & Documentation
Experimental Farm
Stream Ecology & Fishery Management
Seed production & farming potential of Indigenous & Exotic species
Extension & Training
ARIS Cell
Hatchery Management
Lake Ecology & Fishery Management
Nutrition & feed development
NEH Activities
Technical Cell
Fish Wet lab
EIA & Geo-information
Health Management
PIM Cell
Fish Feed mill
Genetics and Biotechnology
Hindi Cell
IPR Cell
Women Cell

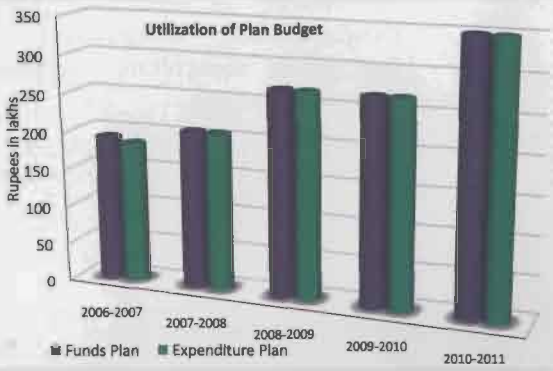
BUDGET 2010-2011

Financial Statement Abstract

(Rupees in Lakhs)

Year	Funds Non-Plan	Expenditure Non-Plan	Funds Plan	Expenditure Plan
2006-2007	124.50	116.21	192.91	186.26
2007-2008	146.00	142.40	208.00	207.65
2008-2009	217.30	214.91	270.00	269.23
2009-2010	282.32	278.23	270.00	269.95
2010-2011	394.00	371.17	350.00	349.46





Budget Statement for the Year 2010-2011

(Rupees in Lakhs)

Head of Accounts	Budget (R.E.)		Expenditure	
	Plan	Non-Plan	Plan	Non-Plan
Pay & Allowances	-	240.00	-	221.65
Traveling Expenses	15.00	2.25	14.99	2.25
HRD	5.00	0.00	4.91	0.00
Other Charges including Equipment	234.00	122.65	233.65	117.41
Information Technology	7.00	0.00	6.97	0.00
(a) Major Works	85.00	0.00	85.00	0.00
(b) Repair & Maintenance	0.00	30.00	0.00	29.86
Other Items Fellowship/ Scholarship/Awards including furniture for New Complex	4.00	0.00	3.94	0.00
Total	350.00	394.90	349.46	371.17

LIST OF ONGOING PROJECTS

Institutional Projects

Project Code	Project Title	Project leader & associate	Year of Start	Likely year of completion
AQ1	Evaluation of growth performance of different strains of Common Carp	N.N. Pandey S.K. Srivastava Prem Kumar S.K. Gupta	2008	2013
AQ2	Study on Water Budgeting and Water Management for Coldwater aquaculture system	N.N. Pandey S.K. Srivastava PremKumar S.K. Gupta	2008	2011
AQ3	Performance of chocolate mahseer *(Neolissochilus hexagonolepis)* in freshwater aquaculture system in Kumaun Himalaya	Debajit Sarma Md. M. S. Akhtar Suresh Chandra	2008	2012
AQ6	Investigations on pathogens in cold water fisheries and their environment	Amit Pande N.N. Pandey Sumanta K. Mallik Dimpal Thakuria Ananda Kumar B.S.	2008	2012
Outreach Activities with Five Hill States				
DP1	Outreach Activity- Sustainable utilization of mountain fishery resources-A Partnership mode	DCFR Five Hill States	2008	2012
Inter-institutional Outreach Activities (Fisheries Division-ICAR)				
NP1	Outreach Activity- Fish Genetic Stock	A. Barat Prem Kumar S .Ali R.S. Haldar	2008	2012
NP2	Outreach Activity- Fish Feed	N.N. Pandey D. Sarma S.K. Srivastava Md.M.S. Akhtar S.K. Gupta	2008	2012
NP3	Outreach Activity- Nutrient Profiling and Evaluation of Fish as a Dietary component	Debajit Sarma N.N.Pandey Neetu Shahi Md. M.S. Akhtar	2008	2012
Completed Research Projects				
CF1	Development of GIS based support system for Aquaculture	Ashok K Nayak Prem Kumar P. C. Mahanta R. S. Haldar A.K Saxena	2007	2010

Project Code	Project Title	Project leader & associate	Year of Start	Likely year of completion
CF2	Modeling of Length-Weight Relationship and Growth Pattern of Selected Coldwater Fishes	N.O. Singh Debajit Sarma	2008	2011
AQ7	Genetic characterization & population structure analysis of coldwater fishes	A. Barat S. Ali	2008	2011
Externally Funded Projects				
DBT	Development and Characterization of microsatellite markers in *S. richardsonii*	A. Barat	2008	2011
	Molecular characterization and development of a diagnostic test for the identification of a filterable agent isolated from diseased Rainbow trout.	Amit Pande	2010	2011
	Studies on the diversity and phylogeny of Bagrid catfishes of the genus *Mystus* Scopoli of northeast India using classical and RAPD techniques	A. Darshan Singh (Postdoctoral Fellow) P.C. Mahanta (Supervisor)	2009	2011
DST	Genome Scale Mining of *S. richardsonii* fish species for formulation of selective breeding Programm.	S. Ali A. Barat	2009	2012
NAIP (Comp-4)	Bioprospecting of Gene and allele mining for abiotic stress tolerance	A. Barat S. Ali	2009	2012
NAIP (Comp-3)	Enhancemnt of Livilihood Security through Sustainable Farming Systems and related farm Enterprises in North-West Himalaya	Prem Kumar	2009	2012

RESEARCH ACHIEVEMENTS

Project Code	AQ1
Project Title	Evaluation of growth performance of different strains of Common Carp
Personnel	N.N. Pandey, S.K. Srivastava, Prem Kumar, S.K. Gupta

Hungarian scale carp, Hungarian mirror carp, existing Bangkok strain were reared in field conditions. Better growth of imported strain was recorded over the existing strain. Increasing growth was found than the previous year due to enough water with heavy rain. Better growth of yearlings of Hungarian scale carp, Hungarian mirror carp was found in field condition due to the low inbreeding depression. Growth of F1 progeny was little better than the recorded growth of parental stock, might be due to better acclimatization. Lower water temperature (4.2-12°C) during the winter months resulted in less feed intake, negligible growth and minor mortality. Higher level of ammonium was recorded during winter months might be due to the less activity of nitrifying bacteria at low temperature. Other water quality parameters were found optimum for the growth. Only fungal infection and ciliates was observed without any mortality during summer. 50 specimen of each strain were reared separately and found more than 80% male specimen. Maturity was not recorded in F1 progeny of imported strain, but it was still existed in Bangkok strain. On set of early maturity in existing stock may be due to the high degree of inbreeding coefficient. Breeding of Ropsa scaly was started from II week of April and ended in III week of May at 16-24°C. Breeding of Felsosomogy mirror carp was started from I week of April and ended in II week of May at water temperature 16-22°C. Imported strains require little higher temperature for the maturity and breeding than the existing strain. Ropsa scaly require temperature in higher side than the imported mirror carp for the breeding activities. Milt from the imported strains has been cryopreserved in liquid nitrogen for the cross breeding at different locations. The improved strains of Hungarian scale carp and mirror carp were released as Champa-1 & Champa-2, respectively by DCFR. The parent stock is being reared at Champawat Field Centre of DCFR. The fingerlings of F1 generation were supplied to different hill states particularly Dept. of Fisheries of Arunachal Pradesh, Sikkim and ICAR Research Complex for NE region, Barapani for culture mainly to evaluate the performance in different eco-climatic condition for later dissemination to fish farmers.

Project Code	AQ2
Project Title	Study on Water Budgeting and Water Management for Coldwater aquaculture system
Personnel	N.N. Pandey, S.K. Srivastava, Prem Kumar, S.K. Gupta

The year was recorded with heavy rainfall (>1200mm) and high RH (50.3-97.1%). Data reflected semi temperate climate. Measured water availability at experimental fish farm Champawat and found 1-4 lps inflow and 1-3 lps outflow. 0-3 lps deficit water was observed, particularly during summer months (April-July). The average availability of water was in higher side due to the heavy rain, which directly affected the water quality with maximum period in optimum range. pH was slightly less than the previous year due to more flushing in stream. Measured water losses at experimental fish farm Champawat and found almost 10% loss due to the seepage and evaporation. Evaporation rate was lower than the previous year due to comparatively higher RH.

Seasonal variation was observed for water temp. (4.2-24.0°C) with slightly higher range in carp ponds (5.3-24.0°C) than in trout raceways (4.2-16.6°C) might be due to continuous flushing of water in raceways. Observed thermal range is optimum for the trout, but, low temperature retards the growth of carps. The lean winter period was 14 days more than in the previous year due to the heavy rain. Feed intake was negligible for the 74 days in case of carps, but it was quit suitable for the growth and health condition of growing trout. On the basis of fish biomass, measured water requirement of broodstock of trout, growing trout fingerlings and exotic carps in polyculture system. It was observed that 5 lps water is required for trout stock and 1 lps is required for growing carps. Efficiency of grit filter was affected by lower water temperature during winter for the removal of ammonia. It might be due to the less activity or less population of nitrifying bacteria at lower temperature (<16°C). Bacteria may be cultured in indoor lab and must be inoculated at the interval of 5 days to maintain the required population.

A team of experts from IIT Kharagpur visited the site for the outdoor re-circulatory system. Recorded data on water availability, water losses, water quality were provided to the experts for the calculation of the capacity of filters.

Project Code	**AQ3**
Project Title	**Performance of chocolate mahseer *(Neolissochilus hexagonolepis)* in freshwater aquaculture system in Kumaun Himalaya**
Personnel	Debajit Sarma, M. S. Akhtar, Suresh Chandra

Diet composition of fry

Gut content analysis of fry showed that the food consisted of 51% zooplankton mainly consist of leg parts of cyclops and copepod, 29% phytoplankton consist of scenedesmus, synedra and pediastrum, unidentified matter 14% & sand and mud were encountered about 6%. Zooplanktons were dominant over the other food items.

Diet composition in advanced fingerling

In advanced fingerling bulk of food consisted of algae 32.8%, phytoplankton 23.3%, zooplankton 20.2%, followed by insects 6.7%, unidentified matter 7.3%, sand, mud and artificial feed 9.7 %. In advanced fingerling plant matter was dominant over the other food items. Along with these much amount of artificial feed was also observed in the gut content of both fry as well as fingerling.

The results of the study revealed that chocolate mahseer fry mainly consumed animal matter including insects, copepods, cyclops, rotifers, eggs and larvae. Along with these plants matter was also observed in the gut of fry. In the fingerling stage it was found that the fish mainly consumed plant matter including algae and phytoplankton. Some amount of animal matter was also observed such as legs of copepods, cyclops and daphnia etc. 51% zooplankton was dominant over the other food items in fry of chocolate mahseer, while the fingerling mainly consumed 56.1 % plant matter. In the fingerling stage plant matter was dominant over the other food items. The results of the present study revealed that the fry of chocolate mahseer are carni-omnivore since it feeds mainly on the animal matter while the advanced fingerlings are herbi- omnivore feeding mainly on the plant matter in comparison to animal matter. The ratio of gut length and the length of the fish showed some indications about the nature of the fish diet. In the present investigation, the RGL values ranged from 1.08 to 2.3 and the GSI values ranged from 5.47 to 6.59 for the fishes having size range of 37 mm to 126mm. It was observed that the RGL values increased with the increase in length of the fish. The fingerlings gradually become omnivorous. The present study revealed that the RLG value is

lowest in fry stage and intermediate in advanced fingerling stage showing the omnivorous in nature.

GSI of fish having size range of 37 mm – 126 mm (0.439 gm – 12.8 gm) was computed to study variation in feeding intensity with respect to the fish size. In the present investigation the maximum 9.39 and minimum 2.2 GSI values was recorded for the fishes having weight group of 0.439gm to 19.7gm respectively. It was clearly observed from the study that the feeding intensity was found to increase in lower size groups (0.439 gm - 5.9 gm) as observed from GSI data. However, certain significant variations were observed in respect to the feeding intensity in the higher size groups (9.1 gm – 19.7 gm) i.e. during fingerling stage. It may be noted in this context that basic knowledge of food preference and feeding habits of species are of primary importance for ascertaining its suitability for aquaculture because it will help to determine the desirable species combination in culture systems with minimum inter-species competition for the natural food. The study revealed that *Neolissochilus hexagonolepis* under culture system in its new environment of Kumaun Himalayas was carni – omnivorous in fry stage, herbi – omnivorous in fingerling stage and found to be column feeder in nature.

Growth performance

The details of the growth performance of fry and fingerlings of *Neolissochilus hexagonolepis* were recorded. The initial average length and weight was 28.1 mm and 0.21 gm respectively. The gross increment in length and weight was about 82.9 mm and 14.6gm respectively after a culture period of 605 days. Net length gain (NLG) and Net weight gain (NWG) values clearly showed that the fishes continued to add length and weight throughout the study period. The highest NLG was recorded in the month of March and lowest in the month of January while the maximum NWG was recorded in the month of September and minimum in the month of January. This may be attributed due to the minimum temperature during the period under culture. Specific growth rate (SGR) was low during the winter from Nov to Jan but an increasing trend was observed from January onwards till April having highest SGR in this months (SGR = 3.0). During the winter period the water temperature was ranging from 8.3° C to 13° C and during the March and April the water temperature ranged between 19° C - 23° C. It was also revealed from the study that the SGR values started declining during the month of July and August when the maximum water temperature was 27° C to 30° C. Again increasing trend of SGR was observed during Sep and Oct when water temperature was ranging from 20° C - 22° C. This clearly suggests that minimum water temperature below 13° C and maximum water temperature above 27° C have affected the growth of chocolate mahseer. It is found out from the study that the chocolate mahseer shows optimum growth during the temperature range of 19° C to 23° C. It may be concluded from the study that chocolate mahseer is ideal for culture in the pond under the agro climatic condition of Kumaun Himalayas and the environment places an important role in governing the food and feeding of the species.

Assessment of nutritional requirement for juveniles and brooders and feed formulation was successfully done. In the new environment this species can be most suitable for culture.

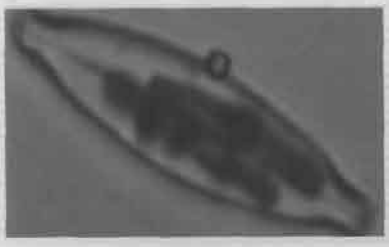
Rearing of Chocolate mahseer

Juvenile of chocolate mahseer

Navicula

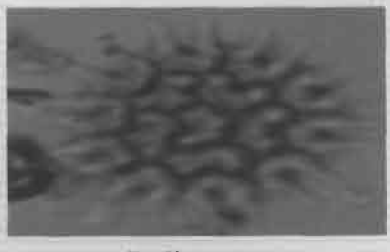
Cymbella

Amphora



Epithemia

Frustulia



Pediastrum

Fig: Plankton in poly culture pond of Chocolate mahseer

Project Code	**AQ6**
Project Title	**Investigations on Coldwater fish pathogens and their environment**
Personnel	Amit Pande, N.N. Pandey, Sumanta K. Mallik, Dimpal Thakuria, Ananda Kumar B.S.

Occurrence of infectious diseases in cold-water aquaculture

Surveys were conducted in the states of Sikkim, Arunachal Pradesh and Uttarakhand. Tissue samples were collected from diseased fish and clinical symptoms were recorded on field. In fish farms of Yaksum and Uttray in Sikkim, lesions over the dorsal body surface and opercular regions were observed in 10% of rainbow trout stock. Eyes were red, resembling initial symptoms of eye disease caused by *Aeromonas* sps. Infected tissue samples were subjected for bacteriological and virological analysis.

Bacterial diseases recorded

Fish health status of Mahseer stock in rearing ponds of the directorate was monitored periodically. During the month of December, 2% advance fingerlings as well as brood stock of Mahseer were observed with eyes disease. In study, it was found that stocks were suffering from two stages of eye disease; primary stage: reddening of eyes (Fig 1a) and secondary stage: corneal opacity (Fig -1b).

Figure showing the trout farm of Uttaray and the lesions observed in infected rainbow trout. Note the hemorrhages over operculum and the body

Fig: Reddening of eye and corneal opacity in mahseer

For microbial analysis, tissue samples were collected from infected parts. Bacteria were isolated and characterized using standard procedures. Three *Aeromonas sp* were characterized from the samples collected.

Isolation of pathogenic fungi from coldwater fish and their environment

An attempt was made to isolate the pathogenic fungus from water, body tissue of Mahseer and trout. Samples were collected from cemented fish ponds at DCFR Bhimtal, Bhimtal Lake, Uttray Trout Farm Sikkim, Yaksum trout farm Sikkim and State Trout farm Bairangna. Fungal infection was more prominent in the cemented tank than the earthen fish pond in the mahseer during winter months. Intensity of the infection in Mahseer during downfall of the water temperature was more prominent in pond raised stock than the samples from lake. The pathogenic fungi was identified as *Saprolegnia parasitica* and *Saprolegnia diclina* with cottonlike appearance, elongated zoosporangia and pear shaped primary sporangium. Fungi was isolated from the tissue samples of gills and fins, but not from kidney, blood and liver of infected golden mahseer and chocolate mahseer. Fungi were not observed in the sample collected from trout farms in Sikkim.

In Mahseer, fungus was present as an ulcerative mycosis that converted into a deep necrotic lesion involving the muscle.

Figure demonstrating inhibitory effects of herbal preparations on the growth of *Saprolegnia*. A- *In vitro* testing of different herbal extract of pathogenic fungi and B Kalmegh treatment

Hematological profile (RBC/WBC/HB) of infected and healthy fish was also analysed and found to have significant difference. Pure cultures of isolated fungi were cultured in SDA media and compared with reference cultures of *Saprolegnia parasitica* and *Saprolegnia diclina*.

To study the mycostatic activity of some of the herbs, aqueous extract of dry leaves of marigold, pine, Kalmegh, kali sarson and lemon grass were used at a concentration of 5%, 8% and 10% w/v. Our results have demonstrated that kali sarson and lemon grass could effectively inhibit the growth of *Saprolegnia*.

Virus isolation and Characterization

Out of the three different sampling sites of Uttrakhand, cytopathic effect was observed in BF2 or RTG-2 cells on repeated passages varying from 5-12%. About 10% of the samples from trout farms of Sikkim also demonstrated cytopathic effect in cultured fish cells. The samples from Arunachal Pradesh did not show the presence of any viral or bacteriological agent as it was recorded a year earlier.

A filterable agent isolated from Champawat farm (RBT 079) was produced in bulk in BF-2 cells. The agent was concentrated and hyper-immune serum was successfully produced in rabbits. Our preliminary experiments have attempted to demonstrate the presence of viral proteins specific to infectious pancreatic necrosis virus. Similar results have been obtained with anti-IPNV and anti-IHNV reference sera, a generous gift from Dr Jim Winton, OIE expert. The serum raised from the purified preparation of the virus has also shown lines of identity with both the reference sera possibly suggesting mixed infection, a prospect that needs to be further investigated.

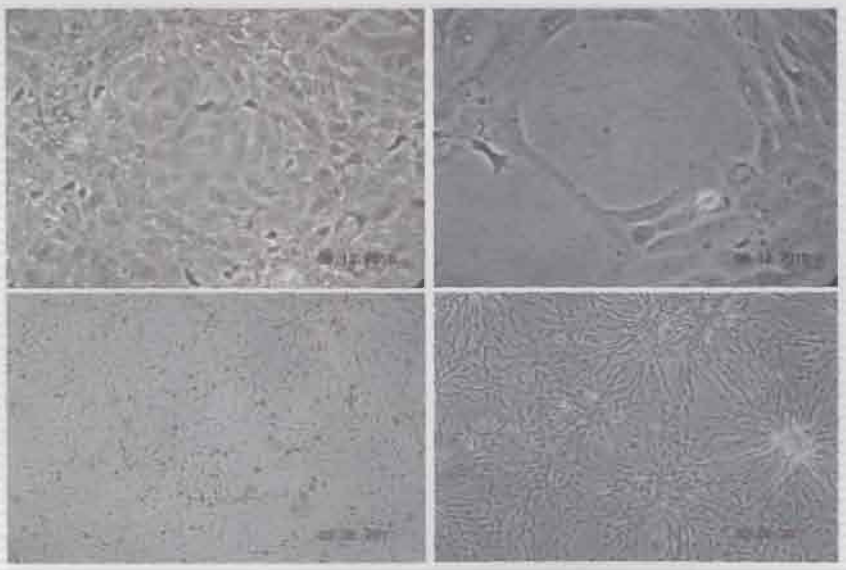


Figure showing Isolation of virus in cultured fish cells: Top left uninfected RTG-2 cells, top right RTG-2 infected with infected tissue sample from Yaksum fish farm. Bottom left healthy BF-2 cells and infected BF-2 cells with the infected tissue sample from *Barelius* sps.

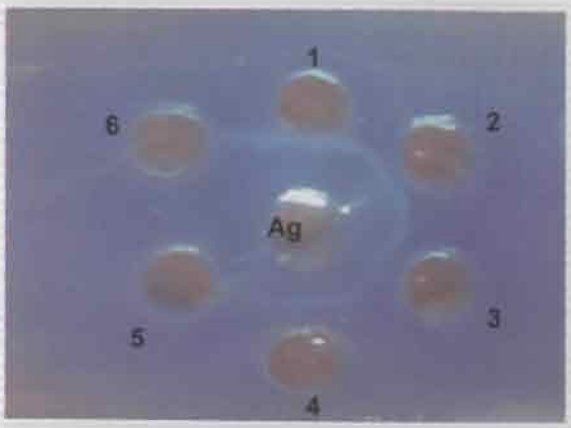


Figure demonstrating the results of the double immino diffusion test conducted with the hyperimmune serum raised against the concentrated virus isolated in our laboratory. The photograph shows the precipitin lines obtained at different dilutions of hyperimmune serum at 2^0, 2^1, 2^2 and 2^4 respectively.

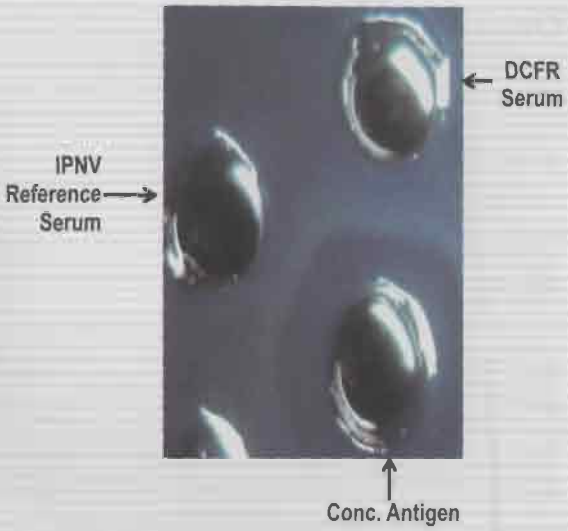


Figure showing the similarity between the IPNV reference serum and DCFR's serum. The precipitin lines observed in agar gel immuno-diffusion test shows that serum samples used in the test are identical.

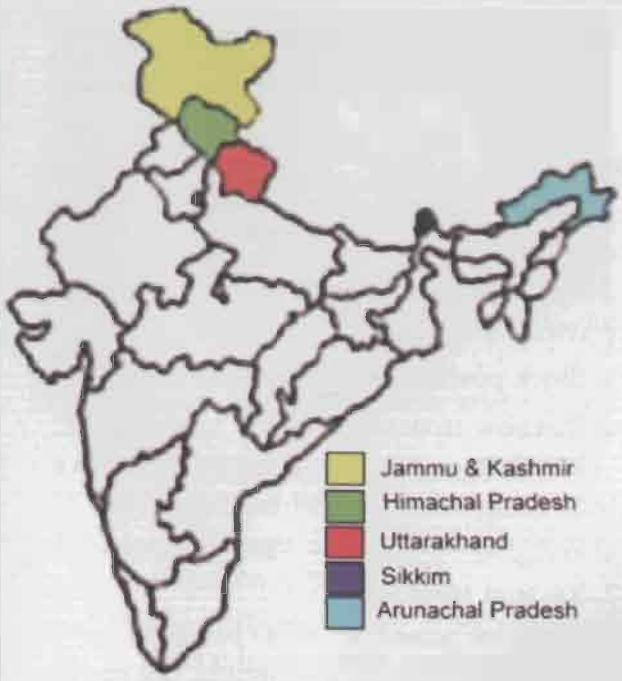
Outreach Activities with Five Hill States

Project Code	DP1
Project Title	Outreach Activity- Sustainable Utilization of Mountain Fishery Resources- A partnership Mode
Personnel	P.C. Mahanta, A. Barat, Debajit Sarma, Nityanand Pandey, Prem Kumar, S. K. Srivastava, A.K.Nayak, S. Ali, Sumanta Mallik, R. S. Haldar

The coldwater resources of India are mainly in the form of upland streams, rivers, high and low altitudinal lakes and reservoirs located in different hill states of India. Large population of indigenous and exotic coldwater fish species in these mountain water bodies forms an immense potential for mountain aquaculture practices, sports fishing and ornamental purposes. The distribution of the fish biodiversity is extended from northeastern to northwestern Himalayan ranges and parts of Western Ghats. In spite of various constraints the sector has made significant contribution in the nation's agenda for food security. Some of the fish fauna can withstand extreme cold climate in very high altitude lakes, which are generally found frozen from three to six months in a year that make fish genome unique for valuable traits. Such a diversified natural resource base with wide range of climatic diversity, depending on altitudinal zones, is very much conducive to conserve and rear various fish species. In order to harness the coldwater fishery potential of the country, the Directorate is working with five hill states in a partnership mode.

Outreach Activity Partners

Name of State	Partners
Arunachal Pradesh	• Department of Fisheries (Govt. of Arunachal Pradesh) • Dept. of Life Sciences, Rajiv Gandhi University, Itanagar, Arunachal Pradesh
Sikkim	• Dept. of Fisheries (Govt. of Sikkim) • ICAR Research Complex, NEH, Sikkim Center, Tadong
Uttara-khand	• Dept. of Fisheries (Govt. of Uttarakhand) • HNB Garhwal University, Srinagar
Himachal Pradesh	• Dept. of Fisheries (Govt. of Himachal Pradesh) • Dept. of Fisheries, CSKHP Agri. Univ., Palampur, H.P
Jammu & Kashmir	• Dept. of Fisheries (Govt. of Jammu & Kashmir) • College of Fisheries, SKUAST, Srinagar



1. Arunachal Pradesh

- Modification of trout hatchery and farm at Shergaon and Nuranang has been done. Breeding and rearing of Brown Trout has been carried out during November- January 2010-11 successfully. 50,000 seeds were produced in the farm. Hatchery produced seeds were reared in the farm and also ranched in the high altitudinal lakes and rivers of Arunachal Pradesh viz. Nuranang, Kameng rivers.
- 10,000 nos. of rainbow trout eyed ova, which were transported from J&K to Arunachal Pradesh and are being reared successfully at Shergaon trout farm. The survival percentage of hatching and rearing was quite good (70%) under the agro climatic conditions of the farm. Physico-chemical parameters of the water bodies were analysed regularly and recorded.
- Breeding and rearing activities of chocolate mahseer was carried out in 2010 at mahseer hatchery and farm at Iduli fish farm, Rowing, Arunachal Pradesh. 5,000 nos. of chocolate mahseer fry were produced in the hatchery during the year.
- Pradesh were carried out by the Department of Zoology, Arunachal Pradesh in the Mehao and Ganga lake respectively.

Activities at Shergaon trout farm, Arunachal Pradesh

2. Sikkim

A. Department of Fisheries, Govt of Sikkim

The technical and financial support has been given to **Department of Fisheries, Govt of Sikkim** by DCFR, Bhimtal for Brood stock development of Rainbow trout which is given below:

1. Stock position at Uttaray trout farm:

a) Rainbow trout brooders	-	223 Nos. and weight 1kg each
b) Yearling	-	500 Nos.
c) Fry	-	2000 Nos.

2. Yaksum trout farm:

a) Rainbow trout brooders	-	47 Nos. and weight 1kg each
b) Fry	-	210 Nos.

B. ICAR Research Complex for NE Hill Region, Tadong, Sikkim

Sample collection and data recording

Representative water samples were collected from various streams, rivers, natural lakes, Govt. fish tanks and from farmer's fish ponds and tanks. Fish samples was collected through fishing with the help of hired fisherman and also procured from the local market. Metrological parameter such as altitude, humidity, wind velocity, air and water temperature recorded to identify agro climatic condition of the sampling site.

Very few persons engaged in fishing and most of them are doing it as a recreational activity. The frequency of fish species found in the river during sample collection by gill net fishing in the river and its tributaries was mostly *Neolissochilus hexagonolepis, Schizothorax progastus, S. richardsonii, Garra gotyla, Gara annandalei* and *Barilius spp.*

Body weight and per cent availability of catch fish species at the site and period of Sample collection

Samples was collected from varying altitude during summer, monsoon and winter months in the month of April, June, July, August November, January and February. More than 100 number of water samples were collected during the reporting period from various streams and small rivers namely Teesta and Rangeet tributaries, natural lakes, samples from private ponds and tanks as well as government fish farm.

The sampling site during reporting period are of varying altitude, streams and rivers ranged from 702 to 11398 ft asl and natural lakes 1144 to 14000 ft asl. The govt. fish farm and hatchery are situated at the altitude between 726 to 8537 ft asl.. Water samples from Fish ponds and tanks available with farmers located mostly at higher altitude from 3000 to 8619 in North district was collected.

Demonstration to Trainee Participants

Trout farm facilities at Uttaray

Fish sampling for biodiversity studies

3. Uttarakhand

- Successful rearing of brood stock of Rainbow trout/ brown trout (3670 nos.).
- Exploration of cultivable fish species from Gangatic drainage.
- Genetic characterization of snow trout by species-specific markers.
- Consultancy for Mahseer hatchery to THDC at Tehri and Pipal Koti.
- Consultancy for Carp hatchery to Department of zoology, H. N. B. University, Srinagar.

State fish farm at Bairangana

- Farmer's training through NGOs, UPASAC and SAMBANDH.
- Health hygiene and disease diagnosis at State fish farm Bairangana.
- During 2010 produced 2,20,000 eyed ova & 150,000 fry with 84% fertilization, 86% hatching. (Incubation period 61 days) at water temperature 4-11°C.

Breeding of Rainbow trout

4. Jammu & Kashmir

The work related to the Exploratory Survey of Fish biodiversity in Jammu and Kashmir with special reference to commercially important secies was carried out during 2010 at Gurez Valley (sites G1 – G4), during 2011 at Jammu (sites J1 – J14) and Kashmir provinces (sites K1 – K24).

A. Fishes

Fishes from river Jhelum were collected by using caste net and the catch was recorded as gm/hr, while as in the fast flowing streams of Kashmir and Gurez fishing was done by Electro Fisher and the catch was recorded as gm/half an hour. In Jammu region fishes were collected by the help of cast net and the catch was recorded as gm/hour.

B. Study sites and their description

S. No.	Name of Site	Location of Site	Site Description
Gurez Valley			
1	G 1	Located at Buduaab (Tulail valley) in the main Kishanganga River, about 40 kilometers upstream of Davar (Gurez main centre, Town).	The bottom of the river was mostly rocky with boulders.
2	G 2	Located in Chorwan Nallah near Chorwan village and about 5 km above Davar (right bank tributary of Kishanganga River and originates from Burzall area of Pakistan).	Bottom rocky and with boulders.
3	G 3	Located in the main Kishanganga River, 2 kms below Davar near village Badwan	Rocky with boulders, gravel and sand.
	G 4	Located in main Kishanganga River at Tarbal about 14 km below Davar in the Baktoor area near LOC.	Bottom rocky and with boulders.
Kashmir valley			
5	K 1	Located in main river Jhelum at Baramullah near new cement bridge	Bottom mostly muddy with muck and sparse stones
6	K 2	This site was located in Buniyar stream about 1.5 km above from main Buniyar bazaar	Bottom rocky with gravel.
7	K 3	This site was located in Buniyar stream near bridge in main Buniyar.	Bottom mostly rocky.
8	K 4	Located in Haji Peer nallah in Uri about 1 km above main Uri near bridge.	Bottom rocky with gravel.
10	K 5	This site is located in main river Jhelum at Salamabad, Uri near bridge.	Bottom rocky with gravel and sand.
11	K 6	Located in main river at Sopore near new cement bridge.	Bottom muddy with muck and sparse rocks on shores.
12	K 7	Located in main Jhelum at the outlet of Wullar lake at Ningli.	Bottom mostly muddy.
13	K 8	This site was located in main Pohru river at Nowpora, Sopore.	Bottom muddy, rocky with gravel and sand.
14	K 9	Located in Madhumati river at Athwatoo village.	Bottom rocky with gravel.
15	K 10	This site was located in Madhumati river at Sandarwani village near Bridge.	Bottom with gravel, pebbles and sand.
16	K 11	Located in Madhumati river at Guzarbal village near Bridge.	Bottom with gravel and sand.

S. No.	Name of Site	Location of Site	Site Description
17	K 12	Located in Erin river at Papchan below bridge.	Bottom with gravel, pebbles and sand.
18	K 13	Located in Erin river at Erin village near Sheikhbagh Trout Farm.	Bottom rocky with gravel.
19	K 14	Located in River Sindh at Vayil below bridge.	Bottom with gravel, pebbles and sand.
20	K 15	This site is located in River Sindh at Weysan.	Bottom with rocks, gravel, and pebbles.
21	K 16	Located in main river Jhelum at Batengoo, Khanabal, Anantnag.	Bottom with mud and muck.
22	K 17	Located in river Sandran at Verinag lower.	Bottom with pebbles, gravel and rocks.
23	K 18	This site was located in river Sandran at Dooru, above bridge.	Bottom rocky with gravel and pebbles.
24	K 19	Located in River Branghi (Kokernag area) at Sagam.	Bottom muddy with gravel and pebbles.
25	K 20	Located in River Branghi above Daksum in forest area.	Bottom mostly rocky.
26	K 21	This site was Located in River Branghi at village Devalgam.	Bottom rocky with pebbles.
27	K 22	Located in River Lidder (Pahalgam area) at Nambal village above Trout Farm.	Bottom with pebbles, gravel and sand.
28	K 23	Located in River Lidder at Sakhras village above bridge.	Bottom with small rocks, gravel and pebbles.
29	K 24	Located in River Lidder (Pahalgam area) at Nambal village above Trout Farm.	Bottom with rocks, gravel and pebbles.
Jammu division			
30	J 1	Located in Nalla Basantar at Amli village, Samba	Bottom with sand and gravel.
31	J 2	Site located in Nalla Aik at Nikwal, about 2 km away from Boader.	Sandy bottom.
32	J 3	Located in Nalla Choli at Bumnal, Bishnah	Bottom sandy and muddy.
33	J 4	Site located in Nalla Khad near bridge near stadium	Bottom with Stones and gravel.
34	J 5	Located in Jandi, Khad nallah near GMS, Jandi.	Bottom with gravel.
35	J 6	Located in Nalla Jarnah near Sai School, Hiranagar.	Bottom with gravel.

S. No.	Name of Site	Location of Site	Site Description
36	J 7	Site located in Nalla Sanyal near Police Chowki, Hana, Hiranagar, Kathua.	Bottom with gravel. (Bottom with sand and mud).
37	J 8	Located in Mansar Lake.	Bottom with muck and mud.
38	J 9	Located in Nalla Banyadi (Sanjimore), Hiranagar	Bottom with gravel and mud.
39	J 10	Site located in River Ujh near barrage, Kathua.	Bottom with Gravel, Sand and rocks.
40	J 11	Located in Nalla Baghe near bridge, Hiranagar, Kathua.	Bottom with gravel and mud.
41	J 12	Site located in Nalla Sardhan at Pangal, Jammu.	Bottom with gravel and mud
42	J 13	Located in Nalla Khour near Nadwal village (Padli), Akhnoor.	Bottom with gravel, pebbles and mud.
43	J 14	Located in River Chenab at village Bakora, Akhnoor.	Bottom with gravel, sand and mud.

5. Himachal Pradesh

In this project two partners, Dept of Fisheries, Govt. of HP and Department of Fisheries, CSKHP Univ. Palampur, H.P. were identified with following technical program with progress.

- Intensive seed production of mahseer and ranching in specific location for developing aqua tourism
- Value addition of the farm produce
- Exploration of new potential and commercially important fish species
- Development of suitable location specific runoff water harvesting technology for coldwater aquaculture in the hills
- To initiate the project a draft of MOU was made between Institute and collaborative partners
- Detailed survey and design for the establishment of fish processing plant for Rainbow trout at Patlikul in collaboration with CIFT, Cochin has been completed.

View of private trout farm at Himachal Pradesh

Trout farming at Patlikuhal Himachal Pradesh

Inter-Institutional Outreach Activities (Fisheries Division -ICAR)

Project Code	NP1
Project Title	Outreach Activity-Fish Genetic Stock
Personnel	A. Barat, Prem Kumar , S Ali, R.S. Haldar

Activity 1: Sample collection and digitization of all sample images

- A total of 287 Mahseer (Tor putitora) fin and muscle tissue samples were collected from eight locations till 2011. Sampling efforts during this reporting period began in April 2008 from Uttarakhand (Bhimtal), in September 2008 from Uttarakhand (Mannan near Almora), in Jan 2009 from Himachal predesh (near Baijnath-Palampur), April 2009 from Arunachal Pradesh-Assam (Bhalukpong), in May 2009 from Uttarakhand (Ramnagar), in September 2009 from Himachal Pradesh (Jogindernager), in Jan 2010 from Maharashtra (Lonavala), in July 2010 from three location of J&K (Anji, Jhajharkoti, Basoli).
- Fin tissue samples has been collected and preserved in 70 % ethanol for DNA isolation.

Details of sample collection

Location	Sample	No. of samples
Punn river, a tributary of river Bias, near Baijnath-Palampur (Himachal Pradesh)	Fin	23
Bhimtal lake, Bhimtal (Uttarakhand)	Fin	10
Kosi river near Manan, Almora (Uttarakhand)	Fin	26
Jiaborali river,near Bhalukpong (Assam)	Fin , Muscles and Scales	36
Kosi river,near Ramnagar (U.K.)	Fin	43
Bias river, near Jogindernagar(H.P.)	Fin	10
Satluj river, Bhakara (H.P.)	Fin	20
Lonavala, Tata hydrolytic power company (Maharashtra)	Fin	20
Chenab river, near Anji (J & K)	Fin	51
Tawi river, near Jhajharkoti (J & K)	Fin	10
Ravi river, near Basoli (J & K)	Fin	38

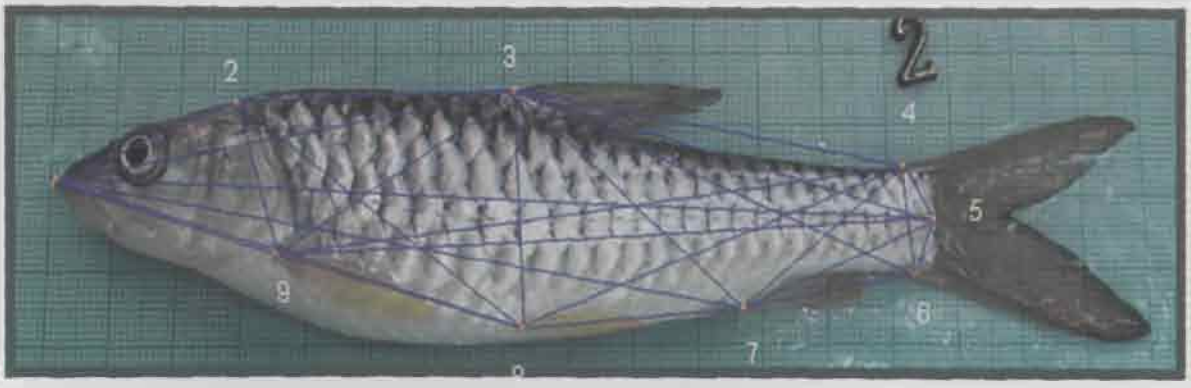
Digitization of Sample imags of *Tor putitora*

- Digitized all sample images of six populations: river Jiabhoreli, near Bhalukpong (Assam-Arunachal Pradesh); river Chenab, near Anji (Jammu & Kashmir); river Ravi, near Basoli (Jammu & Kashmir); river Tawi, near Jhajharkoti (Jammu & Kashmir); river Bias, near Jogindernagar, (Himachal Pradesh) and river Kosi, near Ramnager (Uttarakhand) individually for truss study.

Digitized Tor putitora sample for truss analysis

Activity 2. Preliminary Morphometric analysis (Truss analysis) of above mentioned six populations of *Tor putitora*.

- Selection of 9 landmarks for the study.



Truss measurement

- Truss data was generated by using tpsUtil and tpsdig programmes.
- The data so obtained was analyzed by using PAST, SPSS and Minitab software.
- To reduce the dimensionality, Three Principal Components were computed. Among them 97.1% and 1.4% of the total variation in the multivariate data was explained by first two principal components, PC1 and PCII respectively.
- Preliminary analysis data showed that maximum variation was contributed by Variable 4 i.e, Distance between the landmark 1 and 4 to PCI (30.1%) followed by Variable 5 (29.3%) and Variable 3 (29.1%).
- The Box Plot was obtained using the different populations on the X-ordinate and taking Variable 4 on the Y - ordinate. Since, the length of the Box represents the variability of the population, the plot suggests that the maximum variation observed in Jogindernagar (H.P.) population while the Basoli population had minimum variation.

Activity 3. DNA extraction and Quantitative and Qualitative estimation

- DNA was isolated from all the samples using phenol-chloroform extraction method.
- Quantitative and qualitative estimation of the DNA samples has been carried out by spectrophotometer at 260 & 280 nm and on 0.8% Agarose gel electrophoresis.

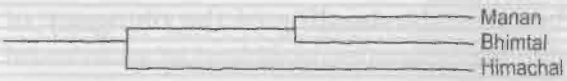
Activity 4. Amplification of two mitochondrial gene(Cytochrome b and ATP Synthase 6/8 gene)

Amplification of Cytochrome b

- Initially a set of universal primers (F'-AAAAGCTTCCATCCAACATCT CAGCATGATGAAA and R'-AAAC TGCAGCCCCTCAGAATGATATTTGT CCTCA) were used for amplification of partial sequence of cytochrome b gene (307 bp). Amplification profile was 95 °C for 5min as initial denaturation, followed by 35 cycles comprising 94°C for 30 sec, 54°C for 30 sec (ann. temp.) and 72°C for 1 min and 72°C for 10 min as final extension. The expected product size excised from 1.2% Agarose gel and purified by Qiagen gel extraction kit. Six PCR products of each populations (e.g., Manan, Bhimtal and Himachal Pradesh) were sequenced (Ocimum Biosolution, Hyderabad). The above sequences were analysed using NCBI BLAST and confirmed the respective gene. The three sequences of each population were submitted in NCBI GENBANK having accession no. HM219854 - HM219862.

Amplification of Cytb (307bp)

- As per multiple sequence alignment (ClustalW) analysis 17 sites found to be polymorphic.
- In major sites Himachal Pradesh population was differing from Manan & Bhimtal populations.
- The overall nucleotide diversity was ranging from 0.46952 to 0.51238.
- Nucleotide diversity was lowest (0.04571) in Bhimtal population, following 0.06857 in Manan population and highest (0.08571) in Himachal Pradesh population.
- The phylogenetic analysis revealed that the *Tor putitora* mtDNA consisted of two divergent clusters, One cluster consisted of Manan & Bhimtal & other with Himachal Pradesh population (fig. 8).
- The data shows close relationship between Manan & Bhimtal populations rather than Himachal Pradesh population.



Phylogenetic tree performed using UPMGA (MEGA4)

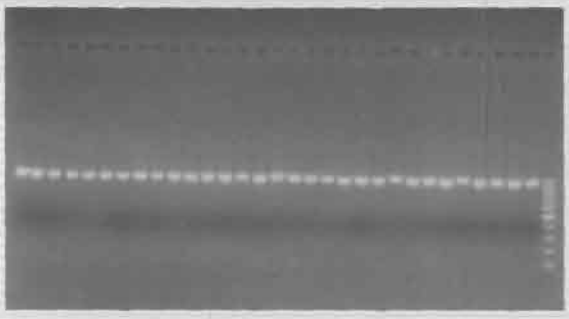
Amplification of Cytb

- Another set of primers for Cyt b was designed to achieve larger product (1140bp) consisting F'-TGACTTGAA AAACCACCGTTG and R'- CTCCGA TCTCCGGATTACAAGAC.
- Mitochondrial gene, cytochrome b (cyt b) about 1140 bp size has been successfully amplified at 94°C for 30sec, 57°C for 1min and 72°C for 1 min 30 sec. from five populations i.e. Bhalukpong, Jogindernagar, Bhakara, Ramnagar and Lonavala (Fig.11).
- Six PCR products of each populations (e.g. Bhalukpong, Jogindernagar, Bhakara, Ramnagar and Lonawala) were sequenced (Bangalore Genei). The above sequences were analyzed using NCBI BLAST and confirmed the respective gene. The five sequences of each population were submitted in NCBI GENBANK having accession no. HM179277 - HM19295.

Cytochrome b (1140 bp)

Amplification of ATPase 6/8

- A set of primer for mitochondrial gene, ATPase 6/8 (840 bp) was designed consisting F'- AAAGCRTYRGCCTTT TAAGC and R'-GTTAGTGGGTCAK GGGCTTGGRTC.
- Mitochondrial gene, ATPase 6/8 about 840 bp size has been successfully amplified at 94°C for 45sec, 52°C for 45sec and 72°C for 1 min 30 sec from five populations i.e. Bhalukpong, Jogindernagar, Bhakara, Ramnagar and Lonawala (Fig.12).



ATPase (840 bp)

- Six PCR products of each populations (e.g. Bhalukpong, Jogindernagar, Bhakara, Ramnagar and Lonawala) were sequenced (Bangalore Genei). The above sequences were analyzed using NCBI BLAST and confirmed the respective gene. The five sequences of each population were submitted in NCBI GENBANK having accession no.HQ603787-HQ603802.

Project Code	**NP2**
Project Title	**Outreach Activity- Fish Feed**
Personnel	N. N. Pandey, D Sarma, S.K. Srivastava, M.S. Akhtar, S.K. Gupta

A. Ontogeny of digestive enzymes of golden Mahseer larvae

Study on digestive enzyme profile of golden mahseer larvae provided an insight on the development of the larvae digestive functions in order to obtain essential data for the formulation of a compound diet adapted to larvae. Samples of mahseer larvae of different age groups viz. 0 day after hatching (0 DAH), 3 DAH, 7 DAH, 15 DAH, 21 DAH, 30 DAH and 45 DAH had been collected from DCFR mahseer hatchery, Bhimtal. Whole larvae (till age 21 DAH) and dissected larvae (30 and 45 DAH) were homogenized with 5 % chilled 0.25 M sucrose solution using a mechanical tissue homogenizer. The

homogenized samples were centrifuged (6000xg for 10 min) and supernatants were collected and stored at - 20 °C for subsequent enzyme assays.

Lipase activity

Activity was minimum at 0 DAH. There was a significant ($p<0.05$) linear increase ($y = 12.15x - 4.95$, $R2 = 0.98$, $p<0.05$) in its activity upto 7 DAH. The activity sharply decreased on 15 DAH followed by a significant ($p<0.05$) abrupt increase to a maximum on 21 DAH. Again, lipase activity sharply decreased to a minimum level on 30 DAH.

Protease activity

It was observed even on 0 DAH and this activity was consistent till 3 DAH. On 7 DAH, the activity increased by 10% and from 7 DAH onward, the activity was sharply decreased (2-fold) to a minimum on 30 DAH. Again, a sharp increase was observed on 45 DAH.

Amylase activity

Minimum activity was found on 0 DAH and 3 DAH. With a sharp significant ($p<0.05$) increase upto 7 DAH and reached maximum. On 15 DAH, there was a slight decrease in the activity. From 15 DAH till 45 DAH.

Alkaline phosphatase activity

Minimum activity was found on 0 DAH upto 7 DAH. There was a sharp (3-fold) increase in the activity on 15 DAH and further gradually increased to a maximum on 30 DAH. A two-fold decrease was evidenced on 45 DAH.

Trypsin activity

Activity was evidenced from 0 DAH and decreased and become minimum on 15 DAH and then fourfold increment was observed on 21 DAH. Again there was twofold decrease in the trypsin activity on 30 DAH and remained similar till 45 DAH.

Better knowledge about the onset and development of the main digestive enzymes during larval development of golden mahseer larvae would be helpful in formulation of a compound diet adapted to larvae. Thus, a better understanding of the ontogeny of digestive enzymes could lead to a successful replacement of live feeds by formulated diet.

B. Up-scaling of existing grow-out feeds and feeding practices in rainbow trout

Grow-out feeds (Floating pellets) were formulated with 3 levels of protein (45, 40 & 35%) with uniform lipid level of 14% by using following ingredients-

Fish meal (Sterlised having >60% protein), solvent extracted soybean meal, mustard oil cake, wheat flour, Starch, fish oil, Brewer's yeast powder, Linseed oil cake and Vit.& min. mixture. Proximate composition of all the 3 diets was analysed. Experiment was conducted in six nursery raceways (size-10x3x0.7mt.) in outdoor condition at Experimental fish Centre, Champawat. Data on growth performance and nutritional value reveals that there is no significant difference between CTF1 and CTF2 in terms of growth, survival and FCR. CTF1 (Champa Trout Feed 1) having 45% protein and 14% lipid is best among all the tested diets. Although, CTF3 is inferior in respect of nutritional value, but it was found cost effective with feed cost of Rs.78/- per kg and feed cost to produce 1 kg fish as Rs. 105/-. High protein level in the diet is always resulted an increase in unwanted ammonia excretion. In case of CTF1 and CTF2 fed fish pond it was noted as 0.12 mg/l and 0.08 mg/l respectively in the drain water. But, lowest level of ammonia as 0.05 mg/l was noted in the pond fed with diet CTF3 having low level of protein. Therefore, for further refinement and to develop a more environmentally friendly, cost effective, nutritious diet for trout, CTF4 was formulated with the same composition as CTF3 with additional inclusion of 40% SESM and 60% fish meal as protein supplements, 0.4% papain powder, 0.1% turmeric powder as anti-biotic, 2 gm/kg asafoetida as appetizer for improving feed intake. CTF4 was found an environmentally friendly, cost effective, nutritious diet for trout with low level of protein and good FCR as 1.26.

Project Code	NP3
Project Title	Outreach Activity- Nutrient Profiling and Evaluation of Fish as a Dietary component
Personnel	Debajit Sarma, Md. M.S. Akhtar , Neetu Shahi, N.N.Pandey

Nutrient Composition of Golden mahseer

Golden mahseer (*Tor putitora*) mostly found in streams, rivers and lakes of upland Himalayan region provide food and nutrition subsistence and supplemental income to the hilly population. Himalayan mahseer is indigenous fish species that form mainstay fisheries of the upland region. The population of the species in highland water bodies is declining due to various natural and anthropogenic factors. However, their abundance and consumer preference make them potential resource not only for capture fishery but also for aquaculture industries (Sarma *et al.* 2009, Mahanta *et al.*1994). The hilly people consume this fish caught by various traditional gears from streams, rivers and lakes having different size groups.

As a whole freshwater fish is being well recognized for its health promoting characteristics. Freshwater fishes contain high quality protein and various major and minor minerals. It is well known that dietary protein act as replacement of endogenous loss of body protein due to tear, formation of new tissues during growth period and synthesis of blood, hormone, etc. which are protein in nature (Torres 2000, Nurullah *et al.* 2003, Harry 1958, Pedrini *et al.* 1996, Huang *et al.* 2001, Mat Jais 1994, Skonberg *et al.* 2002). Certain amino acids like aspartic acid, glycine and glutamic acid are also known to play a key role in the process of wound healing (Chyun and Griminger 1984, Wahbeh 1997, Zuraini *et al.*2006). Although the nutrient quantity of various freshwater fish species have been characterized, coldwater fishes vary widely in their body composition, major minerals - Na, K, Ca and trace elements - Fe, Mn, Zn, Se in relation to geographical location, seasonal variation and production system (Celik *et al.* 2007, Berg and Bremset 1998, Dempson *et al.* 2004, Ekpo and Ibok 1999, Sharif *et al.* 1993). The differences also have been found in concentration of moisture, fat, ash and protein having different size groups of fishes collected from different altitudinal location (Shearer 1994).

Basic knowledge of nutrient quality is very much essential to deal with the production, processing and marketing of high valued Himalayan mahseer for human consumption. However, there is paucity of information available on nutritive composition like amino acid, micro and macro minerals as well as proximate analysis of the king fish, Himalayan mahseer found in different upland streams and rivers of eastern and western Himalayan region. The present study embodies on analysis of proximate composition, macro and micro minerals and amino acid profile of golden mahseer in respect to different seasons, geographical locations and production systems.

Golden mahseer having different size groups were caught from the wild aquatic environment of Kosi river (latitude 29°25¢ to 29°39¢ N, longitude 78°44¢ to 79° 07¢ E and 1960 mts. asl), Bhimtal lake (latitude 29°20¢40¢¢ N, longitude 79°36¢16¢¢ E and 1371mts. asl) of Uttarakhand and Kameng river (latitude 27°48¢36¢¢, longitude 92°26¢38¢¢ and 2443 mts. asl), Arunachal Pradesh, India. The specimens were also collected from aquaculture pond, mahseer hatchery complex of Directorate of Coldwater Fisheries Research, Bhimtal. Seasonal samples (October to January, February to May and June to September) were taken from the different geographical areas, based on the climatological conditions of the region (Jonsson *et al.*1997, Barthakur 1986). The experiments were conducted during 2008 and 2009. The collected live samples were kept in

plastic bags and transported in an insulated icebox to the laboratory. Within 12 hours, samples were gutted, washed and filleted. Samples were pooled considering their location of sampling. Three composite samples of each instance were prepared by blending the meat from 3-4 golden mahseer.

Samples were then homogenized and subjected to moisture, ash and crude fat analysis using Association of the Official Analytical Chemists (AOAC 1984) methods 14004 (1984), 14009 (1984), and 14006 (1984). Nitrogen was determined using the Kjeldahl method. The quantity of protein was calculated as 6.25´ N (method 7015, AOAC 1984). Ashed samples were dissolved in 2 ml of concentrated acid (HCL: HNO_3, 1:1) and then diluted with distilled water (Shearer 1984). The diluted mixture was analyzed for Calcium, Sodium, Potassium, Iron, Zinc, Magnesium and Selenium with an Atomic Absorption Spectroscopy (Thermo-Electron Corporation, FS95-Furnace Auto Sampler). For amino acid analysis, methods of (Ishida *et al.* 1981) were used. Samples were hydrolyzed with 6 (N) hydrochloric acid for 24 hours at 110^0 C. The hydrolyzed samples were then analyzed using an automatic amino acid analyzer (Column- Shimadzu, Shimpack ISC-07/S1504 Na, FLD-6A Fluorescence Detector) with a nynhydrin reagent and lithium buffer system by injecting 20 ml (Yamamoto *et al.* 1998). The reproducibility of the results was within approximately 3%. The net height of each peak produced by the Chart recorder of the analyzer (each representing and amino acid) was measured and calculated. All chemical analysis was run in triplicate. Data was subjected to one-way analysis of variance using the Statistical Package SPSS 12.01 version. Differences between treatment means were detected by the Tukey's test (Zar 1998).

Seasonal effect on estimated average proximate composition (protein, ash, crude fat and moisture) from Hatchery pond was found statistically significant different and the above average estimates ranged between 15.59-17.29 gm/100gm, 1.23-1.55 gm/100gm, 0.62-1.52 gm/100gm and 76.24-79.24 gm/100gm respectively (Table 1). From the estimated average values, higher protein (17.29 gm/100gm) and moderate crude fat (1.50 gm/100 gm) levels were observed during June to September (breeding season). The higher protein level reflected might be accountable due to the maturity stage of the fish species in their seasonal life cycle having higher intake of proteineous artificial feed in pond environment. This agrees with observations made by Berg and Bremset (1998), who reported that significant changes in body composition of young riverine Atlantic salmon and brown trout with the concentration of fat and protein level declined greatly in winter but were replenished rapidly in Spring.

Protein, ash, crude fat and moisture concentration of three geographical locations were recorded (Table 2). The average protein content of hatchery pond, Kosi river and Kameng river were 15.59, 21.00 and 17.20 gm/100 gm respectively. Similarly, average crude fat levels were 1.52, 6.15 and 6.15 gm/100 gm from hatchery pond, Kosi river and Kameng river respectively. Results from the present study revealed that protein and crude fat levels of the above fish species collected from Kosi river was found highest among different geographical locations considered. Moreover, similar results were obtained for variation of proximate body compositions of Atlantic salmon having two different habitats (Dempson *et al.* 2004). The changes of nutritional status may be attributed due to substratum adaptation and survival in mountain streams and rivers having different ecological conditions and significant altitudinal variation. Significant differences in macro minerals content was observed among four different geographical locations of hatchery pond, Bhimtal lake, Kosi river and Kameng river (Table 3). The average values of sodium, potassium and calcium concentration in golden mahseer for Hatchery pond, Bhimtal lake, Kosi river and Kameng river are presented in Table 3. Results of these analyze showed that golden mahseer contains

significantly higher concentration of calcium, potassium but low in sodium concentration. Further, concentration of calcium and potassium decreases with the increase in body weight (Table 4). It may be concluded that Himalayan mahseer is a good source of minerals. The above finding agrees with the observation made by Nurullah *et al.*2003, that reported higher minerals content in some selected indigenous fish species of Bangladesh. Fishes collected from the habitat of Kameng river has significantly higher concentration of selenium (1.56 mg/100gm), whereas Himalayan mahseer of Kosi river has significantly higher concentration of iron (1.28 mg/100 gm) and moderate estimates of manganese and zinc (0.16 and 1.19 mg/100 gm) respectively (Table 5). The higher concentration of selenium in the body composition of mahseer of Kameng river is attributed due to the rich concentration of selenium in water received as a process of anthropogenic sources from the atmosphere by dry and wet deposition from adjacent water, from surface run off, and from surface drainage in the North Eastern Himalayan region (latitude 27°48¢36¢¢ longitude 92°26¢38¢¢ and 2443 mts. asl). Similarly, the rocky substratum in Kosi river of Western Himalayan region (latitude 29°25¢ to 29°39¢ N; longitude 78°44¢ to 79° 07¢ E and 1960 mts. Asl) which contains higher levels of iron mineral have had positive co-relation with the increased body concentration of iron of golden mahseer benefiting the human health. Ekpo and Ibok (1999) and Fawole *et al.* (2007) concluded that any fish species could be a good source of minerals when it contains an appreciable concentration of micro minerals.

The amino acid composition (% of total protein) is presented in (Table 6). The major amino acids were aspartic acid (7.606%), glutamic acid (9.631%), proline (6.684%), glycine (7.456%), leucine (7.585%), and lysine (9.411%). Levels of different amino acids were ranging from 0.482-9.631%. It revealed that amino acids are important component for healing process. Any deficiencies in these essential components will hinder the recovery process (Mat Jais *et al.*1994). Glycine is one of the major components of human skin collagen together with other essential amino acids such as alanine, proline, arginine, serine, isolucine and phenylalanine from a polypeptide, which are found significantly higher percentage in golden mahseer that will promote growth and tissue healing (Heimann 1982, Witte *et al.*2002).

Thus, golden mahseer could be a good source of minerals as it contains higher concentration of micro and macro minerals (potassium, calcium, iron, manganese, zinc and selenium), which helps in metabolic process of development stages and are known to be indispensable to the human beings. Moreover, the values of proximate composition obtained were highly pronounced most especially the protein and crude fat, thereby the fish may provide an alternate source of protein for the upland population of developing countries. It is concluded that the size of fish, seasons and geographical locations are the prominent factors in making a choice for consumption of coldwater fish species especially of golden mahseer for benefiting the human health.

Nutrient composition of rainbow trout

The nutritional quality of fish is, to a great extent, associated with its content of essential fatty acids, essential amino acids, minerals and vitamins. Fishes are the major dietary source of n-3 highly unsaturated fatty acids (HUFA) such as eicosapantaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3) for humans (FAO, 2006). Long chain n- 3 PUFA cannot be synthesized by humans and must be obtained from the diet (Alasalvar, et al., 2002). There is strong scientific evidence that n-3 long chain polyunsaturated fatty acids play important roles in the modulation and prevention of human diseases, particularly coronary heart disease, hypertension, inflammation, arrhythmias, psoriasis, aggression, depression, auto-immune disorders and cancer (Simopoulos, 2002) through several actions including the reduction of triglycerides and very low density

lipoproteins, prevention of irregularity in the rhythm of heartbeat, prevention of the formation of blood clots in blood vessels and inhibition of inflammation.

Muscle tissue of fish is an important source of protein for humans. The amino acid composition is one of the most important nutritional qualities of protein and the amino acid score (FAO/WHO, 1990) is used to evaluate protein quality worldwide. Certain amino acids like aspartic acid, glycine and glutamic acid are also known to play a role in the process of wound healing (Chyun & Griminger, 1984). Amino acids, not only have high nutritive value, but also provide several health benefits, such as reduction of blood cholesterol and antimutagenicity (Simopoulos, 2002). Some amino acids like tyrosine, methionine, histidine, lysine and tryptophan are considered to act as antioxidants (Saito et al., 2003). In addition, Kim et al. (1999) reported that aspartic acid, glutamine, proline, glycine and leucine have strong cytotoxic activity against cancer cells.

Mineral components such as sodium, potassium, magnesium, calcium, iron, are important for human nutrition. These minerals take part in some metabolic processes and are known to be indispensable to all living beings. The deficiency in these principal nutritional mineral elements induces a lot of malfunctioning as it reduces productivity and causes diseases, such as inability of blood to clot, osteoporosis and anemia (Shulman, 1974). Therefore, considering the various health risk and the nutritional benefits associated with fish consumption; it has therefore become important that, fish's mineral and proximate composition and their health status be assessed in order to establish the safety level of the table sized species prior their consumption.

Rainbow trout (*O. mykiss*), a salmonid, thrives well in cold, clear and well-oxygenated rivers and lakes that generally have a water temperature of 15 - 21°C. It is widely used as a candidate species for aquaculture in many countries including the U.S.A., Japan, Europe, the Russian Federation and Canada (Yasmin et al., 2004) because of its rapid growth and high value as food. In India, rainbow trout was introduced during 1900s for the purpose of enhancing sport fishery. But, now its population has well established in the coldwaters of Indian Himalayan region and also has become the most important coldwater aquaculture species in India due to its higher consumer preference and food delicacy. Although studies on fatty acid composition of the rainbow trout consumed elsewhere in the world are available (Kiessling et al. 2001; Halilog¢lu et al. 2004; Özden 2005), but to the best of our knowledge there is no report on nutritional quality of rainbow trout from Indian waters. Moreover, there are not enough findings that give us information on its whole nutritional value. Therefore, keeping in view of these facts, the present study was carried out to determine the proximate composition, amino acid and fatty acid profiles and mineral content of rainbow trout from Indian Himalayan region.

Ten fresh adult rainbow trouts (*O. mykiss*) (1132.0 ± 31.53 g, mean weight ± SD) were caught from experimental aquaculture fish farm of Directorate of Coldwater Fisheries Research (DCFR), Chirapani, Champawat, Uttarakhand, India. Immediately after catching, they were stored on ice in an insulated box and transferred to the DCFR laboratory on the same day. On arrival in the laboratory, fishes were washed with running tap water then beheaded, eviscerated and filleted. Boneless muscles, used for analysis, were collected from all the representative individual fish, pooled together and then mashed. Mashed muscle sample was mixed thoroughly and stored in a plastic bag, and then kept in a refrigerator at -20°C. All analyses were performed in triplicates.

Proximate compositions analyses

The moisture content was determined by drying samples in an oven at 105 °C until a constant weight was obtained (AOAC, 1990). Nitrogen content was estimated by Kjeldahl (2200 Kjeltec Auto distillation, Foss Tecator,

Sweden) method (AOAC, 1990) and crude protein was estimated by multiplying nitrogen percentage by a conversion factor 6.25. Crude fat was determined by soxhlet solvent extraction method (AOAC, 1990) using diethyl ether (boiling point, 40-60 °C) as solvent. Ash was determined by incineration of samples in a muffle furnace at 600 °C for 24 h (AOAC, 1990).

Amino acid analyses

Amino acid analysis was done following the methods of Ishida et al. (1981). Briefly, around 100mg samples were digested with 6.0 N hydrochloric acid for 24 hours at 120 °C in sealed glass tubes filled with nitrogen gas. Cooled the glass tubes and then digested samples were filtered. The filtrates were evaporated using vacuum flask (U-Tech, Star Scientific Industries, New Delhi, India) evaporator. Added 10 ml deionised water (Millipore, New Delhi, India) and evaporation continued until the samples are acid free. Then, the acid free samples, containing free amino acids, were dissolved in 10 ml of 0.05M HCl and then filtered by passing through Whatman filter paper of 0.45µ pore size. 20µl of this filtrate was injected into HPLC (Shimadzu, Shimpack ISC-07/S1504 Na, FLD-6A, Fluorescence Detector) for analysis of amino acids.

Amino acid score

Essential amino acid score was calculated with respect to the FAO/WHO reference amino acid pattern of the pre-school child (age, 2–5 year; FAO/WHO/UNU, 1985).

Amino acid score = {sample amino acid / reference amino acid} x 100

Fatty acid profile analyses

For fatty acid analysis the extraction of lipids from the muscle tissue was made using Bligh and Dyer method (Bligh and Dyer, 1959). Fatty acid methyl esters prepared from the lipid extract following the method of Matcalfe et al. (1966) by using BF3 –methanol and was determined by injecting into a thermo electron gas chromatography-FID (Varian, USA). The Gas chromatograph (GC) is set at required temperature with optimum flow of carrier gas. Programme of GC: injector 275 °C; FID 300° C; Capillary column, 5% phenyl-95% methyl phase, (Elite-5, CP Sil 8CB)(30m, 0.53mm i.d, 0.53mm); carrier gas, nitrogen at flow rate 0.7ml/min; temperature programme -170° C; temperature is programmed to raise at 4° C/min to 250° C and maintained at that temperature for 10 min; split flow 20ml, 1.0ml sample injection. Individual fatty acids were identified and quantified by comparison with retention time and peak area ratio by comparing with respective authentic fatty acid methyl ester standards using Varian Star GC software. The values of fatty acids were presented in area percentage of total identified fatty acids.

Mineral analyses

For mineral estimation, the ash was digested in a boiling nitric acid and perchloric acid mixture (2:1) according to AOAC (1990). After appropriate dilution, calcium, sodium, potassium, iron, zinc, magnesium and selenium contents were estimated by atomic absorption spectrophotometer (FS95-Furnace Auto Sampler, Thermo-Electron Corporation, Waltham, Massachusetts, USA).

Proximate analyses

The results of proximate analysis of rainbow trouts are shown in Table 1. The moisture, crude protein, crude lipid and ash contents of the rainbow trout were 74.00, 19.44, 5.18 and 1.37%, respectively. These values are almost similar to those for *Salmo gairdneri*, reported as 76.23, 18.57, 3.71 and 1.47%, for moisture, protein, fat and ash, respectively (Özden, 2005) except crude lipid content which was slightly higher (5.18%). Based on the moisture and fat contents, the rainbow trout is a medium-fat fish, with a fat content of 5–10% by weight. However, the values in the present study are well comparable with the earlier reports in different salmonid species (Testi *et al.* 2006). Conversely, González-Fandos *et al.* (2004) reported higher lipid content (6.55%) and

lower protein content (16.04%) in rainbow trout (*O. mykiss*) when compared to findings of the present study. This may be due to geographical location or maturity stage of rainbow trout as it has been indicated that the lipid content of fish changes due to species, gender, maturity stage, geographical location and season (Rasoarahona et al., 2005).

Amino acid composition and score

The amino acid composition of rainbow trout muscle is shown in Table 2. Rainbow trout protein had a well-balanced amino acid composition, with high amounts of proline (96.37 mg/g crude protein), aspartic acid (85.23 mg/g crude protein), tyrosine (83.84 mg/g crude protein), glycine (69.87 mg/g crude protein), serine (66.63 mg/g crude protein), arginine (65.26 mg/g crude protein), isoleucine (64.56 mg/g crude protein) and tryptophan (61.63 mg/g crude protein). The major amino acids are glutamic acid, aspartic acid and lysine (Ranging from 9.7% to 21.7% of total). Levels of different amino acids are from 0.9% to 21.7% in *C. striatus*, 0.1% to 19.4% in *C. micropeltes* and 0.6% to 21.2% in *C. lucius* (Zuraini et al., 2006). Proline, which is one of the major components of human skin collagen, together with other amino acids such as glycine, alanine, arginine, serine, isoleucine and phenyl alanine form a polypeptide that will promote regrowth and tissue healing (Witte, et al., 2002). The efflux of glutamine from muscle in critical illness serves as an important carrier of ammonia (nitrogen) to the splanchnic area and the immune system as well as helps in synthesis of purines and pyrimidines essential for the proliferation of cells.

Amino acid scores are summarized in Table 3. When compared to the reference amino acid pattern of pre-school children (2-5 years old), all of the amino acid scores were >100, except for leucine and lysine. The highest amino acid score was observed for tryptophan (560) followed by isoleucine (230). According to the amino acid score, the amounts of leucine and lysine were the lower amongst amino acids in rainbow trout. However, in this study, cysteine was not detected which may be due total loss of cysteine when the muscle tissue was hydrolyzed without performing acid oxidation. The protein in rainbow trout muscle was well balanced in essential amino acid composition and is of high quality.

Fatty acid profile

The fatty acid profile of the rainbow trout is presented in Table 4. The fatty acids analyzed were grouped as saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). In the present study, fatty acid profile showed that total monounsaturated fatty acids (MUFA) were the highest (35.88%) followed by saturated fatty acids (34.51%) and polyunsaturated fatty acids (31.39%). Palmitic acid (C16:0) was the predominant fatty acid in rainbow trout, accounting for about 63.28% of all SFAs followed by stearic acid (C18:0) (22%). Among MUFAs, oleic (C18: 1) and palmitoleic (16:1) acids were the predominant fatty acids, accounting for almost 67.69 and 22.85% of total MUFA, respectively. Linoleic acid (C18: 2n-6), docosahexaenoic acid (DHA) (C22: 6 n-3), linolenic (C18: 3n-3), arachidonic acid (AA) (C20: 4n-6) and eicosapantaenoic acid (EPA) (C20: 5 n-3) were the dominant PUFAs which were accounted for 43.93, 20.52, 15.42, 7.65 and 7.45 % of total PUFAs respectively. Yanar et al. (2006) in rainbow trout fishes found results similar to our findings. However, Testi et al. (2006) reported that PUFA was the highest in rainbow trout followed by MUFA and SFA. Halilog¢lu et al. (2004) also found different results than ours and those of other studies in the same fish species. This may be due to the fact that the lipid and fatty acid compositions of fish differ depending on a variety of factors such as the species, maturity period, size and age of the fish, seasonal conditions and geographical location (González et al., 2006).

In general, the fatty acid composition distribution of the rainbow trout analyzed is in agreement with the data available on the

fatty acid composition of the same fish species (Halilog¢lu et al., 2004; Yanar et al., 2006). Among PUFAs, DHA and EPA have an important role in nutrition for human health. Arachidonic acid is a precursor for prostaglandins and thromboxanes, which influence clotting of blood and the healing process. Apart from this function, it also plays a role in growth. Therefore, fish have been suggested as a key component for a healthy diet of humans. In the present study, we observed that DHA, AA and EPA accounted for 20.52, 7.65 and 7.45 % of the total PUFAs in the muscle of the rainbow trout. Piggott and Tucker (1990) suggested that the n3/n6 ratio is a better index in comparing relative nutritional value of fish. An n-3/n-6 ratio of 1:1 is considered to be optimal for nutritional purposes (Simopoulos, 1989). A dietary intake of fish with an optimum ratio of n-3/n-6 would therefore be beneficial (Økland et al., 2005) and in the present study, the n-3/n-6 ratio was found to be 0.77 in rainbow trout muscle.

Minerals

Table 5 summarizes the mineral contents of the rainbow trout. Among the minerals analyzed, K was the highest followed by Ca, Na, Fe, Zn, Se and Mn. The results, especially K (1447.0 mg g/100 g), Ca (359.33 mg/100g), Na (208.0mg/100g) and Fe (5.17mg/100g) values, show that rainbow trout is suitable for human nutrition. All macro-mineral data fell within the range reported by the USDA (2005) for rainbow trout (*S. gairdneri*) meat. The main functions of essential minerals include skeletal structure, maintenance of colloidal system and regulation of acid-base equilibrium (Erkan & Özkan, 2007). Minerals also constitute important components of hormones, enzymes and enzyme activators. Calcium is necessary to maintain an optimal bone development. Iron has several vital functions in the body. It serves as a carrier of oxygen to the tissues from the lungs by red blood cell hemoglobin, as a transport medium for electrons within cells, and as an integrated part of important enzyme systems in various tissues. Adequate iron in the diet is very important for decreasing the incidence of anemia, which is considered a major health problem, especially in young, children. Iron deficiency occurs when the demand for iron is high, e.g., in growth, high menstrual loss, and pregnancy, and the intake is quantitatively inadequate or contains elements that render the iron unavailable for absorption (Camara et al., 2005). In the present study, it is revealed that rainbow trout muscle is reasonably a good source of iron, supplying 5.17mg/100 g muscle. Zinc is known to be involved in most metabolic pathways in plants, animals including humans (Hambidge, 2000). Zinc deficiency can lead to loss of appetite, growth retardation, skin changes and immunological abnormalities (National Research Council Recommended dietary allowances, 1989). In the present investigation, zinc level of rainbow trout was found to be 1.79mg/100g of muscle, which is sufficient to maintain good health in humans. Selenium plays a protective role in preventing carcinogenesis and other chronic diseases and act as an antioxidant in man (Önnig, 2000). The selenium content (1.66 mg/100g) in rainbow trout in our study is higher than many other species like sea bass, 0.227 mg/kg (Šatoviæ and Beker (2004), herring, 0.347 mg/kg; mackerel, 0.498 mg/kg; turbot, 0.473 mg/ kg; flounder, 0.371 mg/kg (Önnig, (2000). This suggests the nutritional good quality of rainbow trout muscle.

From overall results obtained in present investigation, it is revealed that rainbow trout has a rich amount of high quality protein with well-balanced essential amino acid, polyunsaturated fatty acids (PUFAs) and minerals. Therefore, we conclude that rainbow trout caught from the Indian Himalayan region is recommended for human consumption as a good source of nutrition. This investigation provides practical and useful information on the nutritional quality aspects and chemical composition of rainbow trout which will be important for nutritionists, the fishing industry and investigators for improving processing and marketing.





Fish species studied

Completed Research Projects

Project Code	**CF1**
Project Title	**Development of GIS based decision support system for aquaculture in selected coldwater region**
Personnel	Ashok K Nayak, Prem Kumar, P. C. Mahanta, R. S. Haldar, A.K Saxena

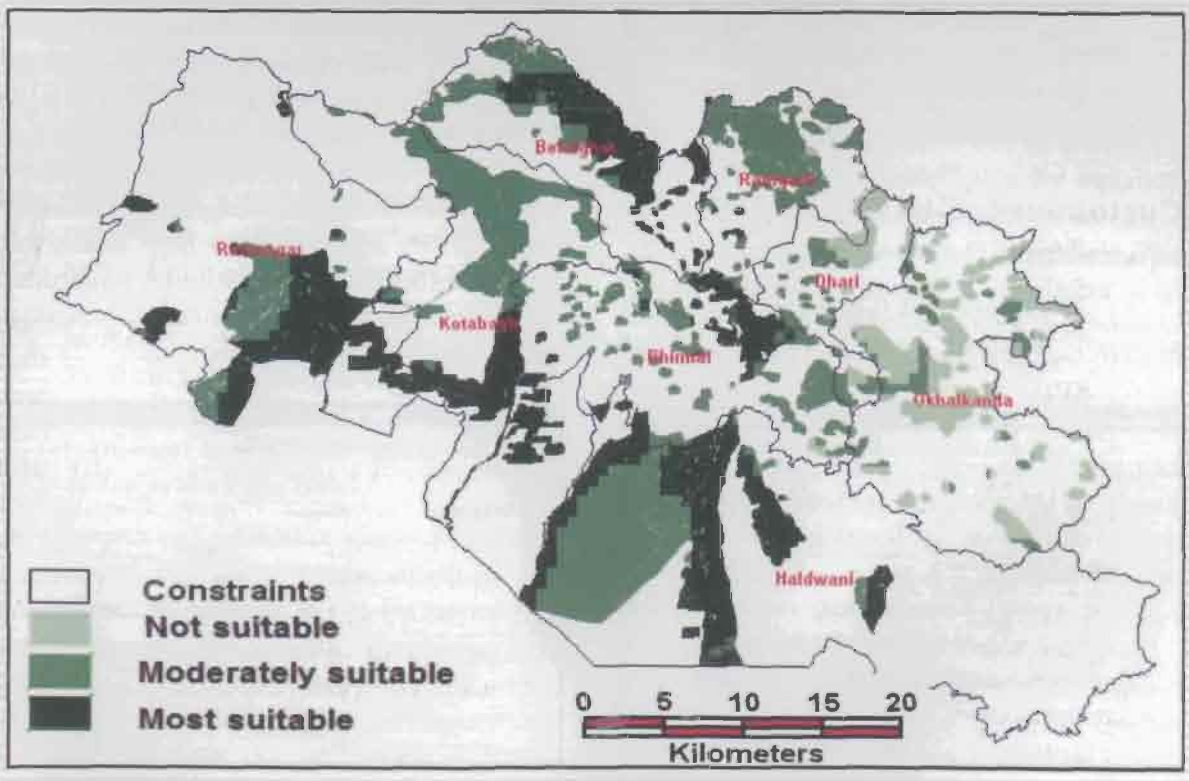
- The present study encapsulates the GIS based decision support system meant for aquaculture in the Kumaon region of Uttarakhand. An attempt has been made to put forward issues of Geoinformatics, Decision Support System with regard to application domain of fisheries. A comprehensive study has been carried out in this regard. Spatial and non spatial databases have been arrived at and an attempt has been made to develop a Decision Support System for retrieving

intelligent inference much to the utility of the planners and people at large. In this context, Nainital district of Uttarakhand was selected for the present study that has geographical area of approximately 401,992 ha and lying between latitudes 28° 59′ to 29° 36′ N and longitudes 78° 52′ to 79° 58′ E.

- The aim of present work was to create a Decision Support System (DSS) based on the spatial database on physico-chemical parameters of soil, water and infrastructure facilities. Based on the DSS, the site suitability for aquaculture can be selected in the unexplored area of hills. The need was felt due to a number of constraints such as availability of water, quality of water with reference to physico-chemical parameters, quality of soil and protected areas that exist in the hilly region. In addition to it, there are number of infrastructural issues such as road connectivity, technical know-how, availability of seed, availability of feed etc. recognised as major parameters. It was felt that if a GIS based software made available for common man use, it will enhance the possibility of developing aquaculture in hills.
- GIS, Remote Sensing (RS) and computing technologies are used in developing this system. The technology can answer for generic questions like locations, conditions, trends, patterns and modeling. These answers support in making authentic decision, which are purely based on realities on the ground and can be used for scientific management of water bodies and explore the suitable in hand information for proceeding aquaculture development. It also provides a long-term outline for sector development including all sub sectors like aquaculture, fish market etc. providing guidance to the farmers and planners where really it can be implemented.
- To follow up the objectives, the work was carried out in four phases firstly a non-spatial database on soil and water quality parameters was prepared. Secondly, spatial database on the infrastructure such as road network, market facilities, location of hatcheries for seed supply etc. was developed. Thirdly, spatial and non-spatial data are integrated and modelling was carried out for finding suitable sites for aquaculture in study area. Finally, a graphical user interface (GUI) was developed for the end user.
- Different physico-chemical parameters of soil and water are used as non-spatial database for the developing the Decision Support System. Soil characteristics include of pH, clay and organic matter whereas water quality parameters such as temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, hardness, phosphate, nitrate and transparency are used. These parameters are determents of suitability of aquaculture. Thematic maps of individual parameter were prepared on block level.
- Geographical thematic maps on road network, market, feed and seed availability were also prepared. This database contains the information of water bodies available in the district on block level. A buffer map of forest cover and road network were also prepared to demarcate as protected area.
- Using the Analytical Hierarchy Process (AHP) model, it was concluded that among the nine water quality parameters, water temperature was the highest importance having 23%, pH and dissolved oxygen having 17% and 16% respectively. Whereas, carbon dioxide and alkalinity having 10% importance each. Hardness having 9% and other parameters such as phosphate, nitrate and transparency contributes 5% importance. In case of soil quality parameters, the organic matter ranked highest having 54% important in compare to soil pH of 30% and soil

texture clay content ranked third having 16% in this region. Among the Infrastructure facilities, distance to water source is found to be most important and its contribution is calculated to be 40%. The distance to hatchery is ranked second and the distance to market ranked third with 26% and 22% respectively. The distant to road ranked fourth having 12% importances.

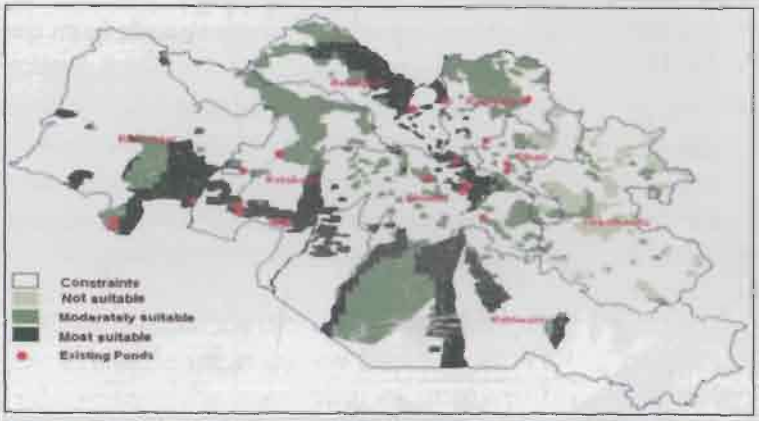
- Considering all the above criteria and according to AHP model, water quality suitability is the most important for assessing site suitability for aquaculture development. It contributes 54% importance and soil quality having 24% where as infrastructure facilities having 22% importance for aquaculture site suitability assessment in this region.
- There are certain criteria established as indicated above for physico-chemical parameters of soil and water that are used for selecting suitable site for aquaculture productivity. Infrastructure facilities were also taken into the consideration before preparing the final suitability map. Based on these criteria suitable sites for aquaculture development in study area was prepared and a front-end tool for production estimation in pond aquaculture was developed.
- A modeling was carried out with all thematic maps using these criteria which suitable sites for aquaculture in Nainital district. An area of 51112 ha falls in most suitable, 61164 ha hectare as moderately suitable and 13844 ha are found as not suitable for aquaculture development in the region.
- After deducting the constraints from the total geographical area of Nainital district, it was observed that around 41% of area was found to be very much suitable, 48% of area was found to be moderately suitable and around 11% of areas are unsuitable for aquaculture.



Site suitability map for aquaculture in Nainital district

Accuracy Test

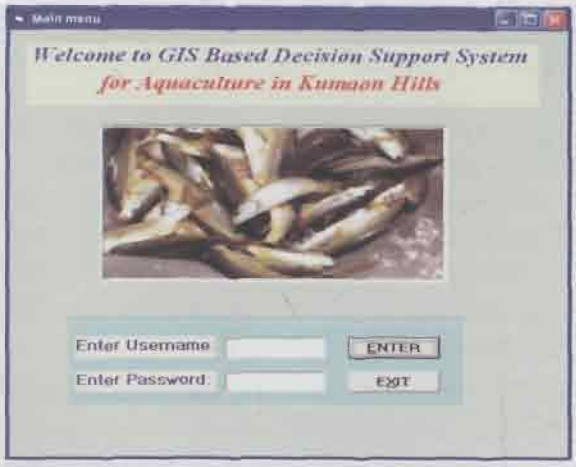
The accuracy test was also conducted by validation of data through field truths using GPS. It was observed that 13 ponds were already existed in the most suitable area out of 20 and other seven ponds are located in moderately suitable area. It observed that sixty five percent of the existed ponds are located in most suitable area where as thirty five percent are in moderately suitable area. Therefore, the model created for the suitability for aquaculture development in Nainital district is satisfactory. The locations of existing ponds in the study area were superimposed over the suitability map and are shown in the figure below.



Verification of site suitability map for aquaculture in Nainital district

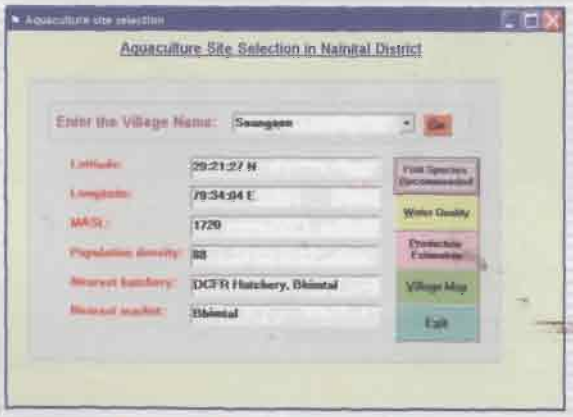
Customized GUI based DSS for aquaculture

A customized GIS based decision support system was developed for aquaculture in Kumaon Hills. While opening the application, it automatically starts in a Welcome window where the title of the application appears with two active buttons in order to "ENTER" or "EXIT" from the Database as shown in the graphical user interface (GUI) hereunder.

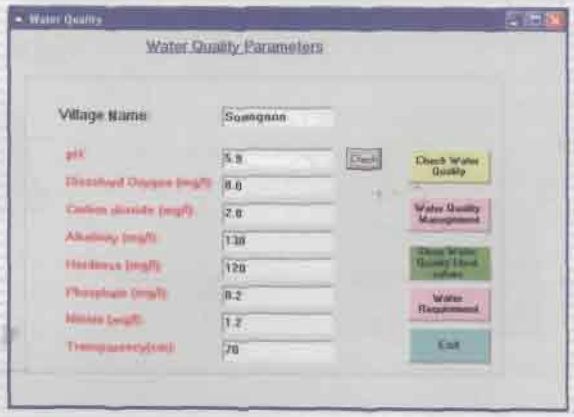


Welcome menu of the GIS based DSS

After entering into the database, another window for aquaculture development opens with option to enter the village name of Nainital district. A combo box was created for clicking the village name, as there are more than thousand villages in the Nainital district. After selecting the village name, the general information like latitude, longitude, masl, population density, nearest hatchery and market will be displayed.



Village Information windows



Water quality parameter checking module

Project Code	**CF2**
Project Title	**Modelling of Length-Weight Relationship and Growth Pattern of Selected Important Coldwater Fish Species.**
Personnel	N. Okendro Singh, D Sarma

- The primary data on length-weight of *Tor putitora* for 224 fish specimens have been collected during June 2008 - March 2009 from various sources viz. local fish market (Ramnagar), river sites at Sunderkhal and Marchula of Kosi River, Uttarakhand (INDIA). The fish specimens were collected from the above river sites through experimental fishing with drag net, cast net, etc. Fish samples were also collected and recorded from the local fishermen as and when they were available at the selected river sites. The length-weight of fish specimens for larger sizes were measured and noted down on the spot, while specimens of smaller sizes were brought to DCFR, Bhimtal and measured at the laboratory of this Institute using scientific instruments to maintain accuracy. The collected primary data comprises of four different stages of *Tor putitora* say, - (1) Fry: 0.00-4.00 cm; (2) Fingerling: 4.00-10.00 cm; (3) Juvenile: 10.00-20.00 cm and (4) Adult: 20 cm & above. This dataset was being analyzed by ANCOVA (syntax method of SPSS), regression (nonlinear) method with the help of SPSS 12.0 version available at DCFR, Bhimtal. The specimens of *Tor putitora* presently considered ranged 2.90-55.00 cm in length and 0.15-1200.00 gm in weight. At the end, only two regression lines for two different stages of *Tor putitora* are fitted.

- Length-weight relationship of *Tor putitora* from wild aquatic environment of Kosi River, Ramnagar is not influenced by different sex, as the corresponding ANCOVA test p-value was 0.990. In the present investigation, three different groups of sex viz. sex 1: male, 2: female & 3: unidentified were considered. However, the slopes of the four regression lines due to different stages are significant different (p=0.014). The regression lines due to different stages are further examined in detail (Table 1). Since the stages 2 and 3 are not significantly different at 5% level of significance, they are combined together and slope of this regression line is further compared with stage 4 and the corresponding test is not significant different at the critical level. Thus, the stages 2, 3 and 4 of *Tor putitora* can be combined together regarding its length-weight relationship. The two stages say, stage-I: fry stage alone and stage-II: a combination of stages fingerling, juvenile and adult has been, further, examined and the corresponding test is found to be highly significant different at 5% level of significance. Thus, we can say that there are only two distinct stages of *Tor putitora*, regarding its length-weight relationship. Hence, we have to fit only two distinct regression lines at the end.

- The allometric model given by equation $W=aL^b$ is fitted to the datasets of newly defined stage-I & stage-II, separately. The estimates of parameter, goodness of fit statistics of the fitted models is presented in Table 2. Isometric or allometric growth pattern of fish was also checked out by setting a null hypothesis $H_0 : b= 3$ against $H_1 : b \neq 3$. The corresponding t-test statistics have shown that the fish growth does not follow isometric growth in both stages (Stage-I: $|t| = 2.34 >$ Table value of $t_{5\%}$ for 21 degrees of freedom and Stage-II: $|t| = 8.12 >$ Table value of $t_{5\%}$ for large sample size say, n>50). The case where the parameter, (b<3) represents fish that becomes less rotund as length increases, whereas when (b>3), fish become more rotund as length increases.

Thus, newly defined stage-I of *Tor putitora* has shown extremely less rotund as length of fish increases in comparison to stage-II of this fish species.

- The correlation coefficient between $\hat{a}$ and $\hat{b}$ i.e., is very close to minus unity for both the stages-I & II. An extreme value of $\rho(\hat{a},\hat{b})$ indicates that the two parameters 'a' and 'b' are not estimated independently (Prajneshu and Ravichandran, 2003). For getting a possible solution to above, it has been attempted to fit equation $W = W_1 \left(W_1/W_2\right)^{\log(L/L_1)/\log(L_1/L_2)}$ using the datasets of both stages separately. For stage-I, a pair L_1=2.9, L_2=3.8 gives the best results in terms of least correlation coefficient. Similarly, a pair L_1=10.5, L_2=48.0 has been identified for the stage-II. In practice, we normally go for pairs of combinations L_1 and L_2, which are not close to each other. The corresponding values of W i.e., W_1=0.22, W_2=0.32 for stage-I and W_1=9.91, W_2=1000 for stage-II are taken as initial values for computation of the final estimates of the parameters W_1 and W_2. The parameter estimates along with asymptotic standard errors in parentheses are given in Table 2. The correlation coefficients, $\rho(\hat{W}_1,\hat{W}_2)$ computed are -0.432 and -0.310 for stages-I and II respectively. Now, we can say that the two parameters W_1 and W_2 are nearly estimated independently as the estimated correlation coefficients between the parameters are reasonably low and acceptable. As a consequent of expected-value parameters, the degree of curvature reduces or exhibits close-to-linear behavior. Moreover, the graphs of fitted models along with observed values are shown in Fig. 1 & 2 for datasets of stage-I and II respectively.

Table 1: User-specified contrasts test results on comparing different stages of *Tor Putitora* by ANCOVA method

Comparison of Stages	p-value
1 v/s 2	0.004
1 v/s 3	0.035
1 v/s 4	0.006
2 v/s 3	0.106
2 v/s 4	0.627
3 v/s 4	0.229
1 v/s 2 & 3	0.011
1 v/s 2 & 4	0.004
1 v/s 3 & 4	0.011
1 v/s 2, 3 & 4	0.008

Dependable Variable: logW; Independent Variable: logL & Covariate: Stage

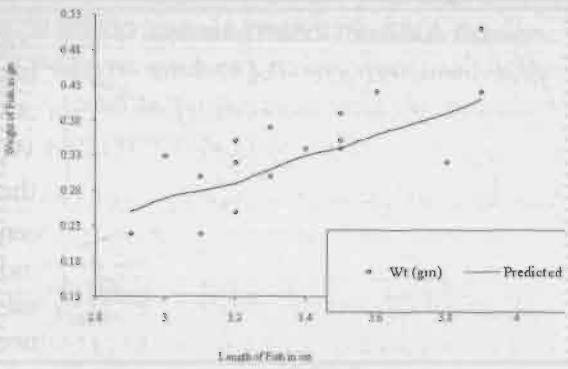
Stage-1: Fry, Stage-2: Fingerling, Stage-3: Juvenile and Stage-4: Adult

Table 2: Summary statistics of the models fitted

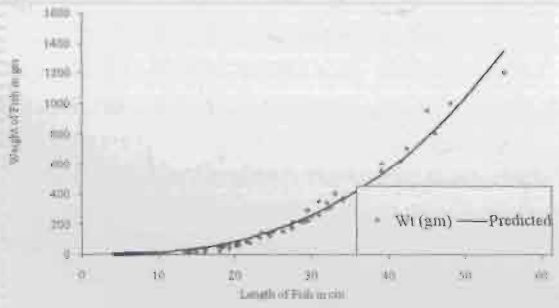
	Model: $W = aL^b$		Model: $W = W_1\left(W_1/W_2\right)^{\log(L/L_1)/\log(L_1/L_2)}$	
	Stage-I	Stage-II	Stage-I	Stage-II
Parameter Estimates				
a or W_1	0.045 (0.032)	0.024 (0.003)	0.251 (0.028)	14.807 (0.704)*
b or W_2	1.624 (0.587)	2.724 (0.034)	0.389 (0.028)	930.123 (8.667)
Goodness of Fit Statistics				
R^2	0.272	0.984	0.272	0.984
RMSE	0.072	22.081	0.072	22.081

*The corresponding asymptotic standard errors are shown in parentheses.

Stage-I comprises fry stage alone while Stage-II is a combination of fingerling, juvenile and adult stages of *Tor putitora* species.



Fitted length-weight model to the dataset of stage-I using expected value parameters



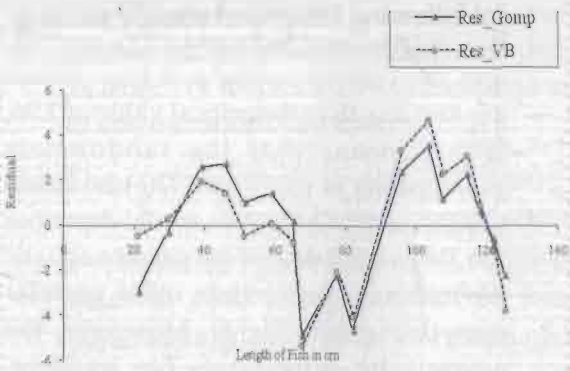
Fitted length-weight model to the dataset of stage-II using expected value parameters

- The popular growth models have been fitted to observations of length-at-age for *Tor putitora* collected from Gobindsagar reservoir. Tandon and Johal (1983) studied age and growth of *Tor putitora*, based on a specimen of size 127.5 cm in total length and weighing 24.5 kg caught in gill net from Gobindsagar reservoir.
- The Gompertz and von-Bertalanffy growth (VBG) models are fitted to the above length-at-age data of *Tor putitora*. When residuals of the Gompertz and VBG models were fitted against expected length, a cyclical pattern was seen (Fig 3). It is suggested to add a sine wave function to the model for a possible solution. The original form of VBG model with a sine wave function of equation failed to give optimal solution for the present dataset considered. The modified versions of the VBG and Gompertz models were again fitted to the above dataset. The values of RMSE and MAE significantly improved, as compared to the simple Gompertz and VBG models, and the corresponding run test values are also less than the critical value of 1.96, which means that the randomness assumption is satisfied. The modified version of the Gompertz model describes the *Tor putitora* data of the present aquatic environment better than other popular growth models (Fig 4). Moreover, the asymptotic length of *Tor putitora*, estimated using the modified Gompertz growth model is approximately 169 cm (Table 3), which is quite acceptable because the maximum size recorded in India is 275 cm (Jhingran, 1975) and in Nepal is 180 cm (Shrestha, 1999).

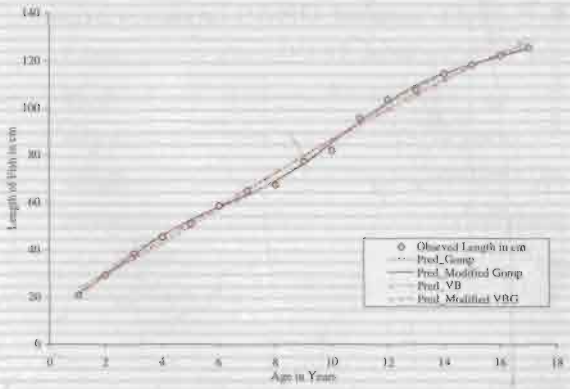
Table 3: Summary statistics for model fitting

	Gompertz	Modified Gompertz Model of equation (14)	Von-Bertal-anffy	Modified VBG Model of equation (13)
Parameter estimates				
L_∞	172.928 (11.71)	169.444 (13.941)	423.500 (176.29)	304.893 (156.39)
K	0.117 (0.01)	0.121 (0.014)	0.019 (0.01)	0.030 (0.02)
t_0	6.849 (0.66)	6.701 (0.733)	-1.651 (0.45)	-1.032 (0.75)
S	-	1.902 (0.778)	-	0.443 (1.23)
C	-	0.059 (0.015)	-	0.016 (0.014)
P	-	8.992 (1.078)	-	10.169 (1.73)
Model adequacy				
RMSE	2.516	1.290	2.665	1.449
MAE	2.108	1.014	2.126	1.187
Residual analysis				
Run test $(\lvert Z \rvert)$	1.936	0.518	0.991	1.020
Shapiro-Wilk test p-value	0.219	0.575	0.913	0.605

Bracketed values are the corresponding asymptotic standard errors.



The residuals remaining after fitting of Gompertz and von-Bertalanffy models to the dataset

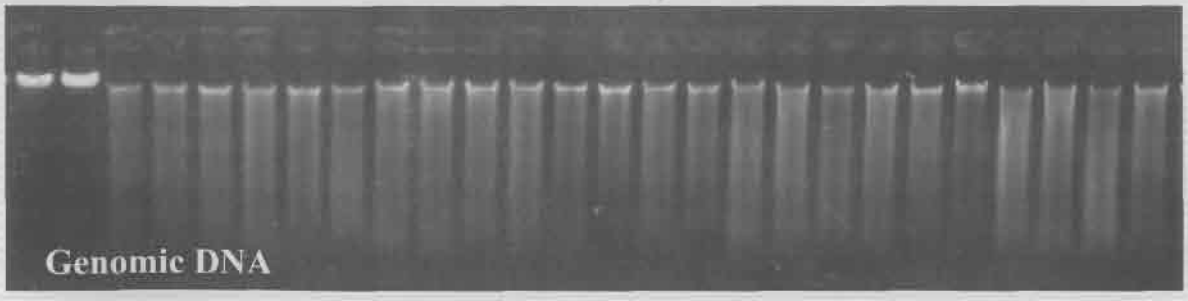


Graphical display of observed and predicted growth in length of *Tor putitora*

Project Code	**AQ7**
Project Title	**Genetic Characterization & Population Structure analysis of Coldwater fishes**
Personnel	A. Barat, S. Ali

- **Collection of fish samples:** The fin Samples of *Tor putitora, Schizothorax richardsonii, Barilius bendelisis* and Garra sp. were collected (n=60) from different water bodies from different areas of Kumaon region of Uttarakhand, viz., river Kosi (Ramnagar), Gola (Ranibagh) and Chirapani stream (Champawat). Fin tissues were preserved in absolute alcohol in the field and stored at -20°C for DNA isolation for studying the genetic relationship among the different parental stock.

- **DNA isolation and quantitative and qualitative estimation:** Total genomic DNA was isolated from 50mg fin tissue samples preserved in absolute ethonal using a proteinase k and phenol chloroform method (Sambrook et al., 1989). Quantitative and qualitative estimation of the entire sample was carried out by UV- visible spectrophotometer (Merck, USA) at 260 & 280 nm and on 0.8% Agarose gel electrophoresis. The good quality DNA having the OD ratio at 1.5-1.9 was subjected to PCR amplification.



- **RAPD and mt-DNA 12S rRNA Primers:** Eleven random primers were used in the present investigation, and the sequence are presented in the table:

List of Operon series primers used in the present study

Sr. No.	Primer name	Primer Seq.	Length	C+G Content (%)
1.	OPA-02	5'-TGCCGAGCTG-3'	10 mer	70
2.	NUSZG4	5'-GGAGCTGGC-3'	9 mer	77
3.	OPA-03	5'-AGTCAGCCAC-3'	10 mer	60
4.	OPA-04	5'-AATCGGGCTG-3'	10 mer	60
5.	OPY-02	5'-CATCGCCGCA-3'	10 mer	70
6.	OPY-19	5'-TGAGGGTCCC-3'	10 mer	70
7.	OPY-02	5'-TGCCGAGCTG-3'	10 mer	70
8.	OPY-05	5'-CCGAATTCCC-3'	10 mer	60
9.	OPY-04	5'-GGCTGCAATG-3'	10 mer	60
10.	OPY-11	5'-AGACGATGGG-3'	10 mer	60
11.	OPA-05	5'-AGGGGTCTTG-3'	10 mer	60

The universal primer pairs (Forward primer 5'- CAA ACT GGG ATT AGA TAC CCC ACT AT-3' and reverse primer 5'- GAG GGT GAC GGG CGG TGT GT-3') based on the published sequences of highly conserved regions of 12S rRNA of the mitochondrial genome from the GenBank for mammal (Anderson et al., 1981 and 1982) were used to amplify the partial 12S rRNA gene from the samples.

- **Polymerase Chain Reaction (PCR) amplification:** RAPD-PCR was performed in a total volume of 25 µL containing 50 ng of genomic DNA, 100 pM of random primer, 200 µM of each dNTP, 2.5 µL 10x PCR reaction buffer, 1.5 Mm $MgCl_2$ and 1U of Taq DNA polymerase. Amplification was carried out in a programme DNA thermal cycler (eppendorf) which consist of initial denaturation of 95°C for 5 min; followed by 34 cycle of 94°C for 1 min, 36°C for 1 min; primer extension at72°C for 1 min and a final extention at 72°C for 5 min, then hold at 4°C. PCR products were stored at 4°C. PCR product were electrophoresed through 1.2 % Agarose gel following Ethidium bromide staining, and visualized under UV illuminating in the Gel-Doc system (Alpha Imager 3400, Alpha Innotech Corporation, USA). Molecular sizes of the amplified products were estimated through in built gel doc system softaware. Only the distinct and the prominenet bands were scored in the RAPD profile, which showed polymorphic patterns and the same were used for estimation of genetic distance.

Mitochondrial gene12S rRNA was performed in a total volume of 50 µL containing 50 ng of genomic DNA containing 5µL of 10x PCR reaction buffer, 1µL (200µM each) of dNTP mix, 1µL or 20 pM each of forward and reverse primers (Bangalore Geni, India),1.66 unit taqDNA polymerase. The thermal profile used to amplify 12S rRNA consisted of an initial denaturation of 95°C for 5 min; followed by 30 cycle of 94°C for 45sec, 60°C for 45 sec; primer extension at72°C for 1 min and a final extension at 72°C for 7 min, then hold at 4°C. PCR products were stored at 4°C. For each sample, 3 µL of PCR product were electrophoresed through 1.2 % agarose gels following ethidium bromide staining, and visualized under UV illuminating in the Gel-Doc system (Alpha Imager 3400, Alpha Innotech Corporation, USA). Molecular weights were determined using 100bp DNA markers (Fermentas, Canada). Successful PCR products of 456 bp were sent to Bangalore Geni, Bangalore for sequencing.

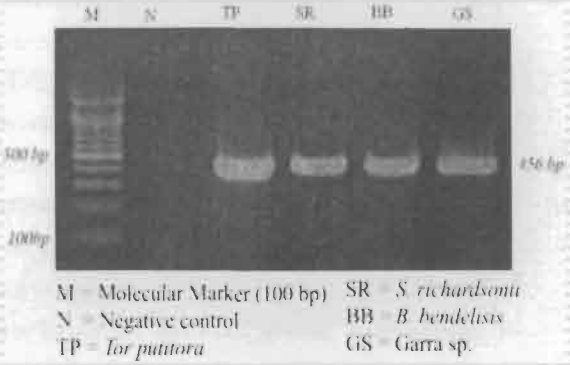


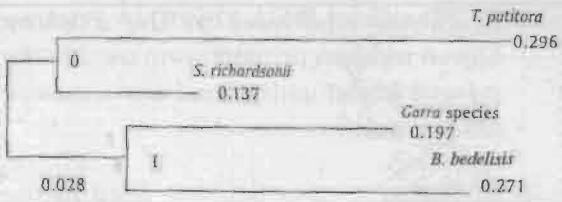
Fig: PCR products of mt-DNA 12S rRNA gene amplified from 4 coldwater fish species

5. DATA Analysis:

- **RAPD Analysis:** The RAPD banding pattern was scored manually based on the presence as 1 or absence as 0 and recorded as a binary matrix of identical molecular size. Standard statistical analysis (Kuhnlein *et al.*, 1990; and lynch, 1990) was carried out to estimate the genetic distance, and the phylogenic tree was constructed using POPGENE software package.

- **Mt-DNA Sequence Alignment:** The DNA sequences were aligned and comparison was done by ClustalX (Thompson *et al.*, 1997) and using MegAlign software package (DNA STAR, Inc.), followed by manual editing. The mt12S rRNA gene sequences of related fish species were retrieved from GenBank nucleotide sequence database (www.ncbLnlm.nih.gov/entrez) and compared. The sequence alignment phylogenetic tree construction, and sequence base pair distances were calculated by using Clustal X method with weighted residue weight table. The sequences were submitted to GenBank under the accession numbers of AM778102, AM7781 03, AM7781 04 and AM7781.

- **RAPD-PCR Analysis for Construction of Phylogenetic Tree:** The phylogenic tree was constructed using POPGENE software package, which showed two common clusters consisting of *Tor putitora* with *S. richardsonii* and *Garra* species with *Barilius bendelisis* by forming a separate cluster. The phylogenetic tree was constructed using UPGM method of arithmetic mean dendogram based on Nei and Li (1978) genetic distance using RAPD data



Phylogenetic tree among the fish species using RAPD analysis

- **MtDNA Gene Sequences Genetic Distance and Phylogenetic Tree Construction:** The mtDNA 12S rRNA partial sequences of the coldwater fish species were amplified with PCR technique using universal primer and sequenced. The alignments of sequences were compared in all the species, and the presence of a common conserved core region in all the four fish 12S rRNA genes indicates that all these species belong to the same family (Cyprinidae). It was further confirmed on the basis of homology with previously published sequences from other fish species from NCBI GenBank. Phylogenetic tree based on mtDNA showed that *T. putitora* clustered with *S. richardsonii* and *Garra* spp. with *Barilius bendelisis*. The phylogenetic trees from both the PCR techniques indicated that two separate monophyly consist of *T. putitora* clustered with *S. richardsonii* and *Garra* spp. with *Barilius bendelisis*. Wang et al. (2002) also amplified the 12S rRNA genes of different vertebrates by the same universal primers and compared with other available gene sequences. The phylogenetic tree indicates the possible occurrence of two subfamilies among these four fish species studied as Schizothoracinae/Cyprininae and Rasboririae. The species *S. richardsonii* and *T. putitora* showed the least genetic divergence (0.43 and 38.2%) with RAPD and mtDNA analysis and showed parallel branches of the phylogenetic tree, indicating that they can be included under the same subfamily Schizothoracinae/Cyprininae or can be included under the subfamily of

Rasborinae because of the existing morphometric differences. The conventional classification by Berg (1940) and Kapoor *et al.* (2002) also suggested that the *S. richardsonii* and *T. putitora* species can be placed under the same subfamily (Cyprininae). The present results based on the RAPD and targeted 12S rRNA sequences absolutely match with the most widely accepted classification given by Berg (1940).

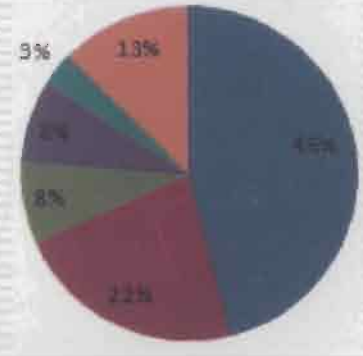
- The targeted mtDNA 12S rRNA sequences and RAPD-PCR analysis could be a valuable tool for establishing the status of molecular systematics and phylogenetic tree construction even at the subfamily level. The present study further suggests that the universal primers for more numbers of mtDNA genes as well as with more numbers of RAPD primers may provide accurate assessment of molecular systematic of fish species even at the species level.

Externally Funded Projects

Project Code	**DBT Project-1**
Project Title	**Development and Characterization of microsatellite markers in *S. richardsonii***
Personnel	A. Barat

- 51 sequences were found with mono, di, tri, tetra-nucleotide repeats and submitted in NCBI GenBank.
- Out of 51 sequences 57 microsatellite markers were develop from which 30 are fluorescent labelled and rest 27 were synthesis conventionally.
- PCR standardization of above 27 markers is carried out successfully for polymorphism and genetic variability studies and they are found to be highly polymorphic

A partial genomic library was constructed using 300-600bp RE digested insert of Indian Snow Trout (*Schizothorax richardsonii*). RE digested product was cloned in dephosphorylated pUC19 vector. Around 5000 positive clones are achieved in the form of white colonies. The white colonies were screened by colony hybridisation using (CA)n/(GT)n, (GA)n/(CT)n, (GAA)n/(CTT)n and (CCA)n/(GGT)n probes. Out of 5000 colonies, 450 colonies were detected as having possibly some repeat motifs. Plasmid DNA was isolated from those selected clones and sequenced. Out of 450 sequences, 51 sequences consisted of mono, di, tri and tetranucleotide repeats. Dinucleotide repeats particularly GT/CA repeats were most abundant in comparison to tri-and tetra-nucleotide repeats. All the sequences containing microsatellite markers were submitted in the NCBI GenBank having following accession numbers (ACC# HM 591233 to HM 591283). Out of 51 sequences a total of 57 markers developed from partial genomic library. Out of 57 markers, 30 markers are fluorescent labelled with FAM and analysis is in progress using automated genotyping by commercial service. The rest 27 primer sets are under process of conventional PCR for validation using different population of Schizothorax and other cross species amplification.



Percentage of repeats

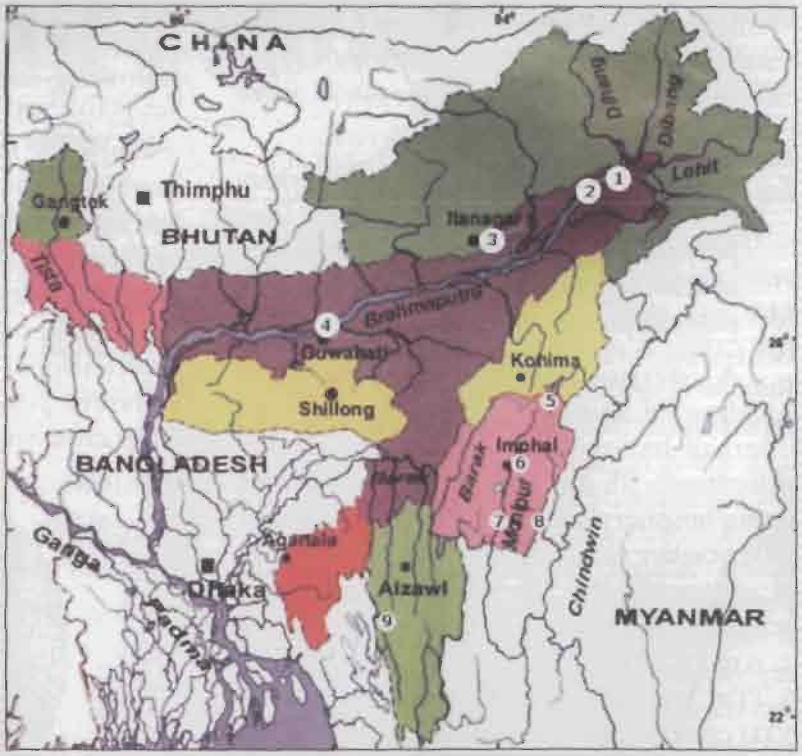
Project Code	DBT Project-2
Project Title	**Molecular characterization and development of a diagnostic test for the identification of a filterable agent isolated from diseased Rainbow trout**
Personnel	Amit Pande

We have initiated the project work and have attempted to isolate the causative agent in BF2 cells. Virus isolation has been attempted from a number of field samples and cytopathic effects have been observed. We have further tried to characterize the agent using RT-PCR with primers specific for infectious pancreatic necrosis virus (Blake et al., 1995) and have observed a 524bp fragment. A hyperimmune serum has been raised against this agent. The firsthand information of our investigations suggests the possibility of a mixed infection of infectious pancreatic necrosis and infectious hematopoietic necrosis viruses as the concentrated infected cell culture supernatant has tested positive with the reference anti-IPNV and anti-IHNV serum. We have been able to establish the similarity between the reference IPNV serum and the serum raised by us.

Project Code	DBT Post doctoral Programme
Project Title	**Studies on the diversity and phylogeny of Bagrid catfishes of the genus *Mystus* Scopoli of northeast India using classical and RAPD techniques**
Personnel	A. Darshan Singh (PDF), P.C. Mahanta (Supervisor)

Objective:

- To study the biodiversity of *Mystus* species in north east India.
- To establish correct identity and resolving taxonomic conflict and describing new taxa and catalogue them.
- To study osteological characters.
- Analysing using RAPD technique.
- Establishing phylogenetic relationships among them.



Northeast India drainage map showing fish collection sites 1 to 9. (redrawn from Vishwanath et al. 2007)

Methodology:

Sample collection and location: During July-December, 2009, extensive collection of *Mystus* was carried out from nine stations belonging to the Brahmaputra and Chindwin basin of Northeast India (Fig. 1). Samples of *M. rufescens* (Vinciguerra), *Mystus sp.* and *M.*

falcarius Chakrabarty & Ng were collected from Chindwin drainage of Manipur and *Mystus bleekeri* (Day), *M. tengara* (Hamilton), *M. cavasius* (Hamilton), *M. dibrugarensis* (Chaudhuri) and *M. montanus* (Jerdon) were collected from the Brahmaputra drainage.

Tissue sampling: About 100 mg of upper lobe of caudal fins were collected in 80% ethanol from the freshly collected specimens. After removing the tissue, specimens were preserved in 10% formalin by giving the same label in the tissue sample to check misidentification of specimens. Collected fishes are deposited in ZSI Kolkata and Fish Museum of Directorate of Coldwater Fishery Research.

Mystus sp. (in the process of publication as *Mystus ngasep* new species)

Identification of Fish Species: Counts and measurement follow Darshan et al. (2010).

For osteological study, clearing and staining of bones follow Hollister (1934). Methods for counting gill rakers and vertebrae follow, respectively, Roberts (1992) and Roberts (1994). Vertebrae count for rare and type specimens were taken from radiograph.

Mystus montanus collected from Dikrong R. Arunachal Pradesh.

DNA extraction and PCR reactions: Genomic DNA was extracted from ethanol fixed fin tissue following the standard Phenol-Chloroform protocols described by Sambrook and Russel (2001). The concentration was determined through serial dilutions on 0.7% agarose gel in 0.5 X TAE (1X=40 mM Tris acetate, 1 mM EDTA) and also by taking Optical densities at 260 nm and 280 nm to calculate quantity and quality.

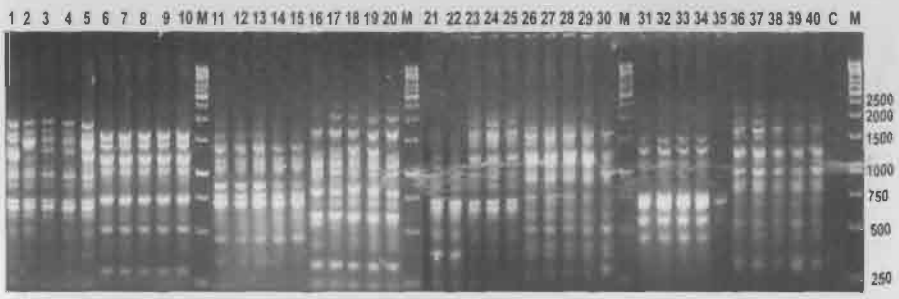
RAPD-PCR reactions was carried out in sterile PCR tubes in a reaction volume of 25 ml containing: template DNA (50 ng), 2.5 ml of 10x buffer, 1.5ml of $MgCl_2$ (25mM), 2 mM dNTPs mix (100 mM), 5 pmoles of Random primer (Operon series), 0.5 U *Taq* DNA polymerase and autoclaved Milli-Q water, by using an Eppendorf mastercycler gradient PCR. The reaction conditions were: denaturation at 94 °C for 4 mins., followed by 35 cycles of 94 °C for 1 min. and 36 °C for 1 min., elongation at 72 °C for 2 mins., with a final elongation at 72 °C for 7 mins. One negative control (absence of template DNA) was included for each set of amplifications. Amplified product was separated on 1.2% agarose gel (SRL) stained with ethidium bromide, by a submarine gel electrophoresis in 1X TBE buffer (Tris-borate EDTA; 89.0 mM Tris, 2.0 mM EDTA, 89.0 mMboric acid), pH 8.0, for 2 hours at constant voltage of 70 V. Size of the bands were estimated by 1 kb DNA ladder (Fermentas Life Sciences) which run in every gel. Visualization of the amplified products was performed under a UV Transilluminator. Photography of the result was taken by a Gel-Doc apparatus.

Codes and sequences of the Operon Technologies random primers used in the present study

SL. No.	Primer codes	Sequence (5' to 3')
1	OPA 1	CAGGCCCTTC
2	OPA2	TGCCGAGCTG
3	OPA3	AGTCAGCCAC
4	OPA4	AATCGGGCTG
5	OPA5	AGGGGTCTTG
6	OPA10	GTGATCGCAG
7	OPA13	CAGCACCCAC
8	OPA18	AGGTGACCGT
9	OPX12	TCGCCAGCCA
10	OPX17	GACACGGAGC
11	OPY2	CATCGCCGCA
12	OPY4	GGCTGCAATG
13	OPY5	GGCTGCGACA

Selection of Primers: In the primary analysis, 60 random primers of 10 mer from Operon Technologies (arbitrary primers from OPA, OPY and OPX series) were tested on 2 samples from each species. Base on the screening data, 13 primers were selected (Table 1) for analysis which amplified in all the 8 species of *Mystus* under study.

Data analysis: Band pattern (0, 1 matrix) were tabulated for individuals primers separately and the data were pooled to obtained a combined matrix of all the 8 species for 13 primers. The software Alpha View SA, (version 3.2.3) was used for the estimation of molecular weight of the RAPD markers in bp (base pairs) by comparing with the known molecular weight (in bp) of the I Kb ladder in the gel. Genetic-distance and dendogram were analysed using the NTSYS-pc (version 2.20e) software.



Comparative analysis of RAPD markers among individuals of eight species of *Mystus*, amplified by primer OPY2. Columns: 1-5= *M. ngasep* (new species); 6-10= *M. bleekeri*; 11-15= *M. tengara*; 16-20= *M. cavasius*; 21-25= *M. rufescens*; 26-30= *M. montanus*; 31-35= *M. dibrugarensis*; 36-40= *M. falcarius*, C= control and M= molecular markers (1 kb DNA ladder).

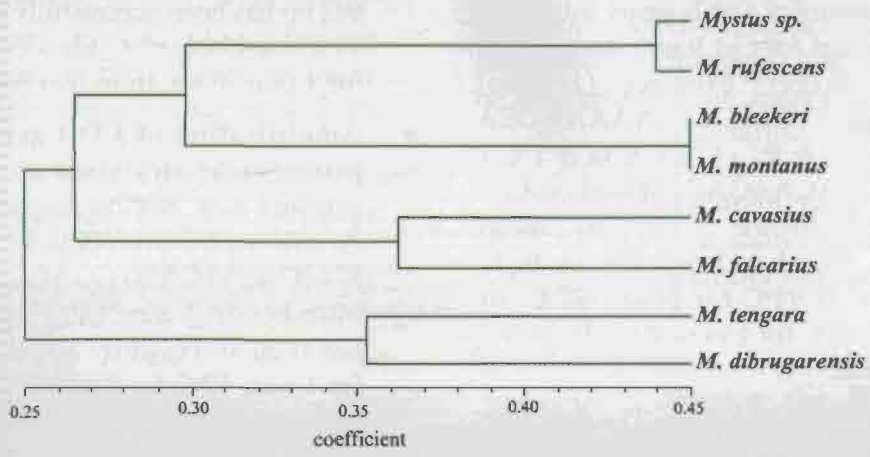
A comparative RAPD analysis was carried out on the eight species of *Mystus* distributed in northeast India to observe the degree of genetic similarity and phylogenetic relationship among them. The study used thirteen RAPD markers which amplified scorable bands in all the species under study. Scorable bands for a selected primer in each samples were compared and allotted 0 (absence) or 1 (presence) values. These markers amplified a total of 639 bands ranging from 285 to 2150 bp, which were assigned to 204 loci with a mean of 15 loci per primer. Among these 204 RAPD loci 11 are found to be monomorphic loci and 20 polymorphic bands are species specific. The similarity index values obtained for each pair wise comparisons among the eight species of *Mystus* ranges between 0.208-0.454. Maximum similarity is observed between *M. bleekeri* and *M. montanus* with a value of 0.454 followed by *M. rufescens* and *Mystus sp.* (an undescribed species) with a similarity index value of 0.444 and a minimum between *M. falcarius and M. montanus.*

The dendogram (Figure 5) so obtained in this analysis reflects the morphological differences among the species of this group of fishes. The dendogram has grouped all the 8 species into two major clusters: A and B. Cluster A is formed by *M. rufescens, M. sp, M. bleekeri, M. montanus, M. cavasius* and *M. falcarius* which are morphologically distinct in having a long base adipose-fin (without interdorsal) and cranial fontanel reached base of occipital process while the species under the cluster B (*M. tengara* and *M. dibrugarensis*) have a short cranial fontanel that does not reached the base of the occipital process and a short adipose-fin base (with a long interdorsal). Cluster A is again subdivided into clusters A1 and A2, in which species under the cluster A1 (*M. sp., M. rufescens, M. bleekeri and M. montanus*) are also morphologically distinct in having a prominent body stripes while those fishes under A2 have no body stripes.

The dendogram have also clearly shows that *M. rufescens* is genetically closer to *Mystus sp.* (an undescribed species) with high similarity index value of .444, even though both are resolved as distinct species. The result of the study also shows that *M. montanus* is genetically more similar with *M. bleekeri* and

both are under a same cluster. *M. montanus* collected in this study have a morphometric data which are within the range of *M. bleekeri* but differ from the later in having a body with a thin black mid-lateral line. *M. montanus* was originally described from Wynaah in Peninsula India.

The above result supported the existence of an undescribed species of *Mystus* in the Chindwin drainage of northeast India. And the result also treated *M. montanus* and *M. bleekeri* as a single species. It is most likely that *M. montanus* reported from the northeast India are misidentifications of *M. bleekeri*. For better understanding of the interrelationship among this group of fishes, more work need to be done using Type-I or dominant markers.



Dendogram obtained by the Jaccard similarity index and method of UPGMA for eight species of *Mystus*.

Project Code	**DST Project**
Project Title	**Genome Scale Mining of *S. richardsonii* fish species for formulation of Selective Breeding Programme**
Personnel	S. Ali, A. Barat

In view of the paucity of information on mitochondrial genome of coldwater *Schizothorax* sp. in India it is planned to characterize coding sequences of mtDNA organization and to study the genetic variability in order to formulate suitable breeding strategies for genetic improvement of the stock. The mtDNA data can be utilized for estimation of genetic distances, genetic similarities and construction of phylogenetic tree among *Schizothorax richardsonii* fish species and documentation of the results. Based on the estimates of genetic distances from different locations the crossbreeding strategies will be planned.

- **Collection of Fish Sample:** The different sizes of Indian snow trout, *Schizothorax richardsonii* were collected from different areas viz., river Kosi (Ratighat), Gola (Ranibagh), Chirapani stream (Champawat), Bairangana and Srinagar (Garwhal). The fin samples were collected in 75% ethanol, processed and stored at -20°C for DNA isolation for studying the genetic relationship among the different parental stock.
- **Isolation of DNA, purification and quantitation:** The fin samples (n= 30) were collected from these samples in 75% ethanol, processed and stored at -20°C for DNA isolation for studying the genetic relationship among the different parental stock.
- **Designing and Synthesis of primers:** The optimal length of forward and reverse primers of having the nucleotide length

of 17-23 mer size as well lengthy primers for amplification of the complete gene(s) viz., 12S and 16SrRNAs, Cyt b, ND3, ND4, CO III, CO II, ATPase 6 and ATPase 8 were designed by using DNASTAR and Primer3 softwares. The custom syntheses of primers were done commercially from Bangalore Genei, Bangalore, India

- **Amplification of Cyt b gene:** Initially a set of primers for Cyt b was designed to achieve larger product (1140bp) consisting F'-TGACTTGAAAAACCA CCGTTG & R'-CTCCGATCT CCGGATTACAAGAC. Mitochondrial gene Cytochrome b (cyt b) about 1140 bp size has been successfully amplified at 94°C for 30sec, 57°C for 1min and 72°C for 1 min 30 sec from five populations.
- **Sequencing of Cyt b gene:** The cytb gene sequence was submitted to NCBI GENBANK Accession No: HM636805-HM636828.
- **Amplification of ATPase 6/8 gene:** A set of primer was designed to achieve a product size 842bp consisting of F'-AAAGCRTYRGCCTTTTAAGC & R'-GTTAGTGGTCAKGGGCTTGGRTC. Mitochondrial gene ATPase 6/8 about 842 bp has been successfully amplified at 94°C for 45sec, 58°C for 45Sec and 72°C for 1 min 30 sec from five populations.
- **Amplification of COII gene:** A set of primer was designed to achieve a product size 989 bp consisting of F'-AAAGGAAGGAATCGAACCCCC & R'-GCTCATCAGTGGAGGACGTCTT. Mitochondrial gene CO II about 989 bp has been successfully amplified at 94°C for 1 min, 52°C for 2 min and 72°C for 2 min from five populations.

Project Code	**NAIP (Component-4)**
Project Title	**Bioprospecting of Gene and allele mining for abiotic stress tolerance-Cold tolerance**
Personnel	A. Barat, S. Ali

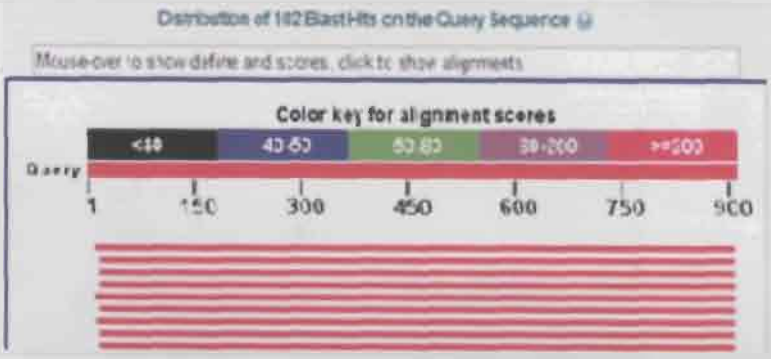
Objective 1: Generation of Genomic resource base to facilitate gene prospecting and allele mining

- We performed three activities. Live samples were collected from rivers, lakes and streams of different altitudes of Himalayan region. The fish species were *S. richardsonii, S. niger, S. progastus, Oncorhynchus mykiss* and *Salmo trutta*. Location specific species were found under Genus Schizothorax. They inhabit a thermal range of 5-20°C. The fishes were identified morphometrically following conventional protocols of fin counts, length and general body features etc. The three different species of Schizothorax were also showed species specific RAPD profiles.
- Physiological and biochemical parameters were established under different temperatures. One tank was maintained at approximately 5°C by adding ice flakes and other at ambient water temperature (15-20°C). Sampling of blood and other tissues were carried out at an interval of 24 hrs, up to 5th day and final sampling was made on 12th day. Different enzymes activities were studied using colorimetric assay. The enzymatic activity of lactate dehydrogenase and Glucokinase shows Significant increase in their activity under cold stress, whereas, Pyruvate kinase has shown decrease in their activity. The level of Glycerol and glucose also rises significantly. The activity of Alanine amino transferase and Aspartate amino transferase is also increased. Hence, the increased activities of AlaAT and AspAT in the liver samples showed the possible carbon source of glycerol accumulation to depress the cold

temperature during the winter months in addition to activities of Glycerol phosphate dehydrogenase through dihydroxy acetone phosphate (DHAP).

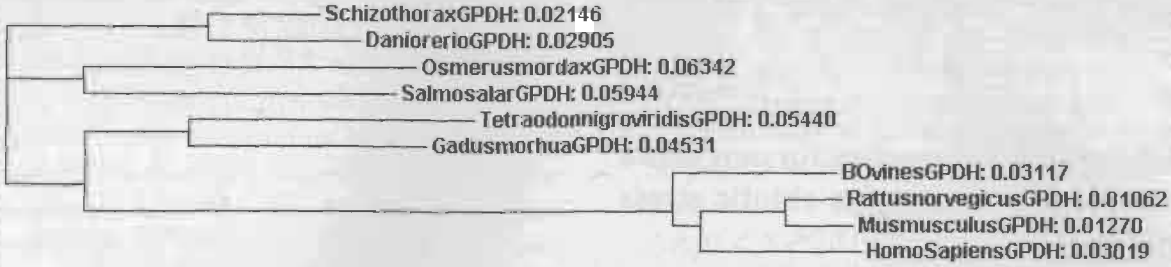
Objective 2. Prospecting for new genes and alleles mining for abiotic stress tolerance

Around seventeen primer pairs were designed from the different AFPs submitted in the public database. One primer pair designed from AFP type III gives an amplicon of about 285bp. The amplicon was sequenced and submitted to the Genbank and named hypothetical protein. Since, the protein is rich in alpha helix (49.47%) and strands (23.16%) so; hence, it is presumed to be associated with stress related protein. To study the transcripts of GPDH in the tissues of *S.richardsonii* using GPDH (Acc. No. AYO24368) of rainbow smelt, *Osmerus mordax*, a primer pair was designed and an amplicon of about 1096bp was amplified. The same fragment was cloned and sequenced. The nucleotide sequenced was analysed using BLASTx and BLASTn for similarities for GPDH gene. 98% and 97% similarities were observed with GPDH gene of *Danio* and *Osmerux* respectively. It is presumed that this NAD linked GPDH gene is responsible for freeze resistance in association with Glycerol accumulation in *S. richardsonii*. The Brain, liver, muscles and heart shows higher expression of GPDH gene as compared to other tissues.



- In an attempt, to develop the EST database initially, around 1200 positive clones were screened from a cDNA library of brain tissue. So far 500 clones were sequenced and the ESTs so obtained were under analysis by using comparative genomics approaches to investigate new genes.

Multiple sequence alignment through ClustalW for GPDH gene



Dendogram constructed using GPDH gene sequences

Project Code	**NAIP (Component-3)**
Project Title	**Enhancement of Livelihood Security through Sustainable Farming System and related farm Enterprises in North-West Himalaya**
Personnel	Prem Kumar

Champawat is one of disadvantaged district of Uttarakhand due to extreme climate, undulating terrains and shallow soil depth with gravels. The total geographical area covers 1.68 lakh hectares of land. Of which 44% is under forest cover, 11 % under agriculture practices and rest is pasture, fellow and cultivable wasteland. 57 % of the land falls under Small and marginal land holding. Agriculture development has its own limits such as non-availability of the flat land and infrastructure facilities for intensive farming. The economy of the villagers is based on the labour in plain areas mainly of Uttar Pradesh and Delhi.

Grass carp produced in farmer's pond

Polytank used for irrigation and fish culture

The young farmers take their way to plain in search of employment since the opportunities of employment are rear in their villages. The agriculture is rain fed and mainly remaining as fellow since the working hands are drained to the plains. The multi-tier model for fish culture was developed for which the polycum irrigation tanks were used for fish culture. The ponds were stocked with Chinese carps and Common carp and were fed with rice polish and

mustard oil cake @ 2% of body weight. The significant production was achieved of 0.7 kg/ m^3 of water in comparison to 0.12-0.36 kg /m^2 in earthen ponds. The reason of the higher production was the difference in temperature of 2-6 °C than of the earthen tanks. Moreover the water was used for the crop production as shown in the figure. These type of ponds were created in the three clusters such as Dharauj, Mudyani and Makot. A total of 36 families were the beneficiaries.

Beneficiaries families of Champawat district, Uttarakhand

FARM ACTIVITIES

Successful rearing and breeding of Rainbow trout at Chhirpani Fish Farm, Champawat

Healthy brooders and yearlings of rainbow trout have been reared at DCFR field centre, Champawat successfully. Approximate 2 years old brooders were used for breeding purpose at Champawat Field centre, Champawat with 84% fertilization, 73% hatching (Incubation period 57 days) at water temperature 4-12°C.

Rainbow trout Brooders at Champawat field centre

Stripping of matured male & female brooders and incubation of eggs

Swim up fry of Rainbow trout

Breeding of Rainbow trout by using cryopreserved milt at Chhirpani Fish Farm, Champawat

Early matured males were used for collection of milt and milt was cryopreserved by using different extenders and cryoprotectants combinations. Breeding trial was conducted by using cryopreserved milt and 85% fertility was recorded as compare to control.

Straws filled with milt of rainbow trout

Straw filled milt kept in liquid nitrogen container

Breeding of grass carp

Farm raised grass carp brooders of 2-4 years age were tried for induce breeding at water temp. 22-26°C and produced 60,000 fry. Average weight of brooder was 2.3 kg. and 1.6 kg for female and male respectively. Fertilization rate was 80-85% with 70-76%. Hatching (incubation period 28-32 Hrs) at 22°C water temperature. Growth of the cold-water farm produced seed is better than the seed from private hatchery of plain area due to the better acclimatization and low inbreeding depression. Produced seed was distributed to farmers and NGO's

Breeding of Snow trout

Snow-trout, *Schizothorax richardsonii* (Gray) were collected from the local streams and Chalthi river and were reared at farm of Champawat field center, Champawat.these fishes were kept in captive conditions and used for breeding purpose. Mature Males and females brooder were selected for breeding purpose, and breeding was done by dry stripping method and produced 25,000 healthy fry. These fries were ranched in local streams.

Visit of participants at Poly house tank of Champawat field Center

Training programme at DCFR Field Center, Champawat

A training programme on Rearing and Breeding of rainbow trout was organised at DCFR field center Champawat. Fisheries officers, extension officers and students participated. In this training programme participants were exposed to techniques of trout breeding and culture. They were imparted the knowledge about the selection of matured brooders, stripping and fertilization. In this training programme they were taught about the broodstock, health and water management for rainbow trout.

Lab visit of participant at Champawat Centre

Demonstrations for collection of blood from suspected diseased fishes of rainbow trout

Office cum farmers training hall under construction

Laboratory facilities at Experimental Field Centre, Champawat

Dr. P.C. Mahanta, Director interacting with staff of Experimental Field Centre, Champawat

EDUCATION AND TRAINING

NFDB Sponsored Training programme

Directorate of Cold Water Fisheries Research (DCFR), Bhimtal in collaboration with Rajiv Gandhi University (RGU), Itanagar organized 5 days training programme during 19-23 October 2010 on **"Three pronged fish farming Technologies for hill regions"** at Itanagar, sponsored by NFDB, Hyderabad. The training programme was designed for the development and

Inauguration of the training program

cultivation of coldwater fishes in the hill states. The training has benefited the local fish entrepreneurs and farmers to take up new fish farming technology suitable for implementation in the hill states. Honorable Parliamentary Secretary (Fisheries), Govt. of Arunachal Pradesh, Shri J.K. Panggeng, graced the program as a Chief guest,

Keynote Address by Dr. P.C. Mahanta, Director, DCFR, Bhimtal

emphasized the role of hill aquaculture for livelihood and nutritional security, that would help to bring farmer's prosperity in the North Eastern states on India. It is also noted that Arunachal Pradesh has enough water resources and if all the available water resources are enhanced, the state can be self sufficient in the fish production thus the large part of fish imported from the Andhra Pradesh and Assam can be stopped. The farmed Golden mahseer has been declared as the "State fish" of Arunachal Pradesh" as informed by Shri Tage Moda, Director, Deptt. of Fisheries during the training program.

Dr. Debajit Sarma, Course Director, DCFR, Bhimtal, in his inaugural address said that the new strategies and technologies of fish farming would result in enhanced fish productivity in plain, mid altitude and hi altitudinal region. Valuable suggestions were proposed by Chairman, Prof. T. Mibang, Vice-

Lecture delivered by Dr. D. Sarma

chancellor RGU, Itanagar. He highlighted that the states government needs to come up with a fisheries policy to encourage and protect the local sector. This would not only help to improve the economic condition but also give a boost to the tourism sector in the Himalayan state. In the training program various lectures on theory and practical aspects were delivered by renowned scientists across the country. Not only the burning issued of cold-water aquaculture, fisheries resources and

sustainable management addressed by speakers but also the corrective measures discussed to solve the problems and challenges.

Dr. P.C. Mahanta, Director DCFR gave a brief lecture on coldwater fisheries development in India with special emphasis to North Eastern states of India. In the valedictory address the Director drew attention to the trainees and the participants

Distribution of Certificates by Director, DCFR

Trainees along with the Scientists and Resource Persons of DCFR & RGU

for the utilization of the existing resources of the region, so that, the production of the fish especially of coldwater region could be increased to many fold thereby benefiting the socio-economic condition of the rural people. The programme was attended by the participants (state fisheries officers, farmers, NGO, students and media persons) from Manipur, Sikkim, Nagaland, Assam and Arunachal Pradesh from various North East state.

Model Training programme on Rainbow Trout

A national level model training course on "Breeding, Incubation and Rearing of Rainbow Trout" was organized by DCFR, Bhimtal From 27th December 2010 to 3rd January 2011 sponsored by Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, New

Inauguration of the training program

Delhi. Fisheries Officers, Extension Officers, Assistant Director of Fisheries (ADF) from various states, University lecturers and Research Scholars and Students participated in the training programme. The training program was organized to develop trained manpower to carry out the activities on rainbow trout breeding & culture in the hilly states especially at A.P., Sikkim, Uttarakhand etc.

Dr. P.C. Mahanta, Director DCFR, inaugurated the training programme. It was informed to the participants that institute has

Visit of Fish ponds at DCFR, Bhimtal

Demonstration at hatchery complex DCFR, Bhimtal

been working in the area of coldwater region from last 3 decades to ensure social and nutritional security for the fish farmers of the hill states. It was emphasized that there is great scope and potential to further enhance coldwater fish production through the interventions of new scientific culture technology. A visit to laboratory and different facilities ar Directorate was also arranged. During the training programme various lectures and visits were also organized. Dr. Debajit. Sarma, Senior Scientist briefed lecture on "An overview of coldwater fisheries development in India". Subsequently, Dr. N. N. Pandey, Senior Scientist highlighted the culture and breeding techniques of rainbow trout and its future prospects in hill states of the India. Dr Amit Pandey, Senior Scientist emphasized on the important viral diseases of coldwater aquaculture, whereas, Mr. S.K. Mallik, Scientist drew attention to important bacterial diseases of coldwater aquaculture. This was followed by a presentation on "Nutrition and feeding strategy of rainbow trout farming" by Mr. M. S. Akhtar, Scientist. Dr. S. Ali, Scientist delivered on the importance of good management practices (GMP) in trout farm and hatchery and water quality management. A success story of rainbow trout breeding and culture in Himachal Pradesh was shown through a film in the auditorium of the institute. The participants visited to Bairagna trout farm to have a practical demonstration of rainbow trout breeding and culture. They also exercised their hands during the process.

A field visit to Experimental Field Centre at Chirapani, Champawat was also organized during the training programme. Farm visit and practical demonstration of rainbow trout farming at Champawat Field Center was organized by Dr. S. K. Shrivastava, Senior Scientist and Dr. S. K. Gupta, Scientist. The participants visited farm facilities such as trout raceways, trout hatchery, nursery ponds, rearing ponds and poly house.

Practical demonstration on trout breeding

Demonstration of trout stripping at Bairngana trout hatchery

Incubation of trout eggs

Training at Champawat Field Center, DCFR

Distribution of Certificates by Director, DCFR, Bhimtal

The trainees were also explained about the improved strain of common carp for coldwater aquaculture *"Champa 1"* & *"Champa 2"* imported and bred by the Directorate.

Other Training Programmes

- Specialized training programme for eight M.F.Sc students from Division of Aquaculture and Fish Nutrition & Biochemistry, Central Institute of Fisheries Education, Deemed University (ICAR), Mumbai from 19th July - 15th August 2010 on the topic "Seed Production and Hatchery Management of Coldwater fish Species".
- Training programme for Four French students during 8-11 August, 2010, deputed by College of Fisheries, Pantnagar, GBPUA&T, Pantnagar.
- Technique of polyculture of exotic carps demonstrated to the farmers during the training programme organized by Paryavaran Sanrakshan Samitee, Pati, Champawat.
- Fish health management and feeding management in polyculture of exotic carps in hills was discussed with farmers of Kumaon region during the training programmes organized by Krishi Vigyan Kendra, Lohaghat and State fisheries department, Champawat.
- Group discussion on prospects of aquaculture in hills with foreign delegates from Afghanistan, visited DCFR Bhimtal.
- Farm advisory service to 14 farmers for carp culture and 2 farmers for trout culture in District Chapawat and Chamoli.

Radio Talk

- Radio talk given by Dr. S. Ali on All India Radio, Aakashwani kendra Almora on the topic मत्स्यवर्धन द्वारा जीविकोपार्जन on 6th September 2010.

Dissertation/Ph.D. Thesis work

- Under the Co-Supervision of Dr. S.K. Srivastava, Senior Scientist, one M.F.Sc. student of CIFE, Mumbai successfully completed dissertation work on the topic "Cryopreservation of Rainbow trout, (*Oncorhynchus mykiss*) Spermatozoa Using Different Cryoprotectants".
- Under the Co-supervision of Dr. Debajit Sarma, Senior Scientist, one student of Kumaun University, Nainital Ms. Suman Sanwal has successfully completed Ph.D. thesis work on the topic "Culture and Growth Studies on Chocolate Mahseer, *Neolissochilus hexagonolepis* (McClelland) in Pond Environment of Kumaun, Uttarakhand".
- Under the Co-supervision of Dr. Debajit Sarma, Senior Scientist, one student of Barkatullah University, Bhopal, Mr. Ghanshyam Nath Jha has successfully completed Ph.D. thesis work on "Ameliorative Influence of Some Feed Additives on Growth, Pigmentation and Nutrient Profile in Selected Upland Fishes".

- Under the Supervision of Dr. A. Barat, Principal Scientist, two students Mr. Prabhaker Goyal and Mr. Sukhdeep Singh of Dept. of Biotechnology & Microbiology of G.F (P.G) college, Shahjahanpur, of M.J.P.Rohilkhand University, Barielly has successfully completed the B.Sc Project work on the topic "Extraction of genomic DNA from fin tissue sample of coldwater fish *Barilius bandelisis* and "Extraction of genomic DNA from fin tissue sample of coldwater fish *Tor putitora.*
- Under the Supervision of Dr. A. Barat, Principal Scientist, one M.Sc.(Applied Microbiology & Biotechnology) student Ms. Surbhi Khandelwal, of Department of Bioscience and Biotechnology of Banasthali University, Rajasthan, has successfully completed M.Sc. dissertation work on the topic "Chromosomal studies on *Schistura rupecola* and *Barilius bandelisis.*
- Under the Supervision of Dr. N.N. Pandey, Senior Scientist, one student of PhD, Kumaon University, Nainital completed research work on "Periphyton based culture of snow trout".
- Under the Supervision of Dr. N.N. Pandey, Senior Scientist three M.F.Sc students completed their dissertation work on "Pathogenic fungi and feed development".

AWARDS & RECOGNITION

- Dr. Debajit Sarma, Senior Scientist and Dr. Prem Kumar, Senior Scientist received Fellowship of Academy of Environmental Biology, Lucknow.
- Ms. Ankita Tyagi and Mr. Chirag Goel, working as a SRF in NAIP project *"Bioprospecting of Genes and allele mining for abiotic stress tolerance-Cold Tolerance"* received Best Poster presentation and 3rd prize in oral presentation respectively by the Academy of Environmental Biology, Lucknow during "National Consultation on Biodiversity of high altitude aquatic resources, conservation and utilization" organized by Directorate of cold water fisheries and Environmental Biology, Lucknow, at DCFR, Bhimtal during 29-30 September, 2010.

Dr. Prem Kumar, Senior Scientist received Fellowship of Academy of Environmental Biology, Lucknow

Dr. Debajit Sarma, Senior Scientist received Fellowship of Academy of Environmental Biology, Lucknow

Dr. R.S. Patiyal, Senior Scientist received Fellowship of Academy of Environmental Biology, Lucknow

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PARTICIPATION IN CONFERENCES/MEETINGS / SYMPOSIA/SEMINARS/WORKSHOPS/TRAINING

Conferences/Meetings/Seminars/Symposia/Workshops	Participants
National consultation on Agro Biodiversity Management organized by ICAR during 26-27 May, 2010.	Dr. N.N. Pandey
"Indian Aqua-Invest Congress and Expo-2010" a special Symposia on Diversification of Aquaculture and Policy Framework for Fisheries & Aquaculture sector in India, held at Central Institute of Fisheries Education, Mumbai during 26-28 May, 2010.	Md. M.S. Akhter
Exhibition at Champawat organized by District administration and KVK, Lohaghat on 5th June, 2010.	Dr. S.K. Srivastava Dr. N.N. Pandey
XXI meeting of ICAR regional committee No.1 organized by Sher-e-Kashmir University of Ag. & Tech. Jammu during 10-11 June, 2010.	Dr. P.C. Mahanta Dr. N.N. Pandey
Software Installation Training cum Workshop organized under the NAIP Project entitled "Strengthening Statistical Computing for NARS" held at Indian Veterinary Research Institute, Izatnagar, Bareilly during 18-19 June, 2010.	Dr. N.O. Singh
DST Sponsored Training programme on "**Science and Society for Rural Societies**" at Lal Bhadur Shastri Academy of Administration, Mussorrie, Dehradun.during 28th June to 9th July 2010.	Dr. S. Ali
"Business Opportunity Workshop" organized by ZTM&BPD Unit, IVRI Izatnagar on 9th July, 2010.	Dr. Amit Pande
"INFISH-2010"- fish food festival organized by NFDB at Hyderabad, from 9-12 July, 2010.	Dr Ananda Kumar B.S.
ICAR Directors Conference at NASC, New Delhi during 15-16 July, 2010.	Dr. P.C. Mahanta
NFDB meeting at Dehradun, on 23rd July 2010.	Dr. P.C. Mahanta
Interactive session on "Biotechnology Research in ICAR" held at NASC held during 26-27 July 2010.	Dr. Amit Pande
Executive Council meeting of AEB at IITR, Lucknow during 6-7August, 2010.	Dr. P.C. Mahanta
National seminar on diversification of Aquaculture, organized by CIFE centre, Kolkata during 26-28 August, 2010.	Dr. N.N. Pandey
"Innovations 4 Industry Meet in Fisheries" organized by the Zonal Technology Management Centre & Business Planning and Development (ZTMC-BPD) Unit, South Zone at Central Institute of Fisheries Technology (CIFT), Cochin along with National Fisheries Development Board (NFDB), Hyderabad held at Visakhapatnam, Andhra Pradesh on 8th September, 2010.	Dr. Amit Pande

Conferences/Meetings/Seminars/Symposia/Workshops	Participants
Seminar on "Caring Wetlands & Conservation of Riverine Fisheries" jointly organized by Central Inland Fisheries Research Institute, Barrackpore and Department of Fisheries, Govt. of West Bengal during National Fish Festival BENAQUA at Kiolkata on 2nd October, 2010	Md. M.S. Akhter
Winter school on "Basic techniques in solid phase peptide synthesis & application of synthetic peptides in animal disease diagnosis and research" for 21 days at IVRI, Izatnagar, Bareilly during 22nd September to 12th October, 2010.	Dr. Ananda Kumar B.S.
Exhibition at IVRI, Bareilly during Kisan Mela during 1-3 November, 2010.	Dr. N.N. Pandey
Interactive meet on "Information and Communication Technology in ICAR" chaired by Hon'ble Director General, ICAR, at NASC, New Delhi during 3-4 November, 2010.	Sh. A.K. Nayak
Sensitization cum Training workshops for the Nodal Officers of PIMS-ICAR at IASRI, New Delhi on 15th November, 2010.	Sh. A.K. Nayak
Study visit of ICAR Scientists to NARC, Nepal under ICAR-NARC Work Plan for 2009-10 during 21-27 November, 2010.	Dr. N.N. Pandey Dr. S. Ali
"National Seminar on Hindi Rajbhasa" organized by Bhartiya Rajbhasa Parishad, New Delhi during 25-27 November 2010 in Goa.	Md. M.S. Akhter
NIE Workshop at Lucknow on 6 December. 2010.	Dr. P.C. Mahanta
Attended and presented a Poster Presentation in International Workshop on "Mountain Diversity and Impact of Climate Change with special reference to Himalayan Biodiversity Hotspot" at G.B. Pant Institute of Himalayan Environment & Development at Kosi Katarmal, Almora, Uttrakhand during 6-8 December, 2010.	Dr. N.N. Pandey Dr. S.K. Srivastava Dr. S.K. Gupta
One day training/demonstration programme on the Uses of SPSS was organized at Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with SPSS South Asia, Pvt. Ltd, Bangalore, India Branch on 13th December 2010.	Dr. N.O. Singh
"Review meeting on Implementation of NFDB funded schemes" held at Directorate of Oilseeds Research, Hydrabad during 15-16 December, 2010.	Dr. Amit Pande Dr. D. Sarma
14th Meeting of Scientific Advisory Committee at KVK Lohaghat on 15th December, 2010.	Dr. S.K. Gupta Dr. S.K. Srivastava

Conferences/Meetings/Seminars/Symposia/Workshops	Participants
Meeting on Project Based Budgeting under the chairmanship of DG ICAR at New Delhi on 20th December, 2010.	Dr. P.C. Mahanta Dr. Amit Pande Dr. Prem Kumar
21 days Winter School on "Development of Expert Systems in Agriculture" at IASRI, New Delhi during 2-22 December, 2010.	Sh. A.K. Nayak
Three days National seminar on "Biodiversity conservation with special reference to Fisheries and its management for food, livelihoods and environmental security and 2nd National Helminthological Congress", held at CIFRI, Barrackpore, during 21-23 December, 2010.	Dr. Dimpal Thakuria
Meeting of ASRB Selection Committee	Dr. P.C. Mahanta
Training programme on "Researcher's Training -III: Data Analysis using SAS" organized by Indian Veterinary Research Institute, Izzatnagar, during 15-20 January, 2011.	Md. M.S. Akhter
Training programme on "Statistical and Computational Genomics Data Analysis" of the NAIP Consortium "Bioprospecting of Genes and Allele Mining for Abiotic Stress Management" funded by NAIP at Indian Agricultural Statistics Research Institute, New Delhi during 11-21 January, 2011.	Dr. S. Ali
"Asian Pacific Aquaculture -2011", Kochi, India organized by the World Aquaculture Society during 17-20 January, 2011.	Dr. P.C. Mahanta Dr. Prem Kumar Dr. Amit Pande Sh. A.K. Nayak Dr. S.K. Gupta
"*Assam Matsya Mahotsav*" held at Guwahati during 27-29 January, 2011.	Dr. D. Sarma Dr Dimpal Thakuria
Interface meeting organized by the Govt. of Nagaland at NRC on Mithun, Medziphema (Nagaland) on 4th February, 2011.	Dr. P.C. Mahanta
Xth Agricultural Science Congress organized by NBFGR, Lucknow during 10-12 February, 2011.	Dr. P.C. Mahanta Dr. A. Barat Dr. N.N. Pandey Dr. S.K. Srivastava Dr. S. Ali

Conferences/Meetings/Seminars/Symposia/Workshops	Participants
National Seminar on Climate Change and its Impact on biological communities (CCIBC-2011) at Department of Environmental Sciences, Dr.R.M.L. Awadh University, Faizabad, during 12-13 February, 2011.	Dr. P.C. Mahanta
Vice Chancellors & Directors' Conference at ICAR, New Delhi during 23-24 February 2011.	Dr. P.C. Mahanta
Attended National Seminar on Conservation and Management of Biodiversity in 21st Century organized by Government Motilal Vigyan Mahavidyalaya, Bhopal during 26-27 February 2011.	Dr. P.C. Mahanta Sh. A.K. Nayak Dr. Prem Kumar
89th Farmer's fair and exhibition at G.B. Pant University of Ag. & Tech. Pantnagar, during 9-12 March, 2011.	Dr. N.N. Pandey
Participated in the Documentary programme On "Eco-fish tourism, its scope and potential" Organized by Prasar Bharti, Doordarshan Kendra, Guwahati at Nameri National Park of ABACA, Nameri (Assam) on 13th March, 2011.	Dr. P.C. Mahanta
Interaction meeting with the Chairs of RAC under the chairmanship of DG ICAR on 17th March, 2011.	Dr. P.C. Mahanta Dr. A. Barat
National training programmed on "Intellectual Property Rights for animal scientists" at SRS, NDRI, Bangalore during 9-18 March, 2011.	Dr. Ananda Kumar B.S.
Exhibition at VPKAS, Hawalbagh during Kisan mela on 29th March, 2011.	Dr. N.N. Pandey Md. M.S. Akhter

DCFR Stall at Assam Matsya Mahotsav 2011

Packing of Mahseer seed at DCFR hatchery complex for transportation to Sikkim

MEETINGS ORGANIZED

NFDB-DCFR Brainstorming Meeting on Coldwater Fisheries

National Fisheries Development Board (NFDB), Hyderabad in collaboration with Directorate of Coldwater Fisheries Research (DCFR) organized a brain storming meeting on coldwater fisheries at Bhimtal on 22nd April

Inauguration of brainstorming meeting of NFDB & DCFR

2010. The programmee was aimed to discuss the progress and constraints in developing coldwater fisheries in the potential areas of the country. The meeting was Chaired by Dr. C. Vasudevappa, Senior Executive Director, NFDB, Hyderabad and Co- chaired by Dr. P.C. Mahanta, Director, DCFR, Bhimtal. Dr. Madan Mohan, ADG(M.Fy), ICAR, New delhi, was guest of honour. Dr. E.V. Gopinath Sai, Executive Director (Tech) NFDB, Hyderabad coordinated the meeting. The other participants were the officers of State Fisheries Departments from Arunachal Pradesh, Himachal Pradesh, J&K, Sikkim and Uttarakhand along with Scientific, Technical and administrative staff of DCFR. During the meeting various issues pertaining to development of Hill Aquaculture were discuused. The Chairman apparised the participants about various schemes of fissheries development under NFDB.

Discussion during brain storming meeting

Institute Management Committee Meeting (IMC)

Institute Management Committee Meeting (IMC) was held on 7th May, 2010 under the chairmanship of Dr. P.C. Mahanta,

Interaction during IMC meeting

Director, DCFR, Bhimtal. Other IMC members, Dr. V.V. Sugunan, ADG (I.Fy), ICAR, New Delhi, Dr. S.A. Ali, Principal Scientist, CIBA, Chenni, Dr. A.K. Sahu, Principal Scientist, CIFA, Bhubaneswar, Dr. A. K. Srivastava, Principal Scientist, VPKAS, Almora and Shri Harish Ram, Member Secretary were present during the meeting. The Scientists and other administrative staff also attended the meeting as special invitee. During the meeting the proceedings of previous IMC meeting held on 28th March, 2009 was approved. Various agenda items pertaining to store purchase and other

infrastructure facilities were discussed during the meeting.

Research Advisory Committee Meeting (RAC)

Research Advisory Committee Meeting (RAC) was held on 18-19 May 2010 under the Chairmanship of Dr. K.K.Vass, Former Director, CIFRI, Barrackpore. During the meeting Former RAC Chairman Dr. S.P. Ayyar, Former Director, CIFRI, Barrackpore

Interaction during RAC meeting

were also present. Other RAC members Dr. P.C. Mahanta, Director, DCFR, Bhimtal, Dr. V.V Sugunan, ADG (I.Fy), ICAR, New Delhi, Dr. Krishna Gopal, Head, Dept. of Aquatic Toxicology, IITR, Lucknow, Dr. R. S. Chauhan, Professor, College of Fisheries, GBPUA&T, Pantnagar, Dr. D.N. Das, Professor, Rajiv Gandhi University, Itanagar, Arunachal Pradesh, Dr. P.C.Joshi, Associate Profesor, Dept. of Life Scince, Gurukul Kangri University, Haridwar and Dr. A. Barat, Senior Scientist & Member Secretary, RAC attended the meeting. The Principal Investigator of the different projects presented the progress of the project before the RAC. Some of the new proposals were also discussed. The RAC Chairman and other members expressed their satisfaction over the ongoing research activities and appreciated the new initiatives taken by the institute.

RAC Chairman Releasing fish seed in DCFR experimental fish pond

Official language Hindi

Quarterly meeting of official language Hindi was conducted under the Chairmanship of Director and review was done on the work going on in official language. The Director encouraged all the staff members to carry out day to day work in the official language Hindi for better understanding and smooth functioning.

Competition during Hindi week

Directorate also celebrated Official Language Week during September 14-20, 2010. On this occasion various types of competition such as easy writing, translation, administrative vocabulary and official noting and drafting were organized. All the scientists and other staffs particularly from non Hindi states participated and winner of different events were awarded with various prizes.

OTHER EVENTS ORGANIZED

Workshop on Intellectual Property Rights (IPR)

A workshop on Intellectual Property Rights (IPR) was organized on the occasion of World Intellectual Property Day on 26th April 2010. Dr.L.M.L. Palni, Director, G. B. Pant Institute of Himalayan Environment and Development. Kosi Katarmal, Almora, was the chief guest of the programme. Dr. J.R. Rao,

Dr. P.C. Mahanta, Director highlighting the IPR issues on IPR Day

Principal Scientist, IVRI, Izatnagar and Shri. Srivastava, Business developer ZTMC, IVRI, Izatnagar, participated in the workshop. Participants from other ICAR Institutes mainly from CITH, Regional Station, Mukteshwar, NBPGR Regional Station,

Felicitation of Dr. L.M.S. Palni, Director, GBPIHED, Almora by Dr. P.C. Mahanta Director highlighting the IPR issues on IP Day

Bhowali also attended the workshop. Dr. P.C. Mahanta, Director, DCFR, highlighted various issues related to the IPR in fisheries research. Dr. Dr.L.M.L. Palni deliberated on the emerging issues of IPR such as copyrights, geographical indicators, trademarks and patents. He also emphasized on the environmental issues of Himalyan region and conservation of its valuable resources. Dr. J.R. Rao highlighted various activities of ZTMC, IVRI and ICAR policies on IPR issues.

Hindi Workshop (Hindi Karyashala)

A workshop on Hindi was organized by the Directorate on the occasion of World Environment Day, 5th June, 2010. The workshop was held on "Matsyaki Anusandhan mei Soochna Prodhyogiki ka Prayog". Dr. A.K. Pant, Director, Birla Institute of Applied Sciences, Bhimtal was the

Deliberation by Dr. R.S. Chauhan during workshop

Chief Guest of the workshop. Shri. Keval Krishna, Hindi Officer from NISCOM, CSIR emphasized the use of Hindi language in research and other official work. He also demonstrated Hindi typing software in Unicode to the participants. The software is easy to use and freely distributed by the Govt. of India to all the departments for the Hindi language uses. Dr. P.C. Mahanta Director, DCFR also emphasized the importance of Hindi language in day to day work. He reiterated that Hindi is national language and must be seen as a language of free communication. Other participants Dr. B.L. Atri, Principal Scientist and Head of the

Demonstration of Hindi typing software by Sh. Keval Krishna

Regional Station, CITH, Mukteswar, Dr. K.D. Joshi, Principal Scientist and Head of the Regional Station, CIFRI, Allahabad and Prof. R.S. Chauhan, College of Fisheries, GBPUA&T, Pantnagar also attended the workshop.

National Consultation on Biodiversity of High Altitude Aquatic Resources, Conservation & Utilization

The directorate has organized two days "National Consultation on Biodiversity of High Altitude Aquatic Resources, Conservation & Utilization" during 29-30 September in collaboration with Academy of Environmental Biology, Lucknow. The consultation was organized to highlight the conservation and sustainable utilization of the high altitude aquatic resources of the country. the emphasis was given to expand fish culture as source of nutritional security in the disadvantaged region of the country particularly in the higher altitude. The programme was attended by different luminaries, Dr. B.S. Bisht, Vice Chancellor, GBPUAT, Pantnagar as the chief guest. The dignitaries were Dr. B. Meenakumari, DDG (Fy.), ICAR, New Delhi, Dr. M.Y. Kamal, Former Director, SKUAST, Kashmir, Dr. S.A.H. Abidi, Former Member ASRB, Dr. Krishna Gopal, Secy.(Hq.), AEB and Dr. P.C. Mahanta, Director, DCFR, Bhimtal. The new strains of Common carp (Champa-1 & Champa-2) were released on this occasion in the presence of Dr. B.S. Bisht, Dr. B. Meenakumari, Dr. M.Y. Kamal, Dr. S.A.H. Abidi, Dr. Krishna Gopal, Dr. P.C. Mahanta, Dr. K.K. Vass, Dr. J.T. Gergan, Dr. M.H. Balkhi, Dr. D.N. Das, Dr. W. Vishwanath. On this occasion Dr. Debajit Sarma, Dr. Prem Kumar scientists of DCFR and Dr. R.S. Patiyal, NBFGR, Lucknow were elected as the Fellows of the Academy (FAEB). The Fellowship certificates were awarded to them at the Inaugural Function of 30th AEB Annual Session, 2010. During the two days deliberation some of the recommendation were made on up-date inventory and database or high mountain aquatic resource using modern tools of Geoinformatics vis-à-vis investigating implications on climatic changes and bio-diversity of the sector. Certain candidate species having cultivable traits should be evaluated for their incorporation in culture systems. Rearing, feeding, water requirement and breeding protocols should be devised for suitable species. Water conservation and management is an important area of research and development in the uplands. The emphasis need to given in applying re-circulatory system schemes for fish production. The phenomenon of climate change must be carefully observed in Himalayan waters and mitigation plans be drawn to protect upland fishery from the likely impacts of changes.

Lighting of lamp during the inaugural session of national Consultation

Address by Chief Guest Dr. B.S. Bisht, VC, GBPUA&T, Pantnagar

Address by Dr. B. Meenakumari, DDG (Fy.), ICAR, New Delhi

Release of DCFR Publication by the dignitaries

Release of Fish Seed Champa1 & Champa 2

International Women's Day

International Women's Day was celebrated on 8th March, 2011. On this occasion participants from GBPUA&T, Pantnagar and other organization attended the programme. Series of lectures were delivered by the dignitaries on the working women issues.

International Women's Day celebration

Independence and Republic Day Celebration

Institute celebrated Independence and Republic Day on 15th August and 26th January with full devotion. On these occasions, Director hoisted the National Flag and addressed the gathering of the staff members. He emphasized to work in cohesion for achieving the goals of the institute and to contribute for the development of coldwater sector of the country.

Independence Day celebration

MEMBERS OF THE MANAGEMENT COMMITTEE

Dr. P.C. Mahanta Director, DCFR, Bhimtal	Chairman
Dr. S. D. Singh Asstt. Director General (I. Fy.), ICAR, KAB II, New Delhi	Member
Dr. A.K. Srivastava, Ex-Principal Scientist, Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand	Member
Dr. A.K. Sahu, Principal Scientist, Central Institute of Freshwater Aquaculture, Bhubaneswar, Orissa	Member
Dr. S.A. Ali, Principal Scientist, Central Institute of Brackishwater Aquaculture, Chennai	Member
Dr. M.K. Das, Principal Scientist, Central Inland Fisheries Research Institute, Barrackpore, West Bengal	Member
Shri Harish Ram, AAO, DCFR, Bhimtal	Member Secretary

MEMBERS OF THE RESEARCH ADVISORY COMMITTEE

Dr. K.K. Vass Former Director, CIFRI, Barrackpore	Chairman
Dr. S.D. Singh ADG (Inland Fy.), ICAR, New Delhi	Member
Dr. P.C. Mahanta Director, DCFR	Member
Dr. Krishna Gopal Head, Toxicology Division, IITR (CSIR), Lucknow	Member
Dr. R. S. Chauhan Professor, College of Fisheries, GBPUA&T, Pantnagar	Member
Dr. D.N. Das Professor, Rajiv Gandhi University, Itanagar, Arunachal Pradesh	Member
Dr. P.C.Joshi Associate Professor, Gurkul Kangri University, Haridwar	Member
Dr. A. Barat Principal Scientist, DCFR	Member Secretary

PERSONNEL

List of staff (As on March 31, 2011)

Research Management

Dr. P.C. Mahanta, Director

Scientific

1.	Dr. Ashoktaru Barat, Principal Scientist	Animal/Fish Genetics & Breeding
2.	Dr. Amit Pande, Senior Scientist	Biotechnology (Animal science)
3.	Dr. Debajit Sarma, Senior Scientist	Fish & Fishery Science
4.	Dr. Nityanand Pandey, Senior Scientist	Aquaculture
5.	Dr. Prem Kumar, Senior Scientist	Fish & Fishery Science
6.	Dr. S.K. Srivastava, Senior Scientist	Fish & Fishery Science
7.	Dr. Suresh Chandra, Senior Scientist	Fish Pathology (joined on 10.03.2011)
8.	Dr. R. S. Patiyal, Sr. Scientist	Animal/Fish Genetics & Breeding (joined on 17.03.11)
9.	Sh. Ashok Kumar Nayak, Scientist (SS)	Computer Application in Agriculture
10.	Dr. N.Okendro Singh, Scientist	Agriculture Statistics
11.	Sh. Sumanta Kumar Mallik, Scientist	Aquaculture
12.	Dr. Shahnawaz Ali, Scientist	Aquaculture
13.	Dr. Neetu Shahi, Scientist	Biotechnology (Animal Science)
14.	Md. Shahbaz Akhtar, Scientist	Fish & Fishery Science (joined on 23.04.2010)
15.	Dr. Dimpal Thakuria, Scientist	Biochemistry (Animal science) joined on 23.04.2010)
16.	Dr. Ananda Kumar B.S., Scientist	Veterinary Microbiology (joined on 24.04.2010)
17.	Dr. Sanjay Kumar Gupta, Scientist	Fish & Fishery Science (joined on 18.09.2010)

Technical

1.	Sh. R.S. Haldar	T-6 (Farm Manager)
2.	Sh. A.K. Joshi	T-5 (Hindi Translator)
3.	Sh. Baldev Singh	T-5 (Librarian)
4.	Sh. Santosh Kumar	T-4
5.	Sh. Ravinder Kumar	T-4
6.	Sh. Vijoy Kumar Singh	T-3
7.	Sh. Amit Kumar Saxena	T-3
8.	Sh. Hansa Dutt	T-3
9.	Sh. Gopal	T-3
10.	Sh. T.M. Sharma	T-3

11.	Sh. R.K. Arya	T-3
12.	Sh. Manoj Kumar Yadav, Driver	T-1
13.	Sh. Partha Das	T-1

Administrative

1.	Sh. Harish Ram	Asstt. Admn. Officer
2.	Sh. B.C. Pandey	Asstt. Fin. & Acc. Officer
3.	Smt. Khilawati Rawat	Asstt. Admn. Officer
4.	Smt. Susheela Tewari	Private Secretary
5.	Sh. P.C. Tewari	Assistant
6.	Sh. J.C. Bhandari	UDC
7.	Sh. Pratap Singh	LDC
8.	Smt. Munni Bhakt	LDC
9.	Sh. Hyat Singh Chauhan	LDC
10.	Sh. Hansa Singh Bhandari	LDC

Skilled Supporting Staff

1.	Sh. Ravinder Kumar	Skilled Supporting Staff
2.	Sh. Om raj	-do-
3.	Sh. Sunder Lal	-do-
4.	Sh. Dharam Singh	-do-
5.	Sh. Prakash Akela	-do-
6.	Sh. Pooran Chandra	-do-
7.	Sh. Manoj Kumar	-do-
8.	Sh. Kulfeep Kumar	-do-
9.	Sh. Bhola Dutt Mouni	-do-
10.	Sh. Chander Shekhar	-do-
11.	Smt. Basanti Devi	-do-
12.	Sh. Mangla Prasad	-do-
13.	Sh. Sushil Kumar	-do-



Farewell of Dr. N.O. Singh, Scientist Dr. K.D. Joshi, Principal Scientist and Dr. B.C. Tyagi, Principal Scientist

DISTINGUISHED VISITORS

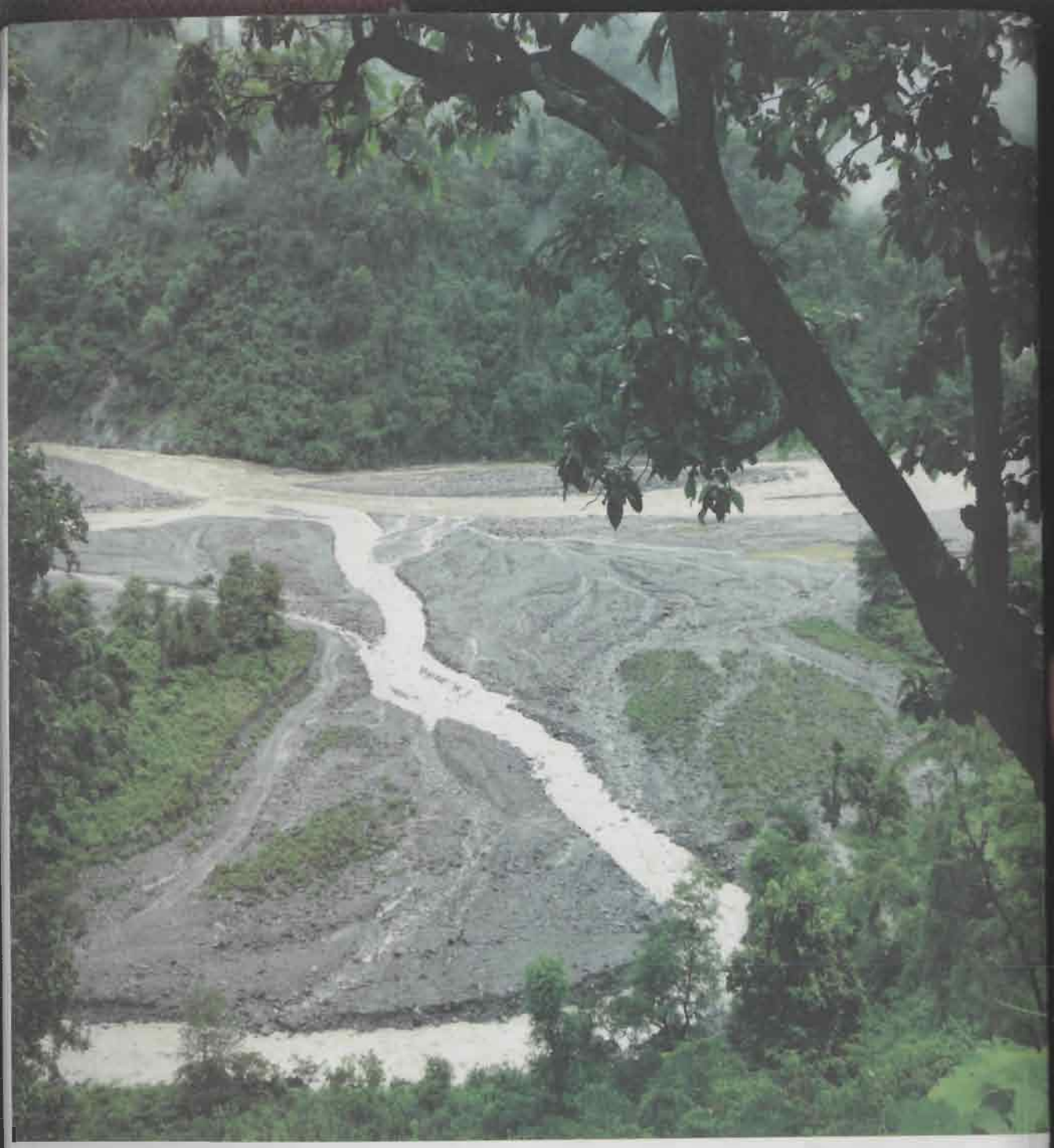
- Dr. B. Meenakumari, DDG (Fisheries), ICAR, New Delhi
- Dr. Umesh Srivastava, ADG (Hort.), ICAR, KAB II, New Delhi
- RAC members of IVRI
- Dr. A.T. Sherikar, Dr.R.N. Srinivasagowda, Dr.J.M. Nigam (All retired VCs)
- Students along with faculty members from S.K.N. College, Jobner, Jaipur (Rajasthan)
- Dr. Jay G. Varshney, Director, Directorate of Weed Science Research, Jabalpur
- Board members of AAU, Assam
- Prof. Suresh S. Honnappagol, Vice Chancellor, KVAFSU, Bidar
- Mr. S. Mall, South Asia Director, Professional Resources , Intl. Dehradun, India/Wisconsin USA
- Mr. Mathew Campbell, Owner, ORA Technologies Inc
- A team of IIT, Khargpur professors
- Dr. A. K. Rawat, Joint Director, DBT, GOI, New Delhi

Visit of IIT Kharagpur Professor

Students from College of Fisheries SKUAST, Srinagar, J&K

Dr. A.K. Rawat, Jt. Director, DBT, New Delhi visiting Molecular Genetics lab at DCFR

Visit of RAC members IVRI Mukteshwar in feed mill of DCFR



शीतजल मात्स्यिकी अनुसंधान निदेशालय
(भारतीय कृषि अनुसंधान परिषद्)
भीमताल, नैनीताल, उत्तराखण्ड

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