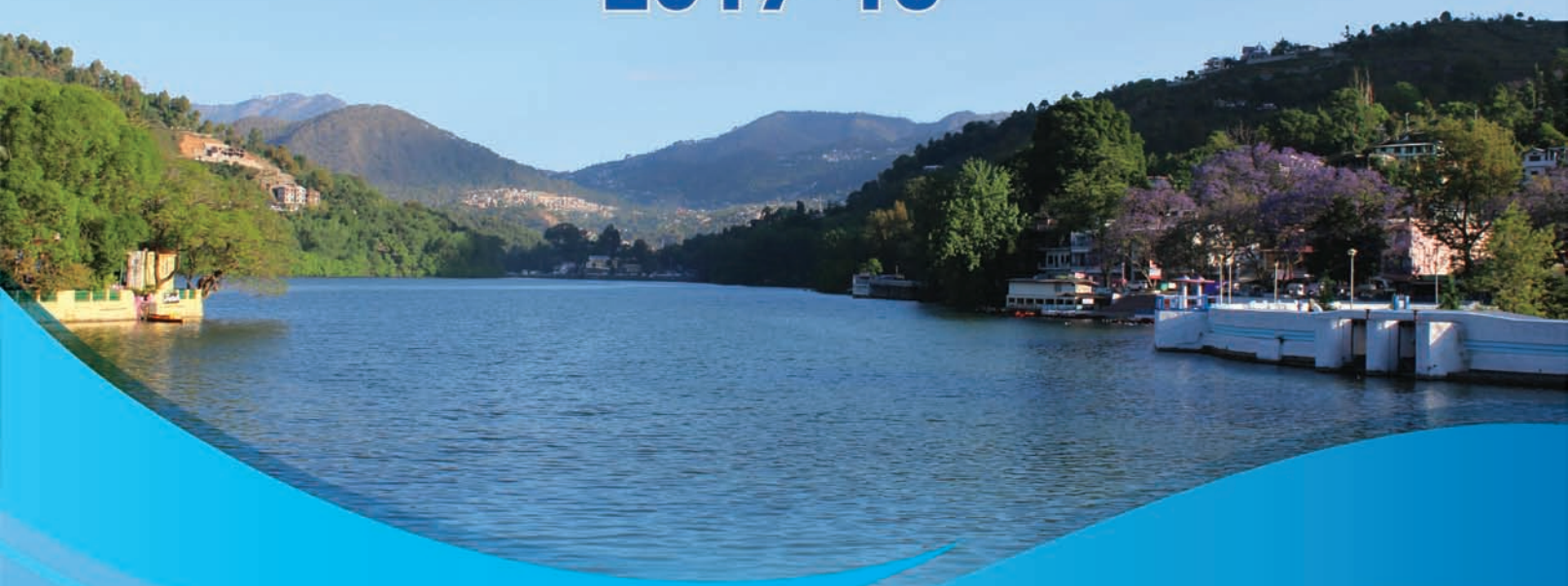
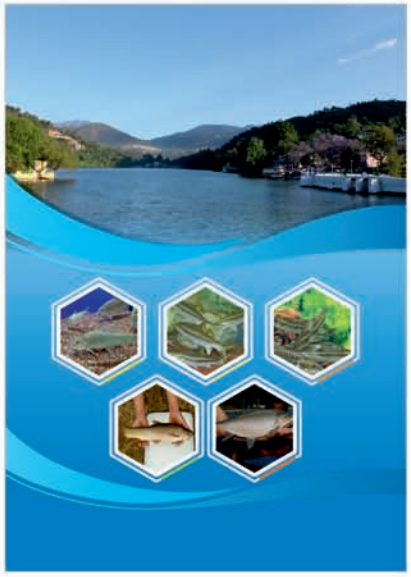
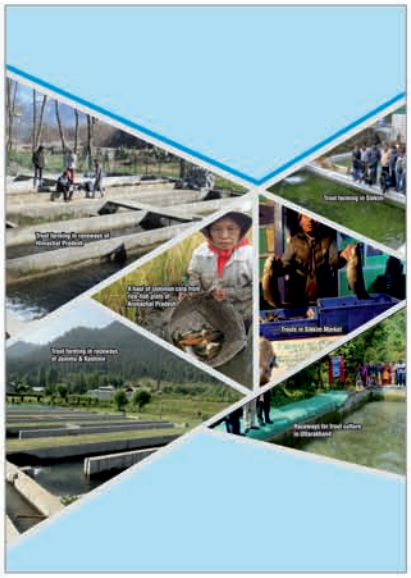
ANNUAL REPORT
2017-18



ICAR-DIRECTORATE OF COLDWATER FISHERIES RESEARCH
Bhimtal-263 136, Nainital, Uttarakhand, India



Front Cover:
Theme: Species diversification
in coldwater fisheries and aquaculture



Back Cover:
Theme: Enhancing fish farmers income
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Bhimtal - 263 136, Nainital
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Preface

Coldwater fisheries have a great potential in generating rural income and providing food security to the rurals in Indian uplands and its sustainable utilization and development have assumed importance in coldwater regions of the country. The ICAR-Directorate of Coldwater Fisheries Research, Bhimtal has been continuously providing empirical inputs through imparting quality research and services for sustainable coldwater fisheries production, management and conservation.

During the year 2017-18, ICAR-DCFR has undertaken comprehensive initiatives towards scientific management of fishery resources, safeguard of coldwater fisheries and promotion of hill aquaculture for enhancing farmer's income in particular and overall development of coldwater fisheries sector in the country through scientific innovations, technological improvements and farmer oriented approaches. Trailing our endeavours and commitments, Directorate has been working towards resource assessment and advancement in GIS based site suitability maps of Leh and Ladakh, generating GIS maps of ichthyofaunal distribution covering major drainages of Jammu & Kashmir, Himachal Pradesh and Uttarakhand along with eco-biological study of selected mountain lakes of central and north eastern Himalayan region. Advancements in hill aquaculture includes captive maturation and spawning of golden mahseer through photo-thermal manipulations, development of captive breeding and rearing protocols of *Neolissochilus hexagonolepis*, *Barilius bendelisis, Naziritor chelynoides*, *Schistura* spp., *Bangana devdevi, Osteobrama belangeri* under controlled conditions. Screening and identification of histology based appetite markers for devising feeding regimen in golden mahseer larvae; characterization of myogenic regulatory transcripts to understand muscle growth mechanism in slow growing *Schizothorax richardsonii*; evaluation of rainbow trout starter feed at phenotypic and molecular levels; development of two efficient and cost-effective single and multiple protein based rainbow trout starter feeds was the prime research achievements of this Directorate during this period. Standardization of composite carp culture with indigenous species *L. dyocheilus* and exotic carps for mid altitudes in polytanks and successful triploidy induction in rainbow trout has also been achieved. Under the national project on innovations in climate resilient agriculture (NICRA), attempts are being made to develop a multi-pronged strategy to counter the climate change related challenges faced by rainbow trout farmers. The issues and challenges of coldwater fish diseases are precisely being addressed by putting sincere efforts in disease surveillance of coldwater fish farms, identification of pathogens and development of management measures including screening of fungicidal effect of various anti-fungal drugs. The modern techniques of molecular biology and biotechnology are imperative to address the issues related to aquaculture and species development more precisely. The Directorate has made significant achievements in peptide synthesis using Fmoc-chemistry, In-silico identification and designing of cell penetrating peptides (CPPs) from fish viral proteins, gene reporter assays using Mx promoter of rainbow trout and IRF3 promoter of snow trout for development of an engineered cell line for the detection of any viralsignal and optimization of protocol for synthesis of Polyhexamethylenebiguanide (PHMB) stabilized cationic silver nano particles (AgNPs).

To promote mahseer based eco-tourism and recreational fisheries in north-east India, North-East angling festival and workshop on "Connecting People, Fish and Nature" was organized by this Directorate at Jasingfaa Aqua Tourism Resort, Nagaon, Assam. The Directorate also organized various other trainings, field demonstrations, farmer advisories and exhibitions to disseminate scientific knowledge on various aspects of coldwater fisheries and aquaculture to farmers, fisheries officers and other concerned stakeholders. Awareness-cum-ranching programmes were organized to revive the natural population of golden and chocolate mahseer. Under tribal sub-plan activity, rainbow trout farming is being promoted as a remunerative livelihood option by provision of infrastructure and inputs for adopted tribal farmers. Under NEH activity, one trout hatchery and three trout raceways were established at Dzuleke, Kohima for the first time. One unit each of chocolate mahseer hatcheries were established in Meghalaya, Mizoram and Nagaland respectively. Likewise, a portable carp hatchery and trout feed extruder were installed in Arunachal Pradesh. Under Mera Gaon Mera Gaurav national initiative, the Directorate provided advisories and consultations to farmers of 17 adopted villages for increasing their farm productivity and production. The Directorate also strengthened linkages with other ICAR research institutes, fisheries departments of hill states, agricultural universities, non-governmental organisations and central agencies such as National Fisheries Development Board and Department of Biotechnology for promoting research, extension and capacity building.

The continuous support, guidance and encouragements received from Dr. T. Mohapatra Secretary, DARE & Director General, ICAR has given courage and strength to achieve our goal benefiting the upland farmers residing in the high mountain areas. The supports, motivation and guidance received from the Deputy Director General (Fisheries), Dr. J.K. Jena and the Assistant Director General (Inland Fisheries), Dr. S. Raizada is recorded with sincere thanks and gratitude.

I sincerely thank and appreciate the contributions of all the scientists and staff members of the Directorate for the successful progress made during the year. I also thank the members of the editorial committee for their meticulous effort in compiling and bringing out the Annual Report 2017-2018 on time.

(Debajit Sarma)
Director (Acting)

Contents

Executive Summary

1

ICAR-DCFR has undertaken comprehensive initiatives towards scientific management of coldwater fisheries resources, safeguard of coldwater habitats and promotion of hill aquaculture to enhance hill fish farmer's income. Meticulous efforts of this Directorate includes explorations of important habitats, study of ecology, biology of endemic species for regular updating fish biodiversity and molecular characterization of commercially important coldwater fish species. For diversification in hill aquaculture using prioritized indigenous candidate species, various protocols for breeding, rearing and seed production of several new species have been developed and standardized. Disease monitoring and activities related to health management of fish also forms a major part of the commitments of this Directorate to enhance productivity and production. Exhaustive nutrient profiling of coldwater fishes are being done at the Directorate to create awareness of dietary nutrient potential and health benefit of these fishes and to promote fish consumption. This Directorate has rendered technical support to different fish farmers and also developed human resources through trainings, on farm demonstrations, consultancies for aquaculture expansion. With an aim to uplift the coldwater fisheries sector, the Directorate is carrying out various activities untiringly and the achievements during the reporting period 2017-18 are briefed below:

Resource Assessment and Management

- Assessment of habitat and ichthyofaunal diversity of the river Western Ramganga indicated that abiotic factors have a significant influence in the organization of species assemblage and therefore likely to be affected by any alteration in the habitat characteristics through anthropogenic interference.
- In eco-biological study of selected mountain lakes of central and north eastern Himalayan regions, a new species of copepods, *Arctodiaptomus shaikhomensis* was collected and identified from Lake Maheshwarkund of Central Himalaya.
- GIS based land use-land cover map of Ladakh region indicated that 99.68 % of the land is waste land in Ladakh region and only 0.32 % land is available for agriculture activities.
- GIS maps of habitat/distribution of ichthyofaunal resources from major drainages (Indus, Shyok, Zanskar and Jhelum) of Jammu & Kashmir, (Sutlej, Beas, Ravi and Chenab) of Himachal Pradesh and (Alaknanda, Mandakini, Pinder, Bhagirthi & Ramganga) of Uttarakhand have been generated.
- In assessment of population status, species diversity and habitat ecology of *Schizothorax* species in selected streams of Indian Himalayan Region, it was found that *Schizothorax richardsonii* and *Schizothorax plagiostomus* were the dominant species in Kameng drainage whereas *Schizothorax progastus* and *Schizothorax richardsonii* dominated in the Siang drainage of Arunachal Pradesh.
- Under National mission for sustaining the Himalayan ecosystems, GIS based site suitability maps for trout farming have been developed using primary data collected on water source, temperature and accessibility of Leh district. In view of the climate change as predicted by IPCC, temporal maps were also generated considering an increment of water temperature by one degree up to 4°C and were observed that 190 hectares of land is fairly suitable for trout culture in Leh.

Aquaculture Research and Development

- Golden mahseer (*Tor putitora*) brooders maintained in FRP tank installed with gravel bed-biofilter and provided with optimum photoperiod and temperature spawned seven times spontaneously within a period of 4 months at an interval of 15-20 days.
- RNA-Sequencing (RNA-Seq) of brain from sexually matured male and female golden mahseer were carried out using Illumina paired-end (PE) platform to understand the molecular mechanism of gonad organogenesis and reproduction. Analysis of the sequence showed that there are 287 numbers of potential sex differentially expressed reproduction related unigenes, of which 153 and 134 genes are upregulated in male and female brain respectively.
- Novel histology based appetite markers were screened and identified to devise a feeding regimen in golden mahseer larvae/juvenile based on return of appetite and it was found that digestion apparatus in these fish starts to reorganize and get ready for second meal after 6 hrs of feeding.
- Thermal, oxygen and metabolic limits of *Schizothorax richardsonii,* which specify the extent of their physiological ability to adapt to temperature shifts in natural and simulated environment has been deciphered.
- *Schizothorax richardsonii* fed with 3% lipid showed significantly higher levels of plasma triglyceride, plasma globulin and plasma total protein compared to group fed with more lipid content.
- Four myogenic regulatory transcripts namely *myod*, *myf5*, *myogenin* and *myf6* and a negative growth regulator *myostatin*1 (mstn1) have been characterised to understand the muscle growth mechanism in slow growing cyprinid *Schizothorax richardsonii*.
- Gonadal histology and plasma sex steroids of *Schizothorax richardsonii* clearly indicate two pronounced spawning seasons: September to early November and February to March.
- Captive breeding protocol of *Raiamas bola* has been developed at water temperature of 18 to 22°C with 40-50% recovery of fry which would be helpful for conservation, rehabilitation and ornamental purpose of this species.
- From reproductive biological study of ngaton (*Bangana devdevi*) and pengba (*Osteobrama belangerii*), it was found that a set of males (in both species) can be used at least two times for fertilization or ratio of female to male can be raised in a breeding pool.
- Breeding and rearing protocols for the fish species like Chocolate Mahseer (*Neolissochilus hexagonolepis*), *Barilius bendelisis,* Black Mahseer (*Naziritor chelynoides*) and Stripped loach *Nemacheilus denisoni* have been developed.
- Multiple breeding of *Neolissochilus hexagonolepis*, *Naziritor chelynoides, Barilius bendelisis* in aquarium within a span of one year without using any synthetic or pituitary hormone or striping method have been achieved.
- Breeding of exotic ornamental Gold fish (*Carassius auratus*), Koi carp, Oscar fish (*Astronotus ocellatus*), Angel fish (*Ptrophyllum scalare*) and tetra varieties like Widow tetra, Red eye tetra and Baenuos tetra etc. were done successfully.
- Successful larval rearing of *Barilius bendelisis, Puntius ticto, Naziritor chelynoides, Neolissochilus hexagonolepis*, *Nemacheilus denisoni* in controlled condition in aquarium was achieved with zero water exchange system.
- Evaluation of rainbow trout starter feed at phenotypic and molecular levels has shown that protein source used in the starter feed substantially influences growth, feed utilisation, carcass amino acid content and hepatic metabolism of rainbow trout.
- Two efficient and cost-effective single and

multiple protein based starter feeds were formulated for initial feeding of rainbow trout fry. The formulated feeds were found to outperform existing commercial feeds having >90% survival and better FCR (1.1-1.3).

- Nutrient profiling of coldwater fishes showed that they are potent sources of vital nutrients and bioactive compounds, which the modern consumers are seeking in present day food market.
- Composite carp culture including *L. dyocheilus* and exotic carps (silver carp, grass carp and improved Hungarian common carp) in species composition of SC:GC:CC:MC (20:40:20:20) was standardized for mid altitudes in polytanks with the production potential of 0.7 kg/m^3.
- Initial success in triploidy induction in rainbow trout is achieved.
- Under the project on National Initiative on Climate Resilient Agriculture (NICRA), this Directorate has taken up the work component to develop a multi-pronged strategy to counter the climate change related challenges faced by rainbow trout farmers.

Disease Surveillance and Health Management

- Under the National Surveillance Programme on Aquatic Animal Diseases, samples collected from Kullu, Mandi, Bilaspur and Sirmaor districts of Himachal Pradesh and Champawat, Almora, Nainital and U.S. Nagar of Uttarakhand were screened for VHSV, IHNV, bacterial, fungal and parasitic infections.
- Gene reporter assays were developed using Mx promoter of rainbow trout and IRF3 promoter of snow trout, to enable the development of an engineered cell line for the detection of any viral signal.
- Two easy and low cost protocols for isolation of genomic DNA from *Saprolegnia* have been optimized and development of rapid assays for detection and identification of *Saprolegnia* species is in progress.
- Protocol for synthesis of Poly-hexa-methylene-biguanide (PHMB) stabilized cationic silver nano particles (AgNPs) has been optimized and evaluation of its antimicrobial activity is in progress.
- Fungicidal effect of various anti-fungal drugs has been screened on *Saprolegnia parasitica* and chitosan was found to be most effective among tested drugs with minimum inhibitory concentration of 50 ppm.
- Experimental trials to study the efficacy of Oxytetracycline (OTC) at different doses on fingerlings of golden mahseer, *Tor putitora* challenged with *Aeromonas hydrophila*, shown that prudent use of 2-8 g OTC/100 pound fish/day through feed, fed @ 2% body weight for 10 days can effectively control the bacterial infection under laboratory condition.

Molecular Genetics and Biotechnology

- Peptide synthesis facility has been established and protocol for chemical synthesis of peptides using Fmoc-chemistry in the laboratory has been optimized.
- In-silico identification and designing of cell penetrating peptides (CPPs) from fish viral proteins has been done successfully and protocols for transfection of fish cell lines using peptide nano system has been optimised.
- Molecular genetic characterization of Assamese kingfish, *Semiplotus semiplotus* is underway.
- Analysis based on mitochondrial marker, Cytb, CO-I and ATPase 6/8 in Chocolate mahseer collected from nine different locations spreading into Arunachal Pradesh, Assam and Meghalaya revealed high haplotype diversities and genetic differentiation in Dikrong river (Arunanchal Pradesh), Sankosh river (Guwahati) and Umiam river (Meghalaya) populations and support their usage in future marker-assisted breeding programs to maintain substantial genetic vigour in the descendent populations.

Important Events, Extension Activities, Trainings and Other Developments

- International Workshop on Mahseer Conservation was organized jointly by Bournemouth University (UK), Mahseer Trust (UK), Coldwater Fisheries Society of India (Bhimtal), ICAR-DCFR, Bhimtal, Vemco and KUFOS at Kochi, Kerala during 5-7th April 2017.
- Swachhta Pakhwada under Swachh Bharat Mission was observed with great enthusiasm at ICAR-DCFR Headquarter and Experimental Fish Farm, Champawat during 16-31st May 2017
- Mahseer ranching programme under the fishery programme of National Mission for Clean Ganga (NMCG) was organised at Laxmanjhula, Rishikesh in collaboration with CIFRI, Barrockpore on 23rd May 2017.
- The Institute Research Committee (IRC) meeting was held at ICAR-DCFR under the Chairmanship of Dr. A. K. Singh, Director during 25-26th May 2017.
- World Environment Day was celebrated at ICAR-DCFR by carrying out plantation in and around the institute campus on 5th June 2017.
- International Yoga Day was observed at ICAR-DCFR, Bhimtal and field centre, Champawat on 21st June 2017.
- National Fish Farmer's Day was celebrated at ICAR-DCFR and its experimental field centre, Champawat on 10th July 2017.
- Three days training program on 'Fish Breeding Techniques' was organized in collaboration with SAMETI (SKUAST-J) at Jammu during 24-26th July 2017.
- Awareness cum Training Programme was organized at ICAR-DCFR, Experimental Fish Farm, Champawat under NSPAAD project on 29th July 2017.
- Independence Day was celebrated at ICAR-DCFR, Bhimtal and its experimental field centre, Champawat with flag hoisting ceremony on 15th August 2017.
- Awareness Program on fish health management in cultivable and ornamental fishes during the "New India Manthan -Sankalp se Sidhi' was organized at ICAR-DCFR Field Centre Champawat under NSPAAD project on 20th August 2017.
- Sadbhavna Diwas was celebrated at ICAR-DCFR Experimental Fish Farm, Champawat on 20th August 2017.
- Three days hands on training programme on "Management and culture of ornamental fishes in coldwater region" for tribal farmers of Jammu & Kashmir and Uttarakhand was organised at ICAR- DCFR, Bhimtal in collaboration with Krishi Vigyan Kendra, Doda, Jammu & Kashmir during 5-7th September 2017.
- Hindi Pakhwada was organized at ICAR-DCFR, Bhimtal and its Experimental Fish farm, Champawat from 14-30th September 2017.
- Swachhta Hi Seva campaign under Swachh Bharat Abhiyan was observed with great enthusiasm at ICAR-DCFR, Bhimtal from 15th September to 2nd October 2017.
- A national seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater fisheries and Aquaculture" was organized at ICAR-DCFR, Bhimtal in collaboration with Zoological Society of India and Coldwater Fisheries Society of India from 22-24th September 2017.
- ICAR-DCFR celebrated its 30th Annual Foundation Day on 24th September 2017.
- The 7th North-East Angling Festival and Workshop on 'Connecting People, Fish and Nature' was organized at Jasingfaa Aqua Tourism Centre, Nagaon, Assam in collaboration with Coldwater Fisheries Society of India, ICAR-DCFR, Pelagic Tribe, Department of Fisheries, Assam on 15th October 2017.
- One day demonstration about the health and hygiene maintenance in rainbow trout and

carp farm was organised at ICAR-DCFR Field Centre Champawat under NSPAAD project to educate visiting progressive farmers of Himachal Pradesh on 18th October 2017.

- Vigilance week was observed at this Directorate under the theme "My vision – corruption free India" during 30th October to 4th November 2017.
- Agriculture Education Day was organized at ICAR-DCFR, Bhimtal with participation of 125 students of Lakes International School, Bhimtal on 3rd December, 2017.
- World Soil Day was organized at ICAR-DCFR, Bhimtal with 50 participants including 24 progressive fish farmers from Nainital district on 5th December, 2017.
- Fish farming and planning expert dialogue meet was organised along with Environs Trust for the farmers of Pati at Experimental Fish Farm, Champawat on 7th December 2017.
- One day training on 'Integrated fish farming and seed distribution programme' was organised by ICAR-DCFR, Bhimtal in village Salmatta, Sitarganj under STC programme for the Tharu tribal farmers of Udham Singh Nagar, Uttrakhand on 19th December 2017.
- The Research Advisory Committee (RAC) of ICAR-DCFR was held at the Directorate, Bhimtal under the chairmanship of Dr. M. Sinha, former Director, ICAR-CIFRI on 29-30th December 2017.
- One day *Sangoshthi* on 'Promotion of Mahseer Eco-tourism in Kumaun Region' was organized at ICAR-DCFR in collaboration with district administration Nainital and Department of Tourism, Uttarakhand on 7th January 2018.
- One day workshop on *'Mahseer, Paryatan ewam Vikaas'* was organized at ICAR-DCFR, Bhimtal on 7th January 2018.
- 'Farmers Interactive Meet' was organized at ICAR-DCFR, Bhimtal during visit of Honable Mr. B.P. Singh, Member ICAR Governing body on 9th January 2018.
- Republic day was celebrated at ICAR-DCFR, Bhimtal and Champawat on 26th January, 2018.
- Skill oriented training programme on 'Conservation, culture and hatchery operation of snow trout' was organized for the officials of Tehri Hydro Development Corporation, Pipalkoti, Uttarakhand during 6-8th February 2018.
- A one day 'Kisan Mela' was organized at ICAR-DCFR, Experimental Fish Farm, Champawat, Uttarakhand on 24th February 2018.
- Three days training program on 'Breeding and rearing technologies of coldwater ornamental fishes' was organized at ICAR-DCFR, Bhimtal for 16 participants of NE Region and Uttarakhand during 7-9th March, 2018.
- An awareness-cum-training programme on the topic, "Avenues in fisheries to combat climate change in high altitude" was organised by Dr. Prem Kumar and Dr. Biju Sam Kamalam for the students of Eliezer Joldan Memorial College Leh, Ladakh on 12th March 2018.
- One day workshop on Intellectual Property Right was organized at ICAR-DCFR, Bhimtal on 20th March 2018.
- A Farmers-Officers-Scientist Interactive Meet on 'Fish farming and seed production in cold regions of Arunachal Pradesh' was organized at Hari village, Ziro valley of Lower Subansiri district of Arunachal Pradesh on 22ndMarch 2018.
- Coldwater fish hatchery installed by ICAR-DCFR at Hari village, Ziro valley of Lower Subansiri district of Arunachal Pradesh was inaugurated by the Hon'ble Parliamentary Secretary Food and Civil Supplies, Er. Tage Takion 22nd March 2018.
- An awareness workshop on Intellectual Property Rights (IPR) was organized at ICAR-DCFR Experimental Fish Farm, Champawat on 28th March 2018.
- A Start-up orientation programme for tribal students on "Ornamental Fish Aqua-gardening" was organized at ICAR-DCFR Bhimtal on 31st March 2018.

2 Introduction

2.1 Brief History

The ICAR-Directorate of Coldwater Fisheries Research, a premier national research institute of Indian Council of Agricultural Research, Ministry of Agriculture & Farmers Welfare, Government of India for the coldwater fisheries and aquaculture in the country and is working towards the development of coldwater fisheries sector in the entire country from Jammu & Kashmir to the Northeastern states of the Himalayas and peninsular India since its inception. The institute has well structured organization set up having scientific, administration & coordination, monitoring and evaluation, account and drawing and disbursing section. During the seventh five year plan, the Indian Council of Agricultural Research created National Research Centre on Coldwater Fisheries (NRCCWF) on 24th September 1987 as an independent research centre and during the eleventh five year plan the centre was made to Directorate of Coldwater Fisheries Research. In the last three decades, the Directorate has made steadfast progress in its research and development efforts to sustainably manage coldwater fisheries resources and enhance farmed fish production in the Indian uplands through scientific innovations, technological refinements and knowledge sharing, using available natural resources and farmers-centric approaches.

Furthermore, the Directorate has emerged as the certified (ISO 9001:2015) nodal facility in the country to carry out research investigations and to develop technologies on commercially important coldwater fish species such as the mighty mahseers, exotic trouts (rainbow and brown trout), carps (Chinese and common carp) and lesser barils. Effort has been to enhance production and productivity in hill locked areas of the Himalayas which has a positive impact on the employment generation and sustainable management of the aquatic resources and their piscine fauna.

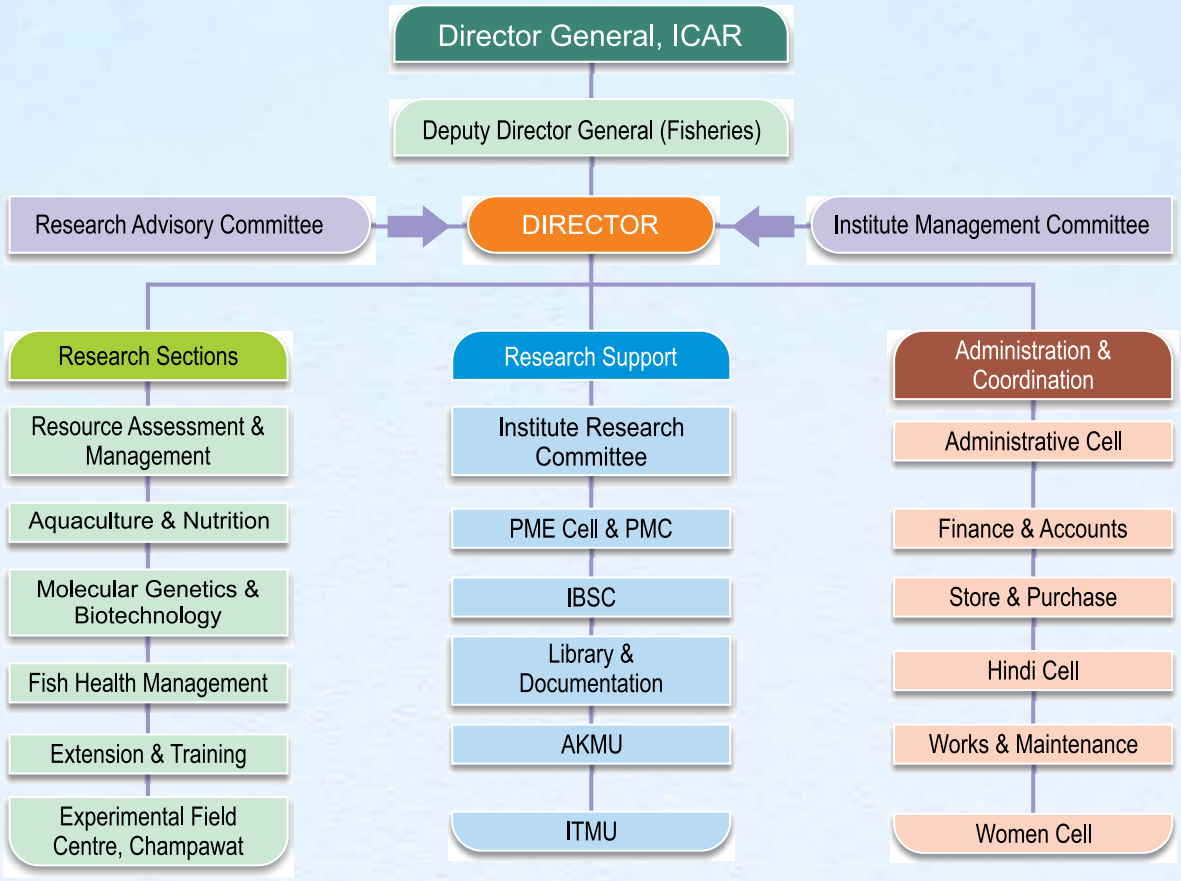
2.2 Location

The headquarters of ICAR-DCFR is located at Bhimtal (29°19'52.647"N 79°33'18.083"E), Nainital district, Uttarakhand, at an altitude of 1470 m above msl. The nearest railway station is Kathgodam, 22 km from Bhimtal and 278 km from Delhi. The nearest major airport is Indira Gandhi International Airport, New Delhi. At present, a small airport is also in operation at Pantnagar. The experimental fish farm of the Directorate is at Chhirapani in Champawat district (29°17'55.537"N 80°6'8.915"E) of Uttarakhand, which is about 150 km from Bhimtal.

2.3 Mandate

- To conduct basic, strategic and applied research in coldwater fisheries and aquaculture
- To act as repository of hill fisheries resources
- Human resource development through training, education and extension

2.4 Organizational Set-up



2.5 Management

As mandated by the Indian Council of Agricultural Research, a high powered Research Advisory Committee (RAC) guides the Directorate on thrust areas of research and on new scientific initiatives. The RAC also evaluates and monitors the progress of research activities carried out in the Directorate. Similarly, the Institute Management Committee (IMC) supervises the various administrative and financial aspects of the Directorate, under the chairmanship of the Director. A number of other internal committees such as Institute Research Committee (IRC), Project Monitoring and Evaluation Committee and Institute Joint Staff Council (IJSC) are in place for decentralized management.

2.6 Infrastructure

Building

The Directorate is functioning from its main building complex situated at Industrial area, Bhimtal. The main complex has several facilities such as sectional laboratories, library, AKMU cell, refurbished aquarium, wet labs, flow-through raceways, hatchery, guest house, committee rooms and auditorium. A mahseer seed production unit is also operational at a separate site in Bhimtal. Moreover, the Directorate has an experimental fish farm facility at Chhirapani, Champawat, Uttarakhand. The field centre has trout hatchery, cemented nursery and grow-out raceways with water recirculation system, ponds, tanks for conducting experiments, check dam, reservoir, laboratories, library, meeting hall, staff quarters and guest house.

ICAR-DCFR premises at Bhimtal

State-of-the-art aquarium unit at ICAR-DCFR, Bhimtal

Auditorium of ICAR-DCFR, Bhimtal

Farm premises at Experimental Fish Farm, Champawat

Laboratory facilities

The Directorate has well equipped laboratories to support research on molecular genetics, biotechnology, diagnostic virology, bacteriology, environmental fish biology, nutrition, molecular biochemistry, nutritional physiology, diagnostic mycology and geo-informatics. The wet laboratory facilities have also been strengthened by the addition of flow through experimental units that can facilitate the conduct of growth trials and physiological experiments in coldwater fishes. One pilot-scale feed mill is also installed in the main campus of the Directorate to meet the basic requirement of fish feed in the experimental farm.

Laboratory facilities at ICAR-DCFR

2.7 Support Services

Prioritization monitoring and evaluation cell

A separate unit called the Prioritization Monitoring and Evaluation cell monitors the implementation and progress of research projects undertaken by the Directorate. This cell organizes the annual meeting of Institute Research Committee (IRC) to evaluate the progress made in each research project and approves the work programme for the following year. The new proposals are also approved by the IRC after thorough evaluation of the objectives, practical utility, manpower and financial involvement. The PME cell is responsible for maintaining the records of project reports through

RPP system and for dealing with all the associated technical matters. The cell also keeps a record of publications, training programmes, deputation and participation of scientists in seminars, symposia, workshop and conferences.

Agricultural knowledge management unit

The Agricultural Knowledge Management Unit (AKMU) of this Directorate provides internet access, scanning and printing facilities to all scientists and other staff members. It also serves as network administrator and monitors the LAN connectivity of around 50 computers at this Directorate. In AKMU cell, desktop computer and internet facilities are also available for research scholars and students working under various project/ programmes. Internet facilities at the experimental field centre, Champawat is provided through BSNL leased line.

The website of the Directorate (http://www.dcfr.res.in) has been modified as per guidelines for Indian Government Website (GIGW) and certified for Standardization Test Quality Certification (STQC). The website is also being regularly updated as per the ICAR guidelines, under the AGROWEB project. The site presents information about the Directorate's manpower, mandate, research projects, major achievements, technology generated and consultancy services. Further, the conduct of training programmes, seminars, symposia, recruitments and tender notices are being notified on the website. The Directorate's website is also linked to the website of Indian Council of Agricultural Research (http://www.icar.org). Electronic mail and messaging solutions (mail server) are also maintained at this Directorate for secure communication via webmail.

AKMU unit of ICAR-DCFR

Library and documentation unit

The library and documentation unit of the Directorate acts as a repository of literature and information. It provides services to scientists, staff members, research scholars, students and other individuals from neighboring organizations interested in scientific literature on coldwater fisheries and allied subjects. All scientific books have been catalogued with barcoding. The library also provides the facility to access free online publications and articles of many international and national journals through www.cera.jccc.in.

Library facility at ICAR-DCFR

The library maintains active reprography services by producing departmental publications and supplying required photocopies to the scientists and research scholars. Recently, an *inventory of e-journals* containing more than 35,000 soft copies of important fisheries research articles has been developed. The documentation section is entrusted with the responsibility of publishing scientific bulletins, brochures, pamphlets, annual report and newsletters. The library maintains exchange relationship with several other research organizations. The annual reports, special publications and technical bulletins published from time to time are being mailed to about 250 organizations, institutions, fishery agencies, etc.

Institute technology management unit

The Institute Technology Management Unit has been constituted under the chairmanship of Director, for dealing with patents and other intellectual property rights developed at the Directorate. It is also responsible for safe transfer of technologies and for providing information about ICAR guidelines on IPR issues. Training and guidance are provided for concerned scientists with respect to IPR issues. The ITMU cell observes World Intellectual Property day on 26th April every year by organizing a special workshop.

2.8 Staff Strength (as on 31.03.2018)

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	-	1
Scientific	30	26	4
Technical	14	13	1
Administrative	13	11	2
Supporting	15	11	4
Total	73	61	12

2.9 Financial Statement for the Year 2017-18

(Rupees in lakh)

S. N.	Head	R.E 2017-18	Actual Expenditure upto 31.03.18
	CAPITAL		
1	**Works**		
	A. Land	-	-
	B. Office Building	35.00	18.94
	C. Residential Building	-	-
2	Equipments	58.00	48.81
3	Information Technology	15.00	13.45
4	Library Books & Journals	25.00	24.97
5	Vehicle & Vessels	-	0
6	Furniture & Fixtures	7.00	7.00
	Total Capital (Grants for creation)	**140.00**	**113.17**
Grants in Aid- Salaries (REVENUE)			
	Establishment Expenses		
	Salaries	640.00	597.88
Grants in Aid- General (Revenue)			
1	**Pension & other Retirement Benefit**	**54.00**	**39.57**
2	**Travelling Allowance**		
	Domestic TA/ Transfer TA	25.00	25.00
3	**Research & Operation Expenses**		
	A. Research Expenses	124.84	124.83
	B. Operational Expenses	55.16	55.16
	Total- Research & Operation Expenses	**180.00**	**179.99**
4	**Administrative Expenses**		
	A. Infrastructure	76.26	76.26
	B. Communication	0.54	0.53
	C. Repair & Maintenance		
	i) Equipments, Vehicle & Others	2.26	2.26
	ii) Office Building	24.05	24.04
	iii) Residential Building	-	0
	iv) Minor Works	0.16	0.16
	D. Other (excluding TA) (instt.)	76.73	76.73
	Total Administrative Expenses	**180.00**	**179.98**
5	**Miscellaneous Expenses**		
	A. HRD within India	2.40	2.40
	HRD (Abroad)	-	-
	B. Other Items (Fellowship)	0	0
	C. Publicity & Exhibition	4.54	4.54
	D. Guest House Maintenance	0.21	0.21
	E. Other Miscellaneous	7.85	7.85
	Total Misc. Expenses	**15.00**	**15**
NEH (Capital)		8.00	8.00
NEH (Revenue)		7.00	6.98
Total NEH		15.00	14.98
TSP (Capital)		5.00	5.00
TSP (Revenue)		5.00	4.97
Total TSP		**10.00**	**9.97**
Total Revenue (Grants in Aid-Salaries + Grants in Aid-General)		**1119.00**	**1062.37**
Total Revenue + Capital		**1259.00**	**1175.54**

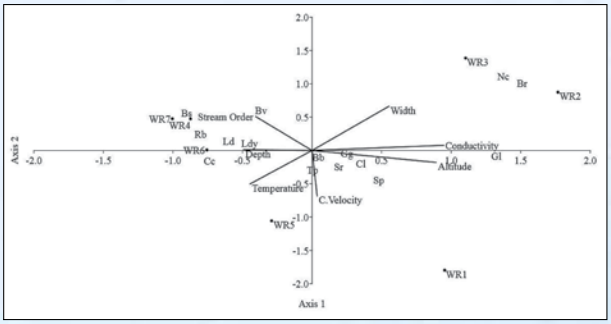
Research Achievements 3

3.1. Resource Assessment and Management

ICAR-DCFR has undertaken comprehensive initiatives towards scientific management of fishery resources and safeguard of coldwater habitats. Meticulous efforts of this Directorate include explorations of important endemic/local species for regularly updating fish biodiversity, habitat, ecology, biology, reproductive physiology and molecular characterization of commercially important species.

3.1.1 Ichthyofaunal diversity, habitat assessment and molecular characterization of important species from the selected Himalayan drainages

Habitat has become one of the most important concepts for managing the environment. The multiple uses of Himalayan drainages in terms of fisheries, hydropower generation, irrigation, ecotourism has necessitated its assessment and mapping for better management and sustainable exploitation. It is known that the diversity of species, both at ecological and molecular level, in a particular habitat is generally defined on the basis of different factors underplaying role in the dispersal and distribution of species in the ecosystem. The fish fauna present in any aquatic system are adapted to the different biotic and abiotic factors operating in the environment and are also sensitive to changes in multiple environmental factors. Apart from natural regulation of species distribution, human alterations to stream ecosystems also result in changes to community structure. In the present investigation, river Western Ramganga, Uttarakhand was selected for the study and attempts have been made to assess relationship of species with environmental variables. Quantitative data on fish species were collected from seven locations (WR1-WR7) at an altitude of 1026 to 755 m MSL in the mountain stretch of the river. Apart from this, different abiotic parameters including physical characters of the surveyed streams were also recorded. The association of species composition to environmental gradients was assessed using canonical correspondence analysis (CCA). It formed a linear combination of environmental variables that maximally separate the niches of the species. In the present study, composition of fish assemblages in different zones was found to be associated with abiotic factors on a spatial scale. The ordination diagram in the form of triplot represented species, sites and abiotic factors by points with respect to the supplied explanatory variables, represented by a line. The scatter plot showed that four environmental factors viz. temperature, conductivity, stream order and altitude significantly affected the distribution of the species. In the downstream sites species are mostly found associated with depth parameter and higher stream order, and those in the upstream sites are influenced by conductivity. The present study shows that abiotic factors have a significant influence in the organization of species assemblage in this river and therefore likely to be affected by any alteration in the habitat characteristics through anthropogenic



Canonical Correspondence Analysis (CCA) triplot depicting the relationship between all cyprinid species, study sites and environmental factors. Species code: Bb-*Barilius bendelisis;* Br-*Barilius barna;* Bv-*Barilius vagra;* Bs-*Barilius shacra;* Cl-*Crossocheilus latius latius;* Cc-*Chagunius chagunio;* Gg-*Garra gotyla gotyla;* Gl-*Garralamta;* Ld-*Labeo dero;* Ldy-*Labeo dyocheilus;* Nc-*Nezitor chelynoides;* Rb-*Raiamas bola;* Sr-*Schizothorax richardsonii;* Sp-*Schizothorax plagiostomus;* Tp-*Tor putitora*

interference. Golden mahseer (*Tor putitora*), an endangered species and popular game fish, as well as other vulnerable species at certain locations in this river need conservation through regulation and awareness programmes.

3.1.2 Habitat assessment and eco-biological study of selected mountain lakes of central and north eastern Himalayan regions

Present study was carried out to evaluate the seasonal changes in physico-chemical parameters of water and plankton diversity in four Kumaon lakes. Water samples were collected quarterly from three selected sites. Water quality parameters like DO, pH, temperature, free CO_2, TDS, conductivity, alkalinity, total hardness, calcium, chloride, iron, ammonium, silicate, phosphate, potassium, sulfate were estimated by standard methods (APHA,1999), Merck SpectroquantMulty® and HACH Turbidity Meter.

The planktons samples were collected from the 3 sites using plankton net (30 µm) on the surface at a minimum speed of a boat. Plankton samples were fixed in Lugol's solution and preserved for further analysis. Qualitative and quantitative evaluation of plankton from each site was carried out with the help of "Sedgwick Rafter" counting cell and by light microscopic observation following standard literature (APHA 1999).

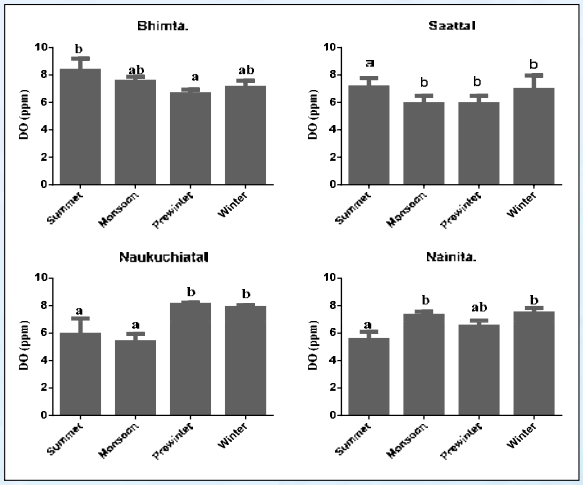
The analysis of plankton revealed significant dominance of Diatoms (Bacillariophyceae) such as *Navicula>Diatoma> Amphora >Denticula> Fragilaria>Pinnularia>Frustulia>Cosmarium> Cymbella* and Chlorophyceae such as *Volvox> Chlorella>Closterium>Cloadophora>Ulothrix* in this lake. In Bhimtal, the density of *Aphanizomenon* was found to be 1440 to 1750 × 10^3 ind/L indicating commencement of blue green algal bloom. Cyanophyceae, Chlorophyceae, Euglenophyceae and Silicoflagellates were the major groups of phytoplankton identified from this lake. Daphniidae and Cyclopoides were the important zooplankton families found, which showed possibilities of higher fish production in the lakes of Central Himalayas with some distinct variations.

The present investigation revealed that the value of calcium and sulfate were comparatively higher in Nainital lake, followed by Bhimtal (17-23 mg/l) and Sattal lake (3-12 mg/l). Similarly the temperature was higher in Sattal lake (23-27°C) and comparatively lower in Nainital lake (17–19°C). Significantly, high value of TDS and conductivity was found between the month of February and April. This was perhaps, due to the higher tropic level of the lake ecosystem compared to others. On the other hand, sewage water which are received from the catchment areas, influenced significantly on the quality of water in the lake. Alkalinity, hardness and conductivity were found to be high which may influence the gonadal status of this species.

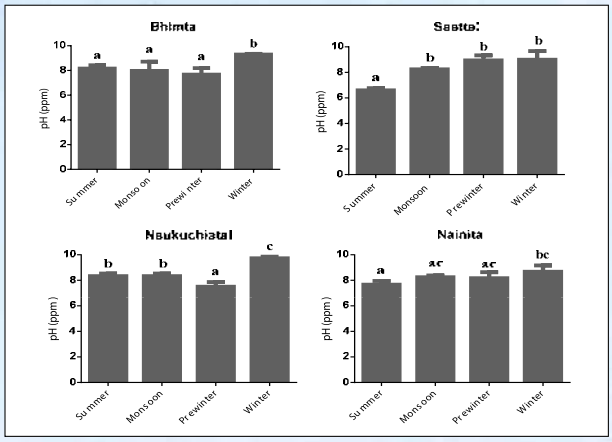
Table : Different plankton species found in flour lakes (Bhimtal, Sattal, Naukuchiatal, Nainital) of Kumaon region

Spicies	Bhimtal	Sattal	Naukuchiatal	Nanital
Fragillaria	+	+	-	-
Nitzschia	+	-	-	-
Microspora	+	-	-	-
Golenkinia	+	-	-	-
Oedogonium	+	-	+	-
Anacystis	-	+	+	-
Brachionus	-	+	+	-
Aphanizomenon	+	-	-	-
Pediastrum	-	+	-	+
Closterium	-	-	+	-
Merospora	-	-	+	-
Navicula	-	-	-	+
Volvox	+	-	-	+

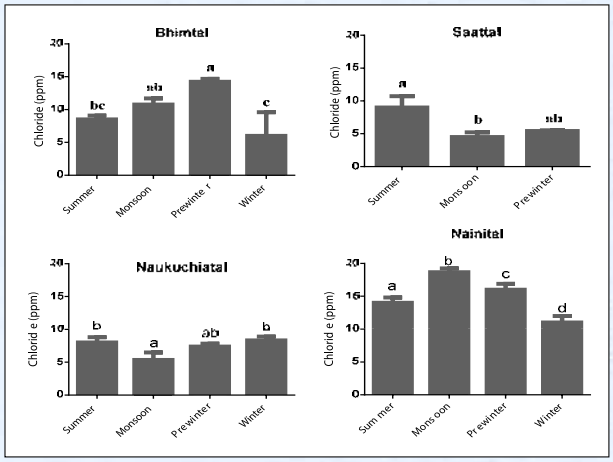
Comparison of seasonal variation of different parameters between four Kumaon Lakes



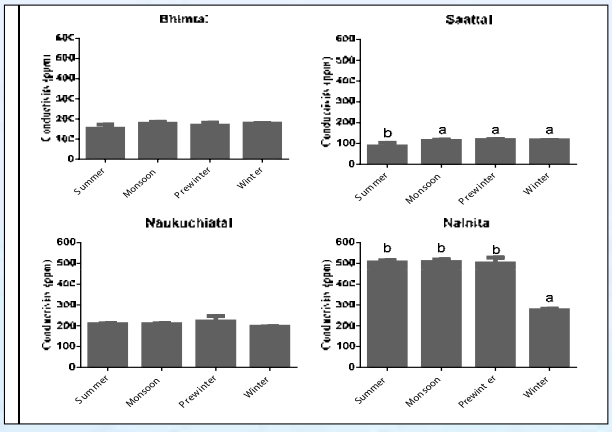
- The seasonal DO trend was similar in Bhimtal and Saattal lake.
- In Naukuchiatal lake the DO value was found to be minimum in monsoon and maximum in prewinter.



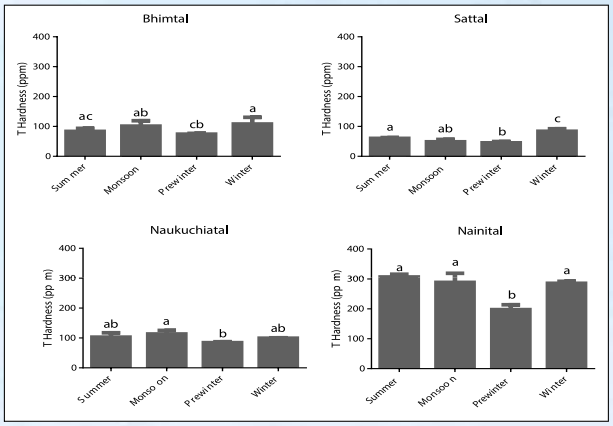
- The trend of pH in Bhimtal and Naukuchiatal, while those of Saattal and Nainital had the similar pattern.
- Naukuchiatal had the highest value of pH in winter among all the season and also among all the lakes.



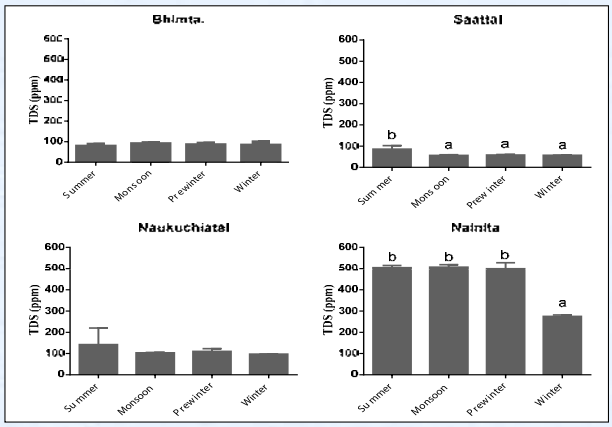
- The value of chloride in Nainital lake was maximum in winter and minimum in summer.



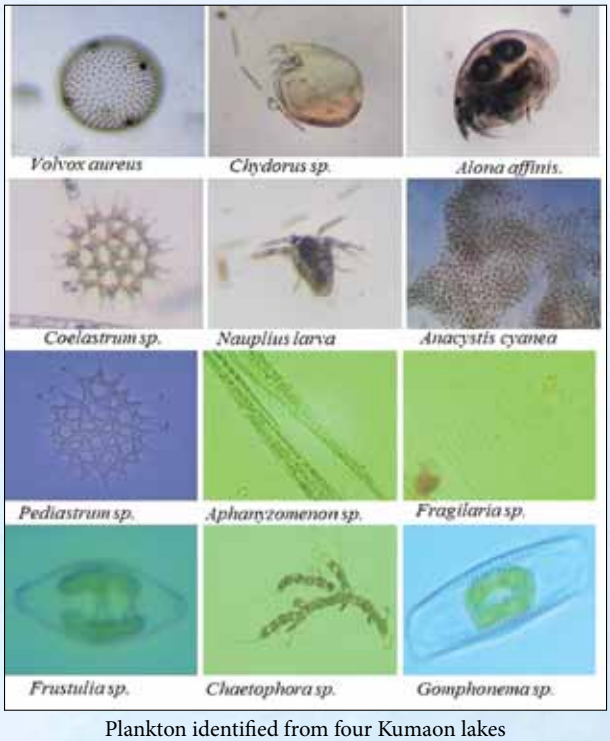
- Tha seasonal pattern of conductivity was more or less same in 3 lakes (Bhimtal, Saattal and Naukuchiatal)
- The seasonal pattern of Conductivity was more or less same in 3 lakes (Bhimtal, Saattal and Naukuchiatal).
- Nainital showed the maximum values in all the seasons among all the lakes round the year.



- Nainital showed the maximum values of total hardness in all the seasons among all the lakes round the year. Maximum value was found in Nainital in Summer (100 ppm) and minimum value was found in prewinter (83 ppm).



- The seasonal pattern of TDS was more or less same in 3 lakes (Bhimtal, Saattal and Naukuchiatal).
- Nainital showed the maximum values in all the season among all the lakes round the year.



Plankton identified from four Kumaon lakes

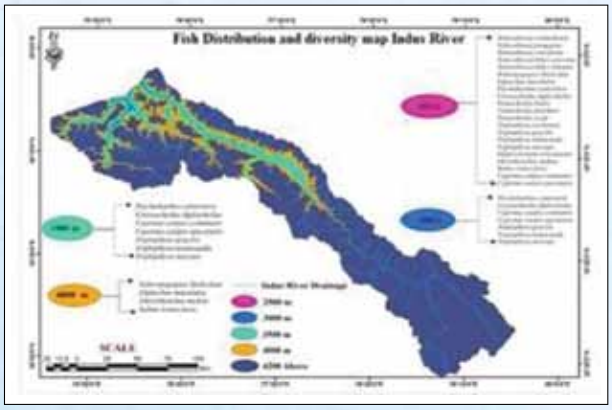
A new species of copepods (Arthropods), *Arctodiaptomus shaikhomensis* was collected and identified from a lake (Lake Maheshwarkund) of Central Himalaya by Dr. Debajit Sarma and Dr. Shaikhom Inaotombi (NPDF). The specimen was reposited to Central Entomological Laboratory (C. E. L.), Zoological Survey of India (ZSI), New Alipore, Kolkata, India.

3.1.3 Study on development of spatial database of coldwater fishery resources in Western Himalayan region

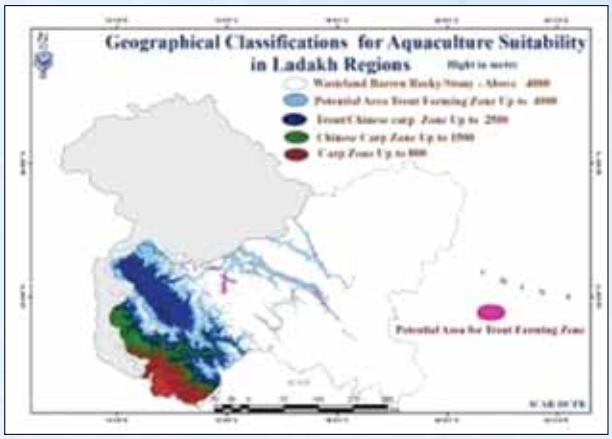
Preparation of land use land cover map of Ladakh region (Process): Ladakh region consist of two districts; Leh and Kargil; the satellite map was classified into known classes based on the spectral signatures and field truth data. It was observed that 99.68 % of the land is wasteland in Ladakh region and only 0.32 % land is available for agriculture activities.

Preparation of habitat/distribution maps: Prepared habitat/distribution maps of ichthyofaunal resources from major drainages (Indus, Shyok, Zanskar and Jhelum) of Jammu & Kashmir, (Sutlej, Beas, Raavi and Chenab) of Himachal Pradesh and (Alaknanda, Mandakini, Pinder, Bhagirthi & Ramganga) of Uttarakhand.

Prepared map of geographical classification: Water temperature and suitability of site are directly proportional to the altitude of the geographical boundaries. It differs from state to state. Based on observations of water quality and altitudes the 3D maps were classified district and state wise and were mosaicked to get a single image. In order to easelocating suitable sites the geographical



Fish distribution & diversity map of Indus river



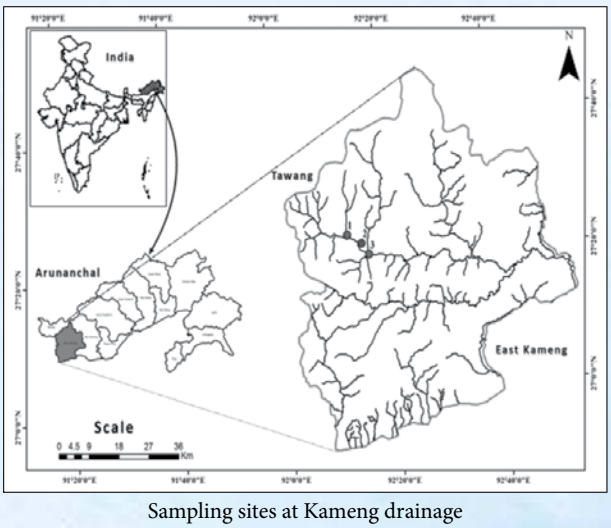
Geographical classification of aquaculture site suitability in Ladakh region

boundaries were classified for rough estimation of site selection.

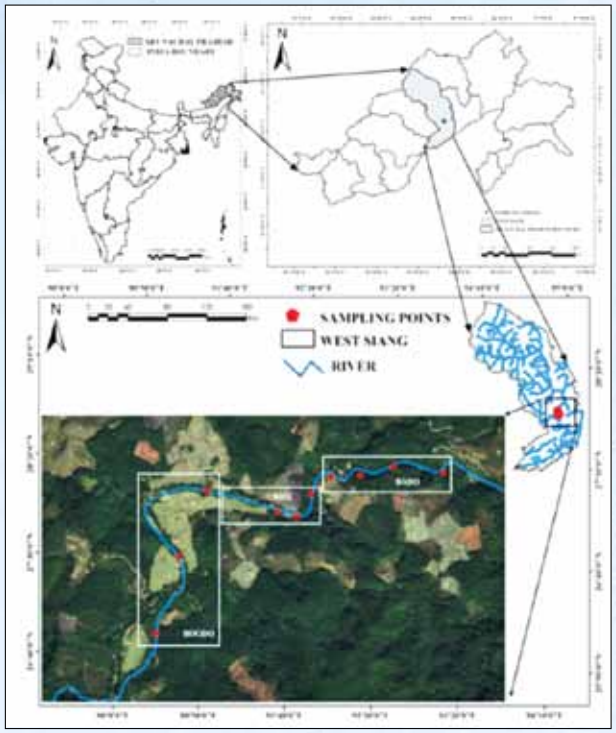
3.1.4 Assessment of population status, species diversity and habitat ecology of snow trout, *Schizothorax* species in selected streams of Indian Himalayan Region

Regular samplings were done in snow-fed tributaries namely, river Dirang *chu* (27.3537^{O}N, 92.2506^{O}E), river Sangti (27.3517^{O}N, 92.2681^{O}E) and river Tenga (27.2186^{O}N, 92.43^{O}E) of Kameng drainage in West Kameng district and river Shei of Siang drainage in West Siang district (28.15-29.15^{O}N; 94.0-95.0^{O}E) of Arunachal Pradesh. The sampling sites were located in high to mid altitudinal terrains of Eastern Himalayas, situated at 1411-1512 m msl (Kameng drainage) and 594-787 m msl (Siang drainage).

The average length of snow trouts was recorded as 24.16±6.17 cm with an average catch size in

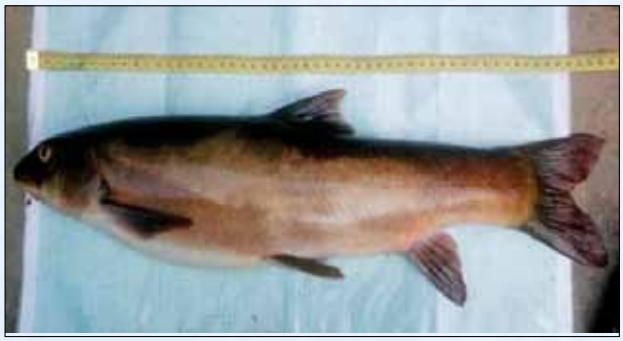


Sampling sites at Kameng drainage



Sampling sites at Siang drainage

weight of 161.2±102.22 g during the investigation. The most dominant species of snow trout identified by morphometric characters and meristic counts in Kameng drainage were *Schizothorax richardsonii* and *Schizothorax plagiostomus* whereas *Schizothorax progastus* and *Schizothorax richardsonii* dominated in the Siang drainage.



A catch of snow trout weighing 1.2 kg and 52 cm in length in upland rivers of Kameng drainage, Arunachal Pradesh during 2017

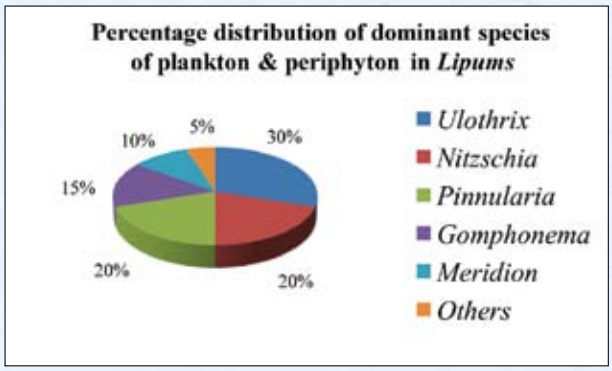
Snow trout samples were collected by noose and line method practised by local fishermen of Kameng drainage whereas samples in Siang drainage were collected from fish aggregating structures, locally known as *Lipum*. Both these techniques of catching snow trout are ancient traditions and were found to have a sustainable way of harvesting riverine resources without damaging the river habitat. The wider objective of using these methods is to conserve the aquatic biota in terms by prohibiting destructive fishing methods *viz.*, dynamites, homemade electro-fishers, poisons and chemicals on river Shei.

Fishing snow trout by noose and line method in Kameng drainage

Fishing of snow trout by Lipums in Siang drainage

Analysis of the major ecological parameters of these water bodies concluded a conducible habitat for the snow trout in the region. The water temperature remained 11.42±0.04-14.09±0.08°C; pH (7.32±0.02); dissolved oxygen (8.43±0.22 ppm); TDS (8.0±0.02 - 25.0±1.12 ppm); alkalinity ranged from 18.33±0.58 mg/L (Kameng) and 34.00±2.10 mg/L (Siang); Hardness 15.0±1.0 mg/L (Kameng) and 32.33±1.15 mg/L (Siang); ammonium (<0.01 mg/L); Nitrate (3.93±0.15 mg/L); Nitrate (11.0±1.0 mg/L); Phosphate (0.11±0.005 mg/L); Sulphate (<0.02 mg/L); Chloride (<2.5 mg/L); Magnesium (<5.0 mg/L); Calcium 17.33±1.53 µg/L (Kameng) and 20.0±1.0 µg/L (Siang); Iron <0.01 mg/L (Kameng) and 0.12±0.01 (Siang); Cadmium (<5.0 µg/L); Zinc (<0.20 µg/L); Copper (<0.05 µg/L).

Analysis of plankton communities in the rivers of Kameng drainage shows 28 species of planktons belonging to 23 families, 18 orders and 8 classes. Plankton communities collected from *Lipums* showed 5 major types of planktons and periphytons.

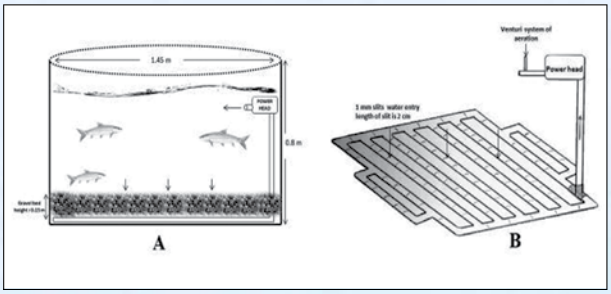


3.2 Aquaculture Research and Development

ICAR-DCFR is continuing its efforts to enhance fish production and promote conservation related hill aquaculture with more emphasis on breeding and captive management of important endemic coldwater fish species. Complete domestication and standardization of culture practice forms the thrust areas of the aquaculture oriented research projects of this Directorate.

3.2.1 Photo-thermal manipulation for gonadal maturity of golden mahseer in captivity

In the previous experiments, we found that optimal photoperiod and elevated temperature distinctly imparted a positive effect on gonadal maturity of golden mahseer under captive conditions. However, we could not achieve captive spawning under the said conditions of these two experiments. This was probably due to fact that golden mahseer being a lithophil and prefers to spawn on water beds with a proportionate mixture of gravels and sandstones in the wild by making nesting pits. Hence, a pilot experiment was conducted to test the possibility of captive spawning in a FRP tank installed with gravel bed-biofilter and provided with optimum photoperiod and temperature. For this purpose, a circular navy blue coloured FRP tank (0.8 m height, 1.45 m diameter, and ≈1.3 m^3 capacity) was used. For the bed-filter, a plumbing design was made as shown in the figure below by connecting a series of parallel PVC pipes (~25 mm diameter) using elbows and T joints. The gravel bed bio-filter simulated natural spawning bed and at the same time helped in maintaining water quality comparable to their pristine natural habitats. A total of 5 numbers of adult golden mahseer (3 ♀s and 2 ♂s; average weight: 1.1 ± 0.12 and 0.82 ± 0.08 kg, mean ± SD respectively) were collected from cement cistern ponds of ICAR-DCFR, Bhimtal (which were wild collected and reared in these cemented ponds for over one year) and stocked into the experimental FRP tank. The water temperature was maintained at 25.36 ± 0.69°C using two thermostatic water heaters (300 W) submerged in the tank itself. Continuous aeration using air compressor as well as venturi system aeration of power heads was provided in the tank to ensure optimum dissolved oxygen level and the tank was covered with 8.0 mm mesh nylon net to prevent fishes from jumping out. An egg collection

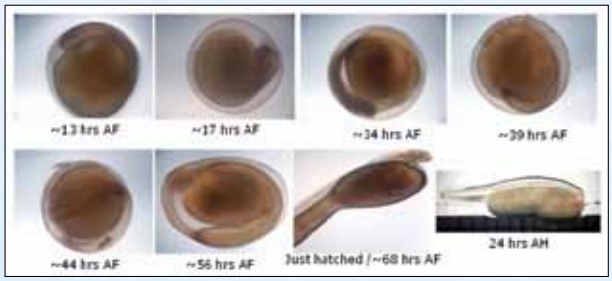


(A) Gravel bed-biofilter installed circular FRP tank used in experiment III. (B) The schematic diagram of the bio-filter made of PVC pipes. Slits of 1.0 mm width and 2.0 cm length were made for entry of water. The 'arrows' indicate the direction of water flow through the gravelbed and pump. Thedistance between two parallel pipes was kept at 15 cm.

tray was provided using airlifting mechanism to indicate any spawning event. The tank was kept in the wet lab of ICAR-DCFR and a photoperiod of

12L:12D again was maintained using a 35 watt CFL bulb. Fishes were fed *ad libitum* twice daily (10.00 and 17.00 hrs) with DCFR's formulated broodstock diet. A water flow of 6-7 L/hr was also maintained in the tank to further ensure the quality of water. Approximately 60% water was exchanged through siphoning of bottom once every 15 days to remove organic matter, nitrate and maintain alkalinity. This pilot experiment was continued from May, 2017 to January, 2018.

After four months of rearing of the brooders, we were able to retrieve 113 fry of golden mahseer from the tank on 19th September, 2017 because few larvae were collected in egg collector check-tray. The fry were advanced and probably the spontaneous spawning might have taken place in the first week of September, 2017 itself. We could not observe the first spontaneous spawning probably because the eggs were demersal and settled down at bottom and after fertilization became transparent making it invisible in the crystal clear water of the tank. The retrieved fry were kept in a glass aquarium having temperature similar to the tank from where they were retrieved and fed with egg yolk twice daily and growth was monitored. On 19th September, 2017, we injected ovatide @ 0.5 ml/kg body weight to females and @ 0.15 ml/kg body weight to males just to see whether it responds to induced spawning or not. Positively, after 12 hrs of injection, the brooders spawned. Some eggs were collected and incubated at 25.21± 0.55°C and we studied the developmental events.



Embryonic development of golden mahseer from captive matured and spawned brooders

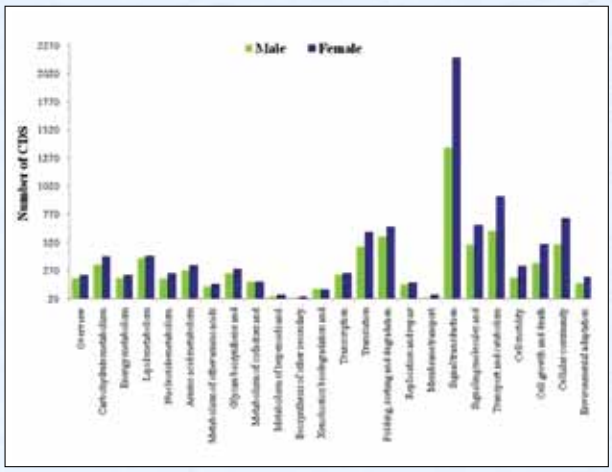
Further, on 30th September, 2017, we retrieved 132 fry and kept them in a thermo-regulated aquarium for monitoring their growth. The incubation period was found to be 68-74 hrs and average length at hatching was 11.36 ± 0.54 mm (Mean ± SEM, n = 6). Yolk-sac absorption was completed 7-8 days after hatching. After 15 days of second (induced) spawning, brooders again spawned on 6th October, 2017 without any hormone administration. The occurrence of further spontaneous spawning by the fishes was observed on 14th November, 3rd & 21st December, 2017 and 7th January, 2018. So far brooders spawned seven times spontaneously within a period of 4 months on an interval of 15-20 days.

3.2.2 Molecular characterization and gene expression profiles of kiss genes in golden mahseer during different gonadal development stages

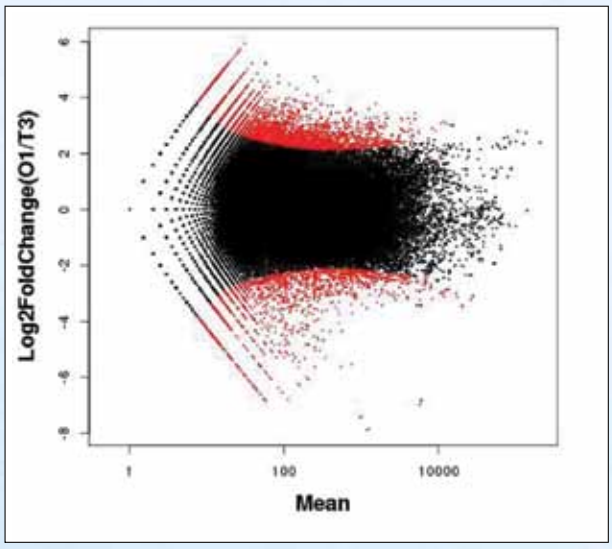
Livestock of adult and juvenile, male and female golden mahseer collected from Bhimtal lake, Sattal lake and various rivers were maintained in cement raceways of DCFR, Bhimtal for functional analysis of Kiss1 and Kiss2 synthetic peptides. Additionally, to understand the molecular mechanism of gonad organogenesis and reproduction in golden mahseer, 20.6 and 21.5 million raw reads were obtained from two cDNA libraries generated from the brain of sexually matured male and female fish, respectively by RNA-Sequencing (RNA-Seq) using Illumina paired-end (PE) platform. The raw sequence has been deposited in Sequencing Read Archives (SRA) at NCBI with accession number SRP095582 under Bio project accession PRJNA358460. The male and female brain samples were listed under individual experiment accession number of SRX2464224 and SRX2442156, respectively. From male and female brain 39,047 and 75,736 numbers of unigenes were identified, respectively, of which 26,252 (male) and 33,446 (female) showed homology to existing protein sequences in the database. Clusters of Orthologous Groups (COG), Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genome (KEGG) analysis indicated that many of these genes encoded for proteins related to gonad development, sex differentiation, germ cell development, sex steroids and reproduction. There were 287 numbers of potential sex differentially expressed reproduction related unigenes, of which 153 numbers of genes

were up-regulated in the male brain, whereas in female brain 134 numbers of genes were up-regulated.

RNA-Sequencing was also carried out on ovary and testis of sexually matured adult golden mahseer, collected from wild. Differential expression of several sex and reproduction related gene was observed in gonad cells of spermiating and ovulating golden mahseer. In ovary, 5863 genes and in testis 4485 genes were found to be up-regulated in golden mahseer. Overall, 18,7443 genes were found to co-expressed in gonad of both the sex. GO identify 14,831 genes in biological process, 5,583 genes in cellular component and 7,423 genes in molecular functions.



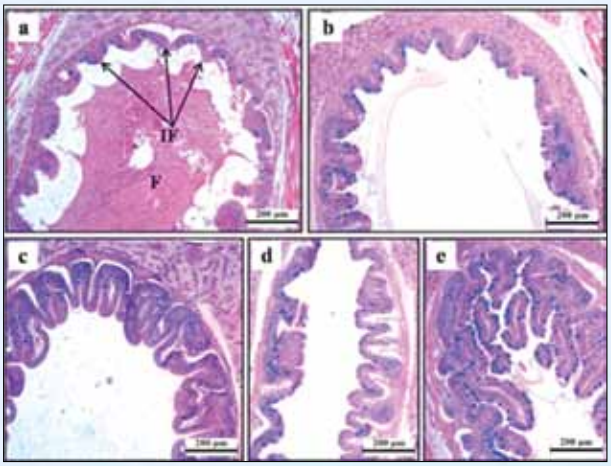
KEGG categories for brain CDS of sexually matured male and female golden mahseer



Changes in gonad of sexually matured male and female golden mahseer

3.2.3 Devising a feeding regimen based on return of appetite in golden mahseer (*Tor putitora*) larvae/juvenile

Novel histology based appetite markers were screened and identified in golden mahseer (*Tor putitora*) juveniles. For this, 45 and 90 days post hatching (dph) juveniles were taken up for screening of appetite markers. Some interesting histophysiological changes such as goblet cell dynamicity (esophagus, fore, mid and hindgut), distention of gut, pancreatic zymogen granule, and supra-nuclear vesicles in hindgut were found as potential markers. At 6 hrs, goblet cell numbers in esophagus was found to be drastically lower compared to all other time of observation, and the gradual building up of the same occurred after 12 hrs. Foregut distention was found to be started at 1 hr; peak was found at 6 hrs, and after that constriction continues until 24 hrs. A gradual progression in density and size of supranuclear vesicles in hindgut were observed between 6 to 12 hrs of feeding, and in 18 to 24 hrs, the same were found to be progressively decreasing. Maximum reduction in pancreatic zymogen granule was seen at 6 hrs of post feeding, following that, the granulation was found to be increasing gradually at 12, 18, and 24 hrs of feeding.



Photomicrographs of foregut of 90 days post hatched (dph) of golden mahseer sampled at 1 (a), 6 (b), 12 (c), 18 (d) and 24 hrs (e) of post feeding. Arrows indicate intestinal fold (IF). There is a significant loss (b) of IF in terms of height and frequency at 1 hr, as a result of bulk of food (F) in the gut. Refolding of gut and repopulation of goblet cells (alcian blue positive blue colored cells in mucosa) start at 6 hrs (c), and progressively increase until 24 hrs (e). Gut is completely distended at 1 (with food (F) in it) and 6 hrs, and from 6 to 12 and 18 to 24 hrs constriction increased sharply. Staining: hematoxylin, eosin and alcian blue.

Overall, the observation revealed that, in natural environment, digestion in golden mahseer juvenile peaks at around 6 hrs of post feeding and absorption of macromolecular protein last from 6 to 12 hrs. Based on interplay of these identified appetite markers, it was concluded that digestion apparatus in these fish starts to reorganize and get ready for second meal after 6 hrs of post feeding.

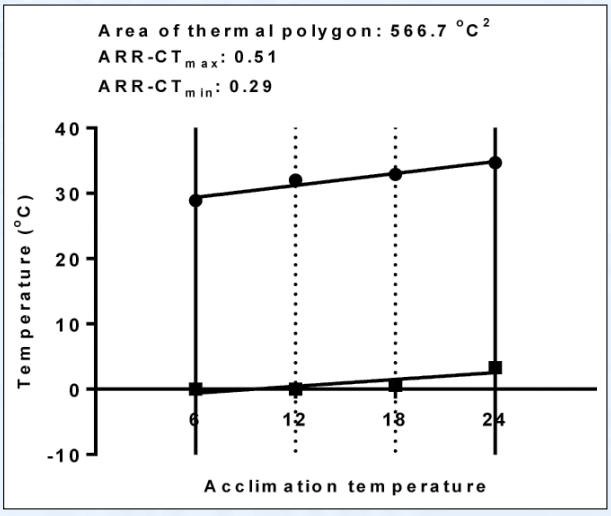
3.2.4 Decoding the constraints in growth, maturation and captive management of snow trout (*Schizothorax richardsonii*, Gray, 1832)

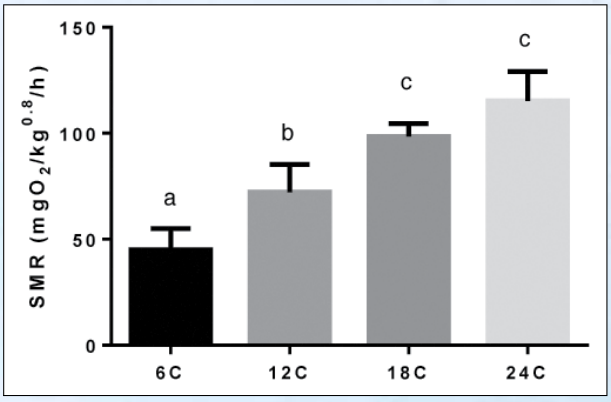
In the context of global warming and climatic shifts, the adaptive capacity of fish in terms of thermal tolerance and aerobic performance will govern their feed intake, assimilation, metabolism, growth, survival, distribution and abundance in their natural habitats. Shifting of fish from its natural habitats and rearing in captivity necessitates proper management and understanding of all the requirements of the fish. Inclusion of snow trout (*Schizothorax richardsonii*) in hill aquaculture is hampered by critical factors such as slow growth, early maturity and lack of captive management protocols. Therefore, the following sub-projects originated to decode the constraints in growth, maturation and captive management of this species.

3.2.4.1 Central and peripheral regulation of feed ingestion and nutrient uptake in snow trout, *Schizothorax richardsonii*

In the present study we investigated the shifts in thermal, oxygen and metabolic thresholds of the Indian snow trout, *Schizothorax richardsonii* under different natural seasons and laboratory based thermal acclimation regimes. In the first experiment, wild snow trout individuals (avg. wt. 13.8 ± 4 g) collected during different perceived seasons (autumn, winter and spring-summer) were immediately examined for critical thermal limits (CT_{max}, CT_{min}), oxygen thresholds (ILOS, ILOC, P_{crit}), aerobic performance (SMR, MMR, AS) and blood chemistry (haemoglobin, haematocrit and blood glucose). In the second experiment, wild collected snow trout (avg. wt. 10.2 ± 0.13 g) were transferred to laboratory conditions and maintained at four different temperatures (6, 12, 18 and 24°C; 40 fish/tank/temperature) for a 10-week period. At the end of the thermal acclimation period, all the above-mentioned thermal, oxygen and metabolic indices were measured along with growth and tissue indices. In general, the results indicated that CT_{max}, CT_{min} and SMR showed linear changes with thermal history in wild and laboratory conditions. CT_{max} and CT_{min} ranged from 0 to 34.7°C (thermal polygon area of 566.7 - 587.7°C^2), suggesting that

Experimental set-up for CT_{min} analysis



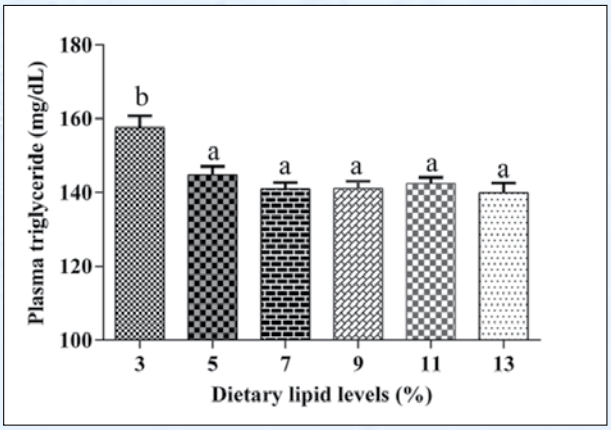


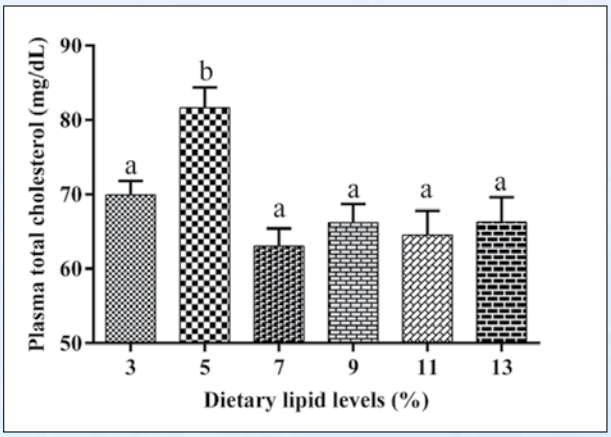
this species may have a reasonably good range of acute thermal tolerance. Maximum growth, HSI, RGL and aerobic scope (by trend) was found at 18°C, indicating a potential thermal optimum near this temperature. The oxygen threshold (P_{crit}) and incipient lethal oxygen limits was better in the autumn season and poor at higher acclimation temperature. Haemoglobin and haematocrit levels in the blood reduced at low temperatures (higher DO saturation) in the wild as well as laboratory condition. MMR and AS showed an increasing trend with acclimation temperature and plateaued at 24°C, whereas an intriguing decrease was also observed in spring-summer season. Overall, through this study we deciphered the thermal, oxygen and metabolic limits of *Schizothorax richardsonii*, which indicate the extent of their physiological ability to adapt to temperature shifts in natural and simulated environment.

3.2.4.2 Nutrient mediated metabolic regulation of growth and well-being in snow trout *Schizothorax richardsonii*

In order to assess the health and well-being status of snow trout (*Schizothorax richardsonii*), five samplings were carried out during the months of June, September and November, 2017, February, 2018 and April, 2018. Nearly 400 snow trout were collected from the Chaffi, Nainital area of river Gola and Sipra (Bhowali range). Electro-fishing was employed for fish collection. The transportation stress and mortality was minimized using oxygen packing. They were acclimated and maintained in the wet laboratory for assessing the health and well-being indices such as anti-oxidative stress enzymes, metabolites, lysozyme activity and myeloperoxidase activity from plasma samples. For this, in each season, a total of 8 fishes were euthanized and blood was collected to get plasma. Plasma samples are stored in -80°C. The health and well-being indices will be analyzed soon. To assess the size/age dependent growth of snow trout, three size/age groups *viz.* 0+, 1+ and 2+ were collected from wild. Tissue samples such as liver and muscle were collected for analysis of growth and metabolism correlating enzymes like cytochrome C oxidase, ornithine decarboxylase, pyruvate kinase.

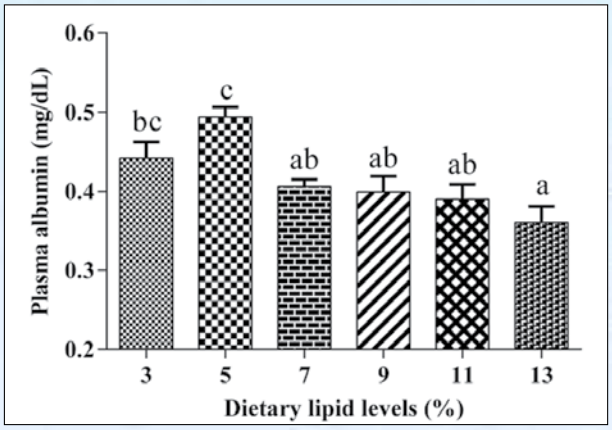
A 68-days feeding trial was carried out in the wet laboratory of ICAR-DCFR to study the effect of graded level of dietary lipid (3%, 5%, 7%, 9%, 11% and 13%) on metabolism in *Schizothorax richardsonii*. Diet contained fish-meal and soybean meal as protein source, soyoil and fish oil as lipid source and wheat flour as carbohydrate and filler source, carboxymethyl cellulose as a binder and vitamin & mineral mixtures specifically prepared for snow trout based on requirement of carp and rainbow trout. Plasma and tissue samples were collected and stored at -80°C for further analyses of different enzyme and expression of metabolic genes. Plasma triglyceride and plasma globulin levels were significantly higher in 3% lipid fed group compared to the other entire lipid fed groups while there was no significant effect of dietary lipid levels on the plasma glucose levels of snow trout.





Plasma cholesterol level was significantly higher in 5% lipid fed group compared to the other

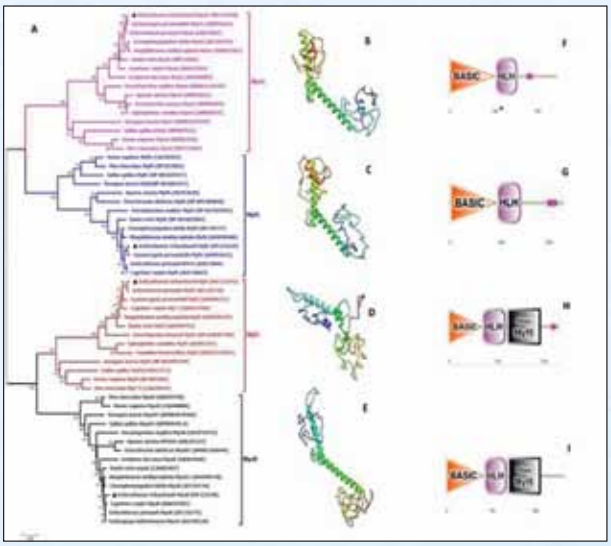
entire lipid fed groups. Plasma total protein was significantly higher in 3% lipid fed group and lowest in 9% lipid fed group. Plasma albumin level was significantly higher in 5% lipid fed group compared to the other entire lipid fed groups and lowest level was observed in 13% lipid fed group.



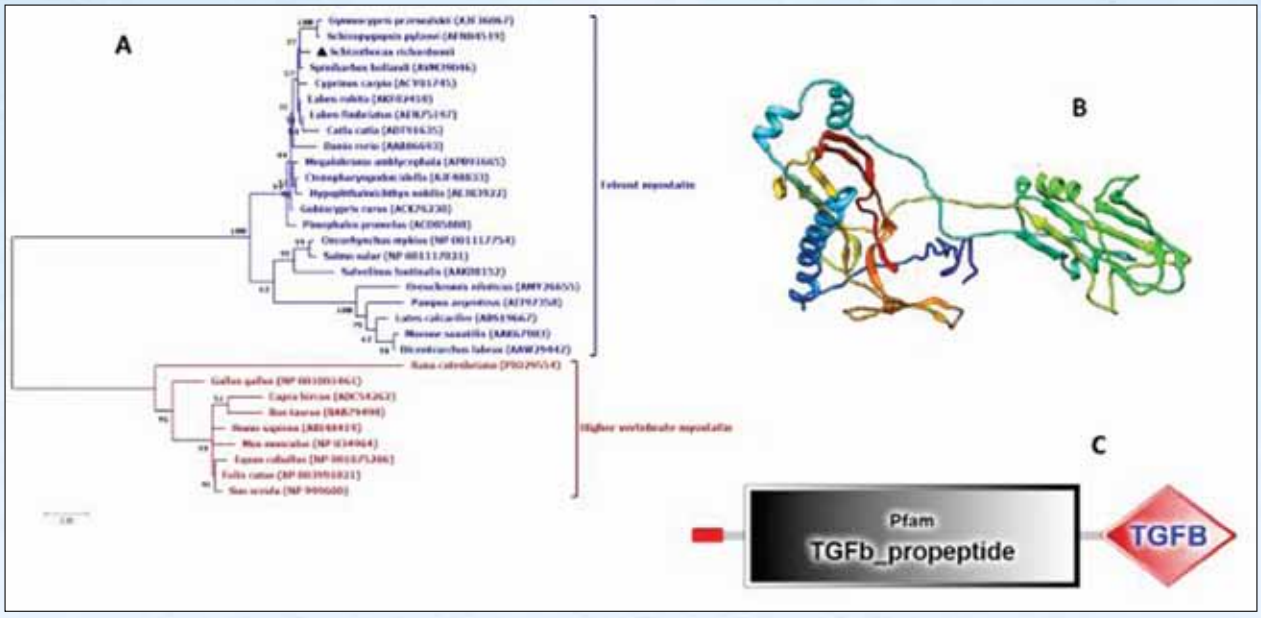
A 100-days experiment was conducted to study the effect of different levels of dietary proteins on the metabolic responses of snow trout. One hundred seventeen snow trout juveniles (average size 23 g) were randomly distributed into three treatment groups in triplicates (13 fishes in each replicate of 100 L rectangular plastic tanks) in a flow-through system following completely randomized design. The treatment groups were based on varying dietary protein levels viz. 25%, 35% & 45%. Fishes were fed twice a day @ 2% of their body weight with their respective diets. The water temperature during the experiment varied from 17-20°C. Other water quality parameters viz. pH, DO, CO_2, alkalinity and ammonia were monitored periodically and were found within safe limits throughout the experimentation. Sampling was done at the end of 100th day after 12 hrs of fasting/feed deprivation and plasma and tissue samples were collected for biochemical and gene expression analysis.

3.2.4.3 Myogenic regulation and protein turnover of muscle growth in snow trout *Schizothorax richardsonii*

To understand the muscle growth mechanism in slow growing cyprinid *Schizothorax richardsonii*, four myogenic regulatory transcripts namely *myod*, *myf5*, *myogenin* and *myf6* and a negative growth regulator *myostatin*1 (mstn1) were completely characterised. The full length nucleotide sequence of *Srmyod, Srmyf5, Srmyog*, *Srmyf6* and *Srmst1* was 1639, 1329, 1437 1296 and 2109 bp long, with an ORF of 825, 723, 762 720 and 1128 bp, encoding a putative protein of 275, 240, 253 239 and 375 amino acids, respectively. Phylogenetic analysis of *S. richardsonii* MRFs reflects their close evolutionary link to other cold water cyprinids which are endemic to northern part of the Himalaya. Structure prediction and domain analysis suggests the presence of conserved basic helix loop helix domains in four MRFs protein (*Srmyod, Srmyf5, Srmyog, Srmyf6*) which is essential for DNA binding and these proteins were mainly localised to nucleus. While *Srmstn1* was mainly localised in cytoplasm and contained a transforming growth factor beta propeptide and a functional TGFb peptide domain and predicted three dimensional structure suggests that they contained 5 helix and 15 beta sheets. These sequence information will be useful to study their expression pattern during the growth phase of the fish which is essential to understand the growth physiology of *S. richardsonii.*



Phylogenetic analysis of *Schizothorax richardsonii* MRFs (MyoG, Myf6, Myf5 and MyoD) with other teleost and higher vertebrate MRFs (A). Predicted protein structure of MyoG (B), Myf6 (C), Myf5 (D) and MyoD (E). Domain analysis of Myog (F), Myf6 (G), Myf5 (H) and MyoD (I).

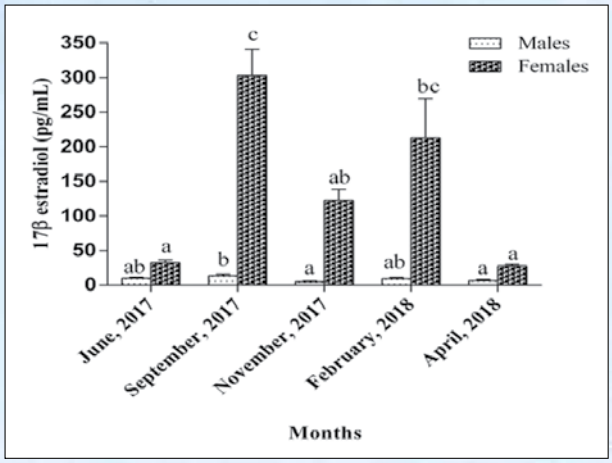


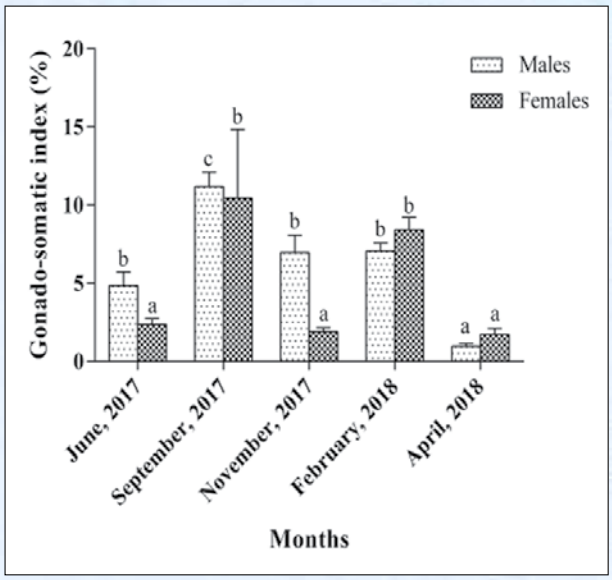
Phylogenetic analysis of *Schizothorax richardsonii* MRFs (MyoG, Myf6, Myf5 and MyoD) with other teleost and higher vertebrate MRFs (A). Predicted protein structure of MyoG (B), Myf6 (C), Myf5 (D) and MyoD (E). Domain analysis of Myog (F) , Myf6 (G) , Myf5 (H) and MyoD (I)

3.2.4.4 Endocrine aspects of growth and maturity of snow trout, *Schizothorax richardsonii*

To understand the endocrine regulation of growth in snow trout, the mRNA sequences of major regulatory components of growth axis namely GH, its receptor (GHr) and IGFs were characterized. Sequence analysis of GH from pituitary revealed a partial open reading frame (ORF) of 593 bp nucleotides. While hepatic GHr expressed in two probable isoforms where one of the isoforms consisted of a 5'UTR of 280 bp and partial ORF of 981 bp encoding 327 amino acids. The presence of two different isoforms of GHr may be attributed to multiple physiological functions of GH. Insulin like growth factor 3 (IGF 3) was cloned from ovary and was found to have a partial ORF of 303 bp encoding 101 amino acids and a 3' UTR of 536 bp. This gonad specific IGF 3 has been reported recently in limited number of fish species and its role in regulation of growth is not clearly established so far. But its role in ovarian functions particularly oocyte maturation is well elucidated. Similarly, we have cloned and partially characterized hepatic insulin like growth factors 1 and 2. The nucleotide sequence of snow trout GH-IGF axis shows similarities with *Labeo rohita*, *Cyprinus carpio*, *Carassius auratus* and *Danio rerio*. The present results can be used for the expression studies of the above genes to address the slow growth phenomenon of *S. richardsonii*.

Further, to assess the maturational status of snow trout, five samplings (covering all five seasons) were carried out during June, September & November months of 2017 and February & April months of 2018. Nearly 300 snow trout (*Schizothorax richardsonii*) were collected from Kalsa rivulet in the Chaffi stretch of river Gola situated in Kumaun hills of Uttarakhand, India. They were acclimatized and maintained in the wet laboratory for assessing the maturational status. For each season, six males and six females were chosen from the total fish caught, euthanized and blood was collected to assess different reproductive hormones. The fishes were dissected for further sex confirmation and the gonads were removed, weighed to calculate the gonado-somatic index (GSI, gonad weight/ body weight ×100). Ovary samples were fixed in Bouin's solution while testes samples were fixed in 10% neutral buffered formalin (NBF) solution for gonadal histology. Additionally, brain and gonad tissues were collected aseptically in RNA later to study the expression of aromatase (brain and gonadal cyp 19) genes. Gonadal histology and plasma sex steroids clearly indicate two pronounced spawning seasons: September to early November and February to March.





Gonado-somatic index and plasma 17β estradiol levels during different seasons

3.2.4.5 Development of captive management protocols and seed production technology for snow trout *S. richardsonii*

To improve the snow trout seed quality, brooders raised in farm and collected from wild were used for stripping. Snow trout of river Gaudi showed female-male sex ratio of 1:6-8 while Chalthi river stretch showed 1:5-6. The brooders were kept in captive condition at Champawat farm raceways under flow-through conditions with stocking density of 25-30 nos./m^2 and flow rate of 15-20 litre/min. Farm made feed fortified with rice bran, oil cakes and vitamin-mineral mix were prepared and fed @ 5-8% of their total body weight. Breeding of snow trout was undertaken during 1st week of October, 2017 with dry stripping in two phases. 11 nos. of females (size range: 205-270 mm & 97-182 g) and 17 nos. of males (size range: 160-230 mm & 26-112 g) with male/female ratio of 1:1-1.5 in their body weight and 1:2-3 in numbers were used for the purpose. Breeding was delayed by three weeks which may be due to collective effect of inhabited environmental parameters and climatic alterations. Hatching was observed within 110-125 hrs of post fertilization at water temperature range of 18.8-19.1°C. Yolk sac absorption occurred during 96-192 hrs at water temperature 17.9-18.6°C. Fertilization and hatching rate was found to be 65-72% and 40-45% respectively. Total 7630 nos. of fry were produced with functional fecundity range 1092-1924 nos./individual. Developmental stages of embryo and larvae were studied under microscope. The size of fry on 1st week of December-2017 was 12.65±0.412 mm in total length and 0.008±0.001 g in body wt. During the incubation period, developing eggs were treated with formaldehyde twice a week for half an hour as prophylactic measure to prevent the attack of fungal infections. For fish germplasm exploration and stock development purpose, approximately 5500 fry have been collected from Kali and Saryu river at Pancheswar, the meeting point of the two rivers. Survey of local Gaudi river for obtaining maturity status of brooders in wild, showed that early fry were available in stream water from September onwards.

Schizothorax richardsonii brooders

Schizothorax richardsonii fry

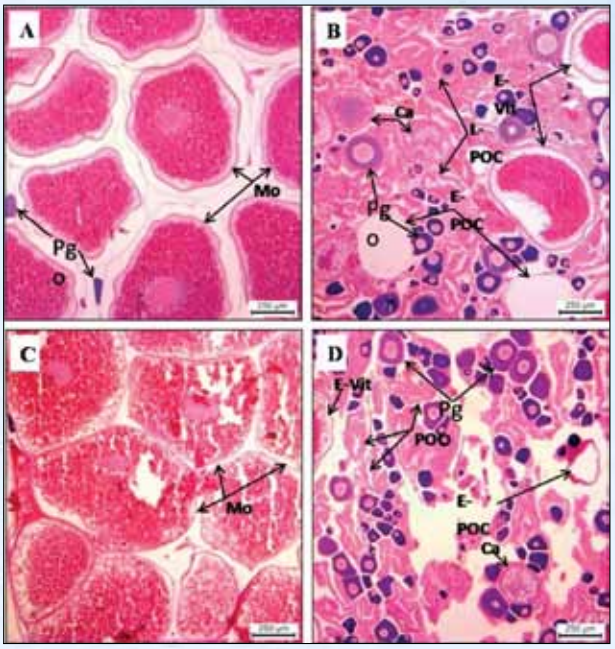
3.2.5 Domestication, biology and captive breeding of Indian trout *Raiamas bola* (Hamilton, 1822)

Developed captive breeding protocol for Indian trout, *Raiamas bola*: This species has good ornamental and food value having attractive body appearance. As per IUCN (2014) the species has been categorized under 'Least Concern' but the population of this species is declining. Captive breeding protocol has been developed at water temperature of 18 - 22°C with 40-50% recovery of fry. Findings of the study would be helpful for conservation, rehabilitation and ornamental purpose. A preparatory dose of inducing agent "Ovatide" was used @ 0.1 ml/kg to induce female during the month of June. Further, hormone @ 0.1 ml/kg to male and @ 0.1 ml/kg female is needed after 20 days of preparatory dose for induced breeding.

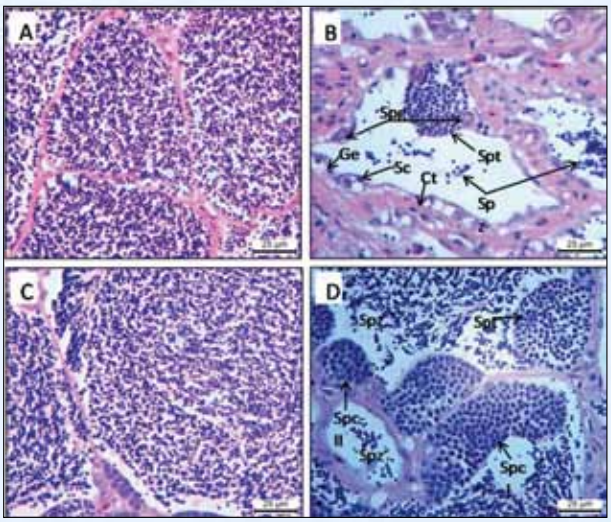
3.2.6 Captive rearing, breeding biology and seed production performance of *Bangana devdevi*, *Labeo pangusia* and *Osteobrama belangeri*, three endemic fishes of North Eastern Himalaya

Reproductive biological study of ngaton (*Bangana devdevi*) and pengba (*Osteobrama belangerii*) was carried out at Tomba & Sons fish farm, Manipur. Other than the basic biological data such as broodstock size, sex ratio, gonadosomatic index, other specific parameter as well, like follicular size, frequency distribution, pre-and post-breeding gonadal and liver histology, fertilization and hatching percentages, hatching times and embryonic development were recorded and analyzed.

Following the study, it was inferred that a set of males (in both species) can be used at least two times for fertilization or ratio of female to male can be raised in a breeding pool.



Photomicrographs of ripe (A and C) and spent (B and D) ovaries of ngaton (A and B) and pengba (C and D). Ripe ovaries are full of maturing oocytes (with eccentric germinal vesicles) and few primary growth oocytes. Spent ovaries, on the other hand, are more constricted and full of late post ovulatory follicle complexes, few early post ovulatory follicle complexes, early vitellogenic follicles, few cortical alveolar oocytes, and comparatively more primary growth oocytes (comprising perinucleolar, multinucleolar and mononucleolar oocytes).



Photomicrographs of ripe (A and C) and spent (B and D) testes of ngaton (A and B) and pengba (C and D). Ripe testes are full of spermatozoa and few nests of spermatogenesis (A and C). Few nests of spermatocytes were also found in pengba (C and D). The spent testis of ngaton (B) comparatively is more devoid of spermatozoa compared to pengba (D).

3.2.7 Domestication, biology and breeding of selected indigenous ornamental fish species of coldwater region

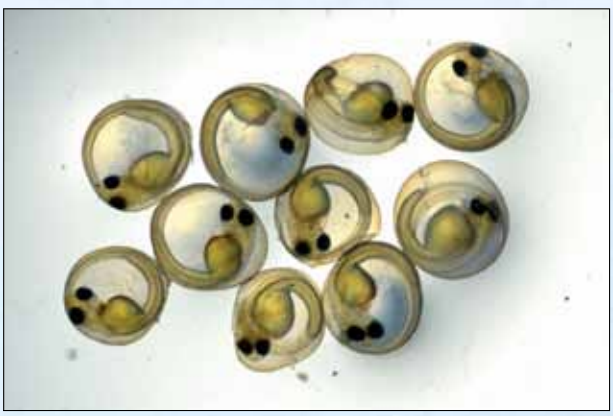
Wild stock of the commercially important ornamental fish species like *Naziritor chelynoides*,

Nemacheilus denisoni, Barilius barna, Barilius bendelisis, B. vagra, Garra gotyla, Puntius ticto, Chagunius chagunio, Channa orientalis, Channa marulius, Chanda nama have been collected from different natural water resources. Efforts are being made to collect more numbers of wild stocks for the further study. Breeding and rearing protocols for the fish species like Chocolate Mahseer (*Neolissochilus hexagonolepis*), *Barilius bendelisis,* Black Mahseer (*Naziritor chelynoides*) and Stripped loach (*Nemacheilus denisoni)* were developed. Multiple breeding of *Neolissochilus hexagonolepis*, *Naziritor chelynoides, Barilius bendelisis* in aquarium within a span of one year without using any synthetic or pituitary hormone or striping method was achieved. For the first time, natural breeding and spawning of loach species *Nemacheilus denisoni* in aquarium was recorded. 200 fry of the species were reared in aquarium. Natural spawning of snow trout *Schizothorax richardsoni* in aquarium condition was achieved. It was observed for the first time that *Barilius bendelisis* and *Neolissochilus hexagonolepis* and *Naziritor chelynoides* lay the eggs in batches and make pits inside the pebbles for eggs incubation. Breeding of exotic ornamental Gold fish (*Carassius auratus*), Koi carp, Oscar fish (*Astronotus ocellatus*), Angel fish (*Ptrophyllum scalare*) and tetra varieties like Widow tetra, Red eye tetra and Baenuos tetra etc. were done successfully. Successful larval rearing of *Barilius bendelisis, Puntius ticto, Naziritor chelynoides, Neolissochilus hexagonolepis*, *Nemacheilus denisoni* in controlled condition in aquarium was achieved with zero water exchange system. Water quality in aquarium and zero water exchange egg incubation device chamber were analysed and found that ammonia level can be minimized and sufficient dissolved oxygen can be maintained. By maintaining low ammonia (<0.1 ppm) and high dissolved oxygen, survival (95%) and growth was recorded 3 times higher than in FRP tanks. It might prove to be a mile stone for cold water fish species breeding and culture practices. Experimentation for zero water exchange egg incubation and larval rearing of *Neolissochilus hexagonolepis, Naziritor chelynoides, and Barilius bendelisis* was successfully conducted.

The unit is also capable of rearing fry to fingerlings stage with minimum water exchange. Zero water exchange device may be a mile stone for fish hatchery and rearing unit. Egg incubation and different stages of egg development for *Barilius bendelisis, Puntius ticto, Naziritor chelynoides, Neolissochilus hexagonolepis* and *Nemacheilus denisoni* were observed. Five thousand fingerlings of *Neolissochilus hexagonolepis, Barilius bendelisis, Naziritor chelynoides* and *Nemacheilus denisoni* were produced.

Spawning pits of *Barilus bendelisis*

Hatchlings of *Barilus bendelisis*

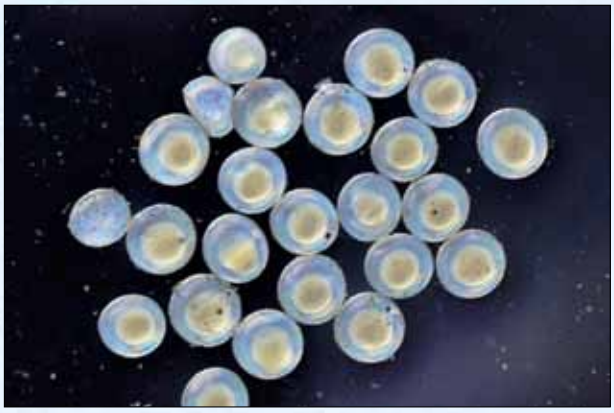


Developing embryos of *Chagunius chagunio*

Chagunius chagunio fry

Naziritor chelynoides brood stock

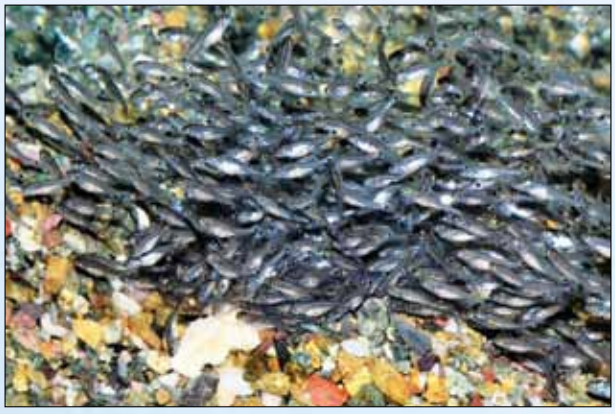
Chagunius chagunio broodstock



Naziritor chelynoides eggs

Chocolate mahseer hatchlings

Naziritor chelynoides spawn



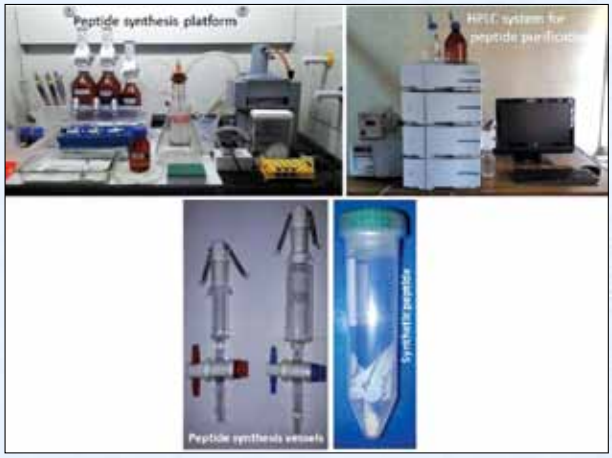
Chocolate mahseer fry in aquarium

3.3 Molecular Genetics and Biotechnology

Research in aquaculture genetics and biotechnology has steadily grown and is extremely active in recent years. As aquaculture develops further to meet the ever increasing demand of fish and fish products by the growing population, application of fisheries genetics and biotechnology can contribute to enhance productivity, production and hence sustainability. ICAR-DCFR has also undertaken research on fish genetics and biotechnology for applications in aquaculture.

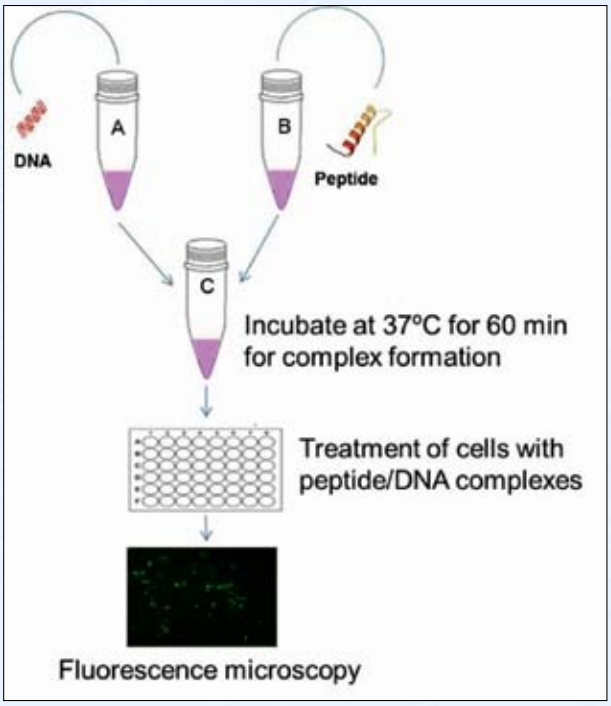
3.3.1 Development of fish viral peptide based nano system for intracellular delivery of biomolecules

Optimization of protocol for chemical synthesis of peptides using Fmoc-chemistry in the laboratory: With the aim to study the cargo carrying ability of certain synthetic peptides derived from fish viral protein as well as synthesis of neuropeptide hormones (e.g. GnRH, kisspeptin) for field application, we have established peptide synthesis facility and optimized a solid-phase method (Fmoc-chemistry) to create synthetic peptides in the laboratory. This facility will also help us to synthesize peptide nucleic acid (PNA) for development of future PNA based diagnostics and therapeutics.



Peptide synthesis facility

Optimization of protocol for transfection of fish cell lines using peptide nano system: Delivery of gene into fish cells is a challenging task as fish generally have a lower body temperature than mammals. A hybrid peptide nano system (RR28) was designed from infectious pancreatic necrosis (IPN) and betanoda viral proteins using bioinformatics tools. The peptide nano system was synthesized by solid phase peptide synthesis (SPPS) using Fmoc chemistry and purified by semi-preparative RP-HPLC. The mass of the peptides was confirmed by mass spectrometry (MALDI-TOF-MS). The RR28 was found to interact with the plasmid DNA (pDNA) and formed non covalent complexes with it. The peptide showed potential for delivery of green fluorescent protein (GFP) gene inside fish cell line, chinook salmon embryo (CHSE). This study suggest that the peptide based nano system may be an alternate DNA delivery vector for fish cells and also providing new insights into the transfection of fish cells with peptide. The protocol for transfection of DNA in fish cells is mentioned in the figure. Briefly, plasmid DNA was mixed with peptide nano system in a standardized nitrogen (NH3+)/phosphate (PO4–) (N/P) ratio in phosphate buffer and allowed to form complexes at 37°C for 60 min. Fish cells were then treated with peptide/DNA complexes for 4 hrs. The cell culture media was removed and replaced with fresh growth media. After 24-48 hrs of treatment, the cells were observed for green fluorescence under fluorescent microscope.



Transfection of fish cells with plasmid DNA using peptide nano systems

In-silico identification and designing of cell penetrating peptides (CPPs) from fish viral proteins: In recent years, cell-penetrating peptides (CPPs) have shown its potential to deliver various cargos that includes protein, DNA, RNA and antisense molecules into live cells in a non-toxic manner. In this project, we have identified/designed a total number of seven CPPs from fish viral proteins using online CPP prediction tools viz. CPPpred and CellPDD. These predicted CPPs will be synthesized and evaluated for its cargo carrying ability inside fish cells. The predicted CPPs ID along with their properties are provided in table.

CPP ID	Net Charge	CPPpred score	CellPDD score	Prediction	Fish viral source
RV13	10	0.915	0.81	CPP	Infectious salmon anemia
RV10	6	0.895	0.76	CPP	Red spotted grouper nervous necrosis
KR14Y	7	0.745	0.13	CPP	Spring viremia of carp
RV11	9	0.919	1.07	CPP	Epizootic hematopoetic necrosis
WT17	8	0.891	0.69	CPP	Infectious hematopoetic necrosis
RQ20	7	0.68	0.25	CPP	Infectious pancreatic necrosis
RR11N	9	0.897	0.49	CPP	White spot syndrome

3.3.2 Transcriptome based sex specific marker discovery in golden mahseer (*Tor putitora*)

Controlling sex ratio is crucial for aquaculture, particularly in those species with sexual dimorphism for productive traits and skewed sex ratio. Golden mahseer (*Tor putitora*) is one such fish species, which exhibits skewed sex ratio in wild condition. The genetic basis of sex determination (SD) and the details about the master SD genes remain unknown in this species. Identification of sex-related genes and investigation of their expression profiles would be helpful to understand the molecular regulatory mechanism underlying the SD process in this fish. In face of this challenge, the sex-specific transcriptome data of gonad, brain and fin tissues have been developed using IlluminaHiSeq 2500 platform. Sequencing of male and female golden mahseer samples yielded 333,057,804 (166,528,902 read pairs) and 309,996,622 (154,998,311 read pairs) reads, respectively. Concurrently, an experiment to find out the onset of sexual differentiation in golden mahseer has been successfully conducted and the samples at various life stages from 1 dph to 300 dph have been collected. Further, histological identification of sex differentiation, gene expression studies and bioinformatics analysis are in progress.

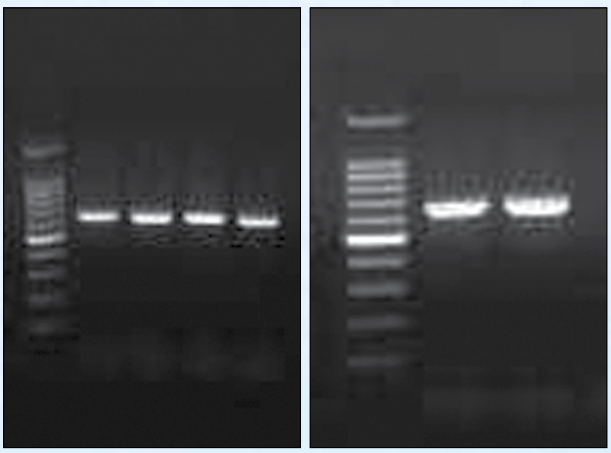
Golden mahseer samples collected at 240 dph

3.4 Disease Surveillance and Health Management

Diseases in aquaculture may be due to rearing densities, water quality, fish handling, nutrition and pathogens. With increase in aquaculture, detection and treatment of microbial pathogens have become an important routine for economic and health management reasons. ICAR-DCFR has taken up many research projects for detection and therapy of important coldwater fish pathogens.

3.4.1 Development of rapid assays for detection & identification of *Saprolegnia* species

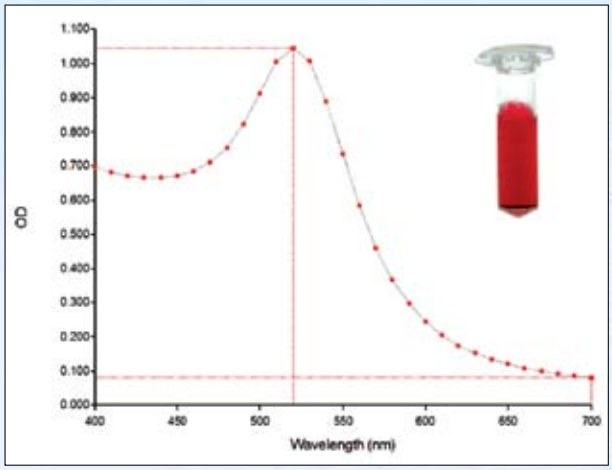
Easy and low cost protocols for genomic DNA isolation: Two low cost and easy protocols for isolation of genomic DNA from *Saprolegnia* have been optimised. Both the protocols could be used to isolate genomic DNA from *Saprolegnia* grown in broth as well as agar plates. The whole procedure can be done in a relatively short period of time without employing liquid nitrogen, CTAB, lysozyme digestion etc. thereby reducing the overall costs involved. Isolation of DNA was further validated by PCR amplification of ITS region using universal primers ITS1 and ITS4.



PCR amplification of ITS region using universal primers ITS1 and ITS4 and DNA isolated by the optimised protocols

Synthesis of gold nanoparticles in the laboratory: For development of visual assay, protocol for synthesis of gold nano particles (AuNPs) in the laboratory has been optimized. AuNPs were

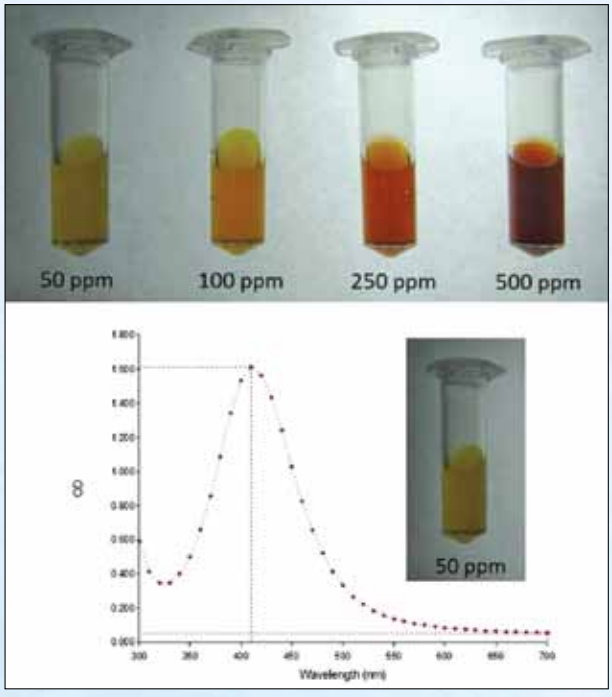
prepared by treating hydrogen tetrachloroaurate (HAuCl4) with trisodium citrate in boiling water, where the citrate acts as both reducing and stabilizing agent. The laboratory synthesized AuNPs were characterized using UV spectroscopy and the absorption peak was found to be 520 nm.



UV-Vis characterization of laboratory synthesized gold nanoparticles

3.4.2 Evaluation of antimicrobial activities of nano & polymer-based formulation against *Saprolegniasis*

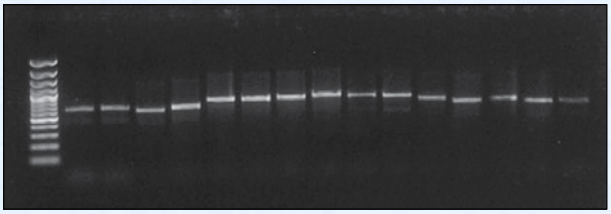
Optimization of protocol for synthesis of Polyhexamethylenebiguanide (PHMB) stabilized cationic silver nano particles (AgNPs): To synthesize PHMB stabilized AgNPs (500 ppm), a given volume of PHMB aqueous solution (0.4%v/v), was added to an aqueous solution of silver nitrate ($AgNO_3$) (46 mM) under vigorous stirring. The reaction mixture was stirred vigorously for 2 hrs to let PHMB form a complex with silver. Freshly prepared aqueous solution of sodium borohydride (64 mM) was then added quickly to PHMB-Ag solution, and the reaction was allowed to complete for 2 hrs. The resulting colloidal solution was stored at room temperature for further characterization.



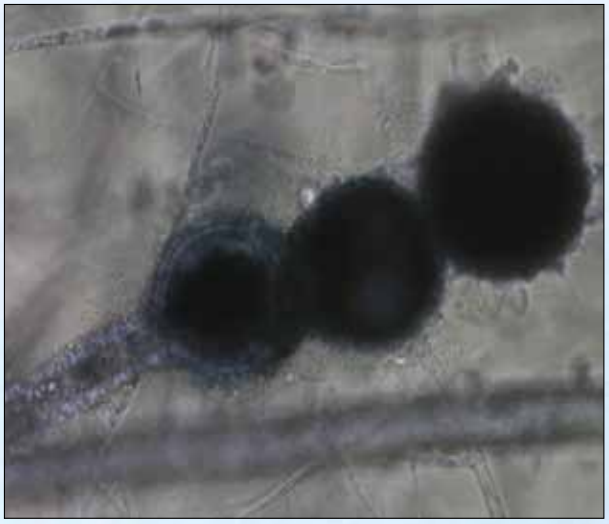
3.4.3 Evaluation of available anti-fungal agents and herbs for their efficacy against oomycetes infection in farmed rainbow trout

Tissue samples (skin, mucus and gills), eggs of trout and water from Champawat and Bhimtal were collected for isolation and identification of fungus pathogen. Fungal genomic DNA was isolated using HiPurATM Fungal DNA Purification Kit (Himedia) and PCR screening was performed using ITS 1 and ITS 4 as forward and reverse primers.

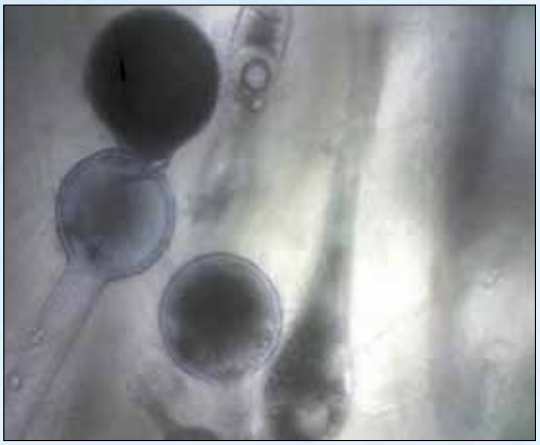
Oomycetes i.e. *Saprolegnia parasitica* and *S. australis* were identified based on morphological and molecular techniques.



Morphological and physiological identification of isolated and putative *Saprolegnia* species



Development of Gammae



Mature Subcentric Oospore (Black round shape); Maturing Oogonia with zoospores (White circle with blackish shade)

Oogonia with immature oospores & diclinous antheridia

Screening of fungicides to measure the minimum inhibitory concentration (MIC):

To screen fungicidal effect of various anti-fungal drugs on *Saprolegnia parasitica*, the spread plated oomycete was grown at 20°C for 48 hrs on PDA and SDA media with ampicillin 250 mg/L for mycelial growth.

Inhibition was found to be most prominent in chitosan starting from 50 ppm of MIC. None of the drugs showed inhibition at 1 ppm & 10 ppm. MIC of Malachite green was found to be 50 ppm and 100 ppm for formalin. Boric acid and NaCl was not so effective at such lower concentrations. The gradation of MIC was found to be Chitosan >Malachite green >Formalin >Boric acid >NaCl.

3.5 Outreach Activities

3.5.1 Fish Genetic stock

DNA marker is the best molecular tool for studying the population structure, genetic diversity, gene flow within and between the natural populations of fish. The genetic stock structure of Brown trout (*Salmo trutta fario*) and Chocolate mahseer (*Neolissocheilus hexagonolepis*) populations from different geographic locations was studied based on mitochondrial and microsatellite markers. The basic information about the stock structure is prerequisite for planning and conservation measure for both of these species. Samples of chocolate mahseer were collected from nine different locations spreading into Arunachal Pradesh, Assam and Meghalaya. The analysis based on mitochondrial marker, Cytb, CO-I and ATPase6/8 in Chocolate mahseer revealed high haplotype diversities and genetic differentiation in Dikrong river (Arunanchal Pradesh), Sankosh river (Guwahati) and Umiam river (Meghalaya) populations support their usage in future marker-assisted breeding programs to maintain substantial genetic vigour in the descendent populations. The major concern highlighted in the present study is the low level of allelic variations and low haplotype and nucleotide diversities in Nongbareh (Meghalaya) and Pamblang (Meghalaya) populations. A total of 12 SSR markers were validated in six populations of brown trout and 25 markers in seven populations of chocolate mahseer through constructing a partial genomic library using Next Generation Sequencing (IIuminaMiseq platform). Validation and analysis of SSR loci in Chocolate mahseer is in progress.

3.5.2 Fish feed

Inclusion of fresh azolla in the diet of carp in mid hills: Fresh azolla was produced in mid hill condition and included in the farm made feed of the exotic carp and minor carp. The field study was conducted at 6 farms sites (80-100 m^2 each) in Almora district of Uttarakhand state. 30% azolla

is optimum in the diet of carp having protein level of 24% with other ingredients i.e rice polish, mustard oil cake. Excess inclusion of azolla in the diet adversely affects the growth and survival. Farm made wet feed reduced the feeding cost upto 25%. *Azolla pinnata* and *Azolla microphylla* can be grown in coldwater condition. Demonstration was given to the fish farmers of Uttarakhand state.

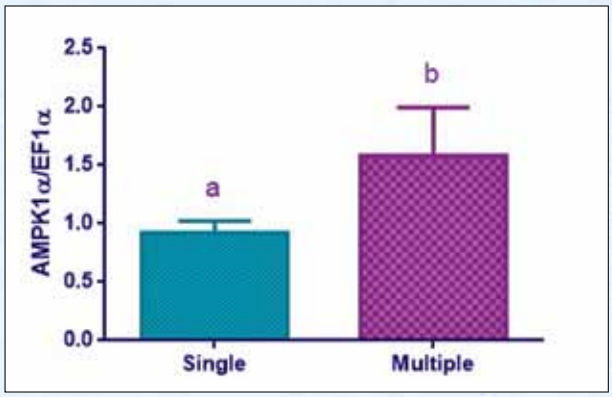
Cost effective & efficient starter feed for rainbow trout: Trout feed is the most expensive input in operational trout farm as trout feed are made up of concentrated animal protein. Keeping in view, two efficient and cost-effective single and multiple protein based starter feeds were formulated for initial feeding of rainbow trout fry. In the single protein diet, 65% fish meal with other ingredients and in multiple protein diet a blend of animal and plant protein ingredients was used with 32% fish meal. These diets were made up of commercial ingredients and were conventionally prepared by steam cooking, pelleting and drying. The formulated feeds found to outperform existing commercial feeds having >90% survival and better FCR (1.1-1.3). Starter feed I,II & III were released on the occasion of *Kisan Mela* on 24th February 2018 and demonstrated in the Sikkim & Uttarakhand state.

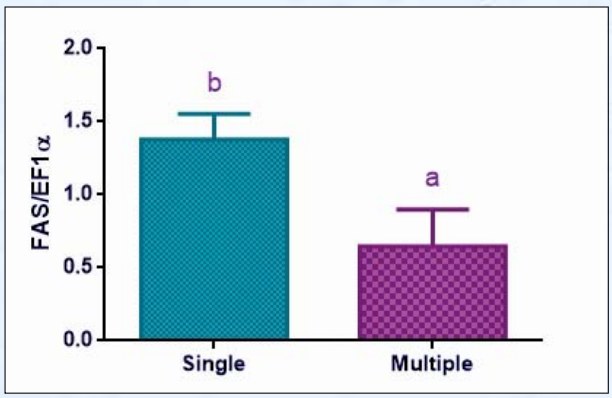
Vitamin and mineral pre-mixture for supplementation in rainbow trout feed: Based on the basal formulation commonly used in rainbow trout feeds, a vitamin and mineral premix was developed which will sufficiently meet the requirement of rainbow trout when supplemented in their diet at a level of 0.5 and 1%, respectively. Except for choline chloride (hygroscopic nature) and tocopherol acetate (liquid form), all the water soluble vitamins of the B complex group, vitamin C and fat soluble vitamins A and D are present in the vitamin premix. Likewise, all the essential macro-minerals (phosphorus, calcium, magnesium, sodium, potassium and chloride) and trace elements (zinc, copper, manganese, iron, iodine, selenium and cobalt) are present in the mineral premix.

Dietary lipid levels for snow trout in captive condition: A field trial was conducted for snow trout (*S. richardsonii*) to elucidate their growth and physiological response to dietary lipid levels (feed availability/deprivation). Plasma, tissue and whole body samples were taken for biochemical, molecular and histological analyses related to digestion, nutrient uptake and feed utilization for growth. Concerning phenotypic observations, there was no significant difference between the dietary lipid levels in terms of growth and feed conversion.

Evaluation of rainbow trout starter feed at phenotypic and molecular levels: Conventionally, fish meal is the preferred protein source in starter feed formulations of rainbow trout (*Oncorhynchus mykiss*). However, in recent times, the stagnating production of fish meal and sustainability metrics such as fish-in fish-out ratios has raised serious challenges to lower the aggregate level of fish meal used in carnivorous fish feeds. In this context, we comparatively evaluated two practical starter feed formulations based on single (fish meal) or multiple (partial replacement of fish meal with squid meal, soybean meal and fish soluble) protein sources in the present study. A five week feeding trial was conducted in rainbow trout fry weighing 192 mg on average. Triplicate groups were fed either a single (S) or multiple (M) protein source diet (pellet crumbles) containing approximately 50% protein and 17% lipid, on dry matter basis. Amino acid profile of the diets was found to be influenced by the dietary protein source. At the end of the experiment, mean final body weight (2.9 g), specific growth rate (7.74%) and condition factor (1.3) in the S group was significantly higher than the M group (2.3 g, 7.06% and 1.2). Reciprocally, the apparent feed conversion ratio was lower in S group (1.13) as compared to the M group (1.35). Average survival rate was high in both the dietary groups (~93%), but not different. Likewise, whole body composition and tissue indices were not significantly different between the dietary groups. In case of whole body amino acid content, lysine was significantly higher in the S group than the M group, whereas it was vice versa for arginine, histidine and tyrosine. With respect to the hepatic transcriptional response, mRNA levels of cellular integrative sensors AMP-activated protein kinase (AMPK1α) and mTOR was concurrently up-regulated in the M group when compared to the

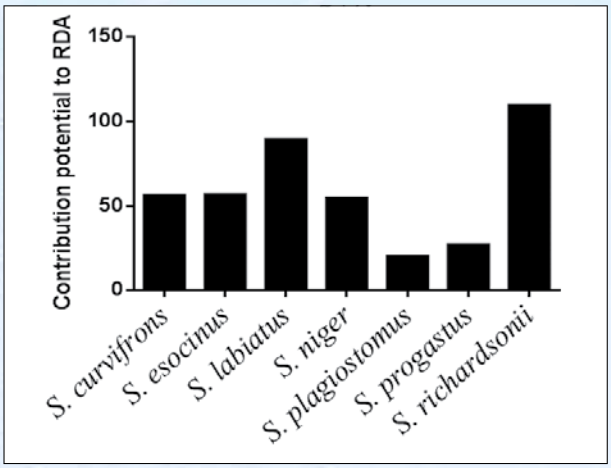
S group. Concerning the changes in the transcripts of intermediary metabolic enzymes, glucokinase and fatty acid synthase were elevated in the S group, whereas a reciprocal regulation was observed for glucose 6-phosphatase. However, gene expression of the analysed protein metabolic enzymes (GLUD, ALT and GOT) and components of somatotropic axis (GHR, IGF1 and IGF2) were not significantly different between the two dietary groups. Overall, our findings indicated that protein source used in the starter feed substantially influences growth, feed utilisation, carcass amino acid content and hepatic metabolism of rainbow trout.





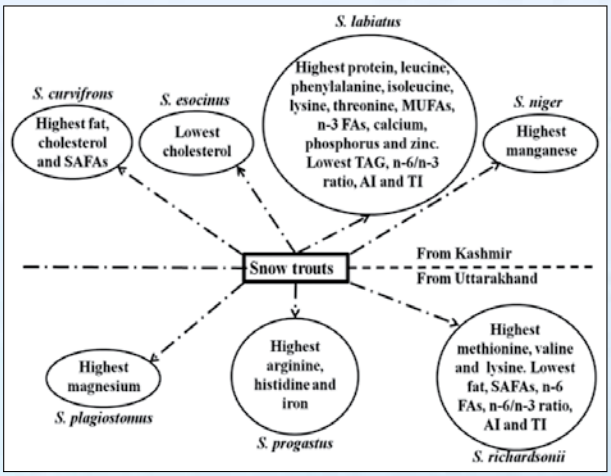
3.5.3 Nutrient profiling and evaluation of fish as a dietary component

Nutrient quality of important coldwater food fishes of entire (western to eastern) Himalaya, and small indigenous fish species (SIFs) from Brahmaputra river and its tributaries were evaluated and their nutrient contribution potential was also calculated for dietary recommendation. Important indigenous Indian coldwater fishes evaluated include mahseers (*Tor putitora* and *Neolissochilus hexagonolepis*), hill carps (*Labeo dero, L. dyocheilus* and *L. pungusia*), snow trouts (*Schizothorax curvifrons, S. esocinus, S. labiatus, S. niger, S. plagiostomus, S. progastus* and *S. richardsonii,*) and small indigenous fish species, namely *Aspidoporia morar*, *Barillius bendelisis, Clupisoma garua*, *Macrognathus aral*, *Semiplotus semiplotus* and *Setipinna phasa*. In general all these fishes have the superior fatty acid composition, but in particular, snow trout followed by chocolate mahseer are the best in term of n-3/n-6 fatty acid ratio.



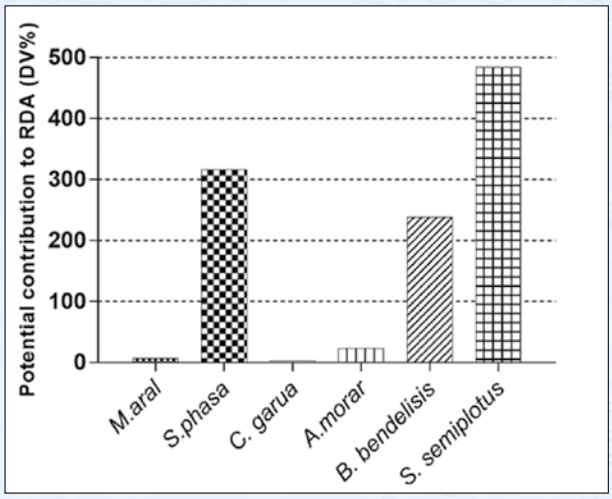
Graphs showing the sum of all n-3 long chain polyunsaturated fatty acids (n-3 LC PUFAs, especially eicosapentaenoic acid, EPA and docosahexaenoic acid, DHA), and their contribution potential (or daily value, DV%) to recommended dietary allowance (RDA from seven species of snow trouts (*Schizothorax* spp.)

Further, among the various species of snow trouts, *S. labiatus* is the superior fish with best attributes like the highest contents of protein, leucine, phenylalanine, isoleucine, lysine, threonine, MUFAs, n-3 fatty acids, calcium, phosphorus and zinc, and lowest contents of TAG, and n-6/n-3 ratio. Similarly, *S. richardsonii* is the second best, and *S. progastus* and *S. esocinus* respectively are the third and the fourth best.



Summary of the nutrient contents of seven species of snow trout (*Schizothorax* spp.).

SIFs from Brahmaputra river yield best nutrient composition in terms of proximate, total lipid, total cholesterol, fatty acid and mineral compositions for healthful nutritional options. All these species were found to be best in nutritional entity in one way or the other. For example, *M. aral* and *C. garua*, exhibited the healthy proximate compositional combination with high moisture, high protein and low lipid values. On the other hand, *S. semiplotus*, *S. phasa* and *B. bendelisis* were best in both n-3 LC-PUFAs content and their potential contribution to RDA for PLW.



Overall, all coldwater fishes were good in one way or the other in their nutrient load and dietary nutrient contribution potential. Despite of some variations all are potent sources of vital nutrients and bioactive compounds, what modern consumers are seeking in present day food market.

3.6. Inter-Institutional Collaborative Project

Development and evaluation of polyhouse covered fish polytank for fish rearing in high hills of Uttarakhand

Species compositions for indigenous minor carp based polyculture of exotic carps in mid hill region: Composite carp culture including indigenous (*L. dyocheilus*) and exotic carps (silver Carp, grass carp and improved Hungarian common carp) in species composition of SC:GC:CC:MC (20:40:20:20) was standardized for mid altitudes in polytanks with the production potential of 0.7 kg/m^3. Growth performance of grass carp is better followed by improved strain of common carp. Growth of minor carp is comparatively less but is compatible with other carps, however, this fish showed more climate resilience with >96% survival and supported cleaning of excessive periphyton assemblage due to its browsing habit. Practice demonstrated in 6 farmer's pond at village Jyurkafun, district Almora.

Fish farming at higher altitudes: On the basis of field experimentation at Mukteshwar, Uttarakhand in collaboration of VPKAS Almora, polytank without any covering material on the polyfilm but having bottom sand bed of 75-100 mm and the whole polytank covered with polyhouse is a suitable model for fish farming at high altitudes having dimensions of polytanks as 9.8 m × 3.0 m top, 7.4 m × 0.6 m bottom, 1.2 m depth, 1:1 side slope with capacity of approximately 20 m^3 water volume. Polytanks were covered with dome shaped galvanized iron (GI) pipe polyhouse. The dimensions of the polyhouse is 11.0 m length, 4.2 m width, 1.0 m span with central height of 3.0 m. Average temperature of the pond water remain 3.72 -9.66°C higher than that of open pond without polyhouse. With the advantage of increasing temperature and protection from frost condition, the growth of grass carp and improved strain of common carp was in the range of 270 - 600 g. The growth of the minor carp also remains encouraging with the advantage of cleaning of the excess periphyton. The average production is 1.1 kg/m^3 in 12 months after stocking of stunted fish. Practice is applicable for the higher altitudes having limited water availability, where trout farming is not possible.

3.7 Externally Funded Projects

3.7.1 Development of a method for detecting the presence of any virus signal in clinical samples of fish (ICAR National Fellow Scheme)

Gene reporter assay with snow trout Mx promoter did not work therefore, as an alternative approach the promoters of PKR and IRF-3 were identified and characterized. Further, gene reporter assays were developed using Mx promoter of rainbow trout and IRF3 promoter of snow trout, to enable the development of an engineered cell line for the detection of any viral signal. Transient

transfection technique demonstrated earlier in CHSE-214 and EPC-2 cells was employed to standardize gene reporter assay with pGL-GFP-Neo-RBTMxpro and pGLGFP-Neo-SNTMxpro. Preliminary efforts in CHSE214 and EPC-2 cells transfected with pGL-GFP-Neo-RBTMxpro and pGLGFP-Neo-SNTMxpro followed by treatment with poly I:C, a model for intracellular dsRNA, did not work as fluorescence was not observed from the transfected cells even after 72 hrs post treatment with poly I:C.

To resolve the problem, Mx promoter of rainbow trout was re-excised from the construct pTZ57RMxpro, using a set of different restriction enzymes namely *SacI* and *HindIII*. The Mx promoter so obtained was ligated in the developed reporter vector pGL3-GFP-Neo. The recombinant plasmid pGL-GFP-Neo-RBTMxpro was transformed in *E. coli* and the reporter plasmid was isolated for gene reporter assay. Transient transfection of CHSE-214 and EPC-2 cells was carried out with new reporter plasmid pGL-GFP-Neo-RBT-Mxpro. After 24 hrs post transfection, the transfected cells were treated with poly I:C and observed under a fluorescent microscope (Nikon). Transfected cells exhibited green fluorescence after 48 hrs and the intensity of the fluorescence increased at 72 hrs post poly I:C treatment.

Moreover, using genome walking, the promoter of interferon regulatory factor-3 (IRF-3) was identified, characterized and cloned in the reporter vector pGL-GFP-Neo. Similarly, transient transfection of CHSE-214 and EPC-2 cells with pGL-GFP-Neo-SNTIRF3pro was carried out. Transfected cells when treated with poly I:C also expressed green fluorescent protein that could be observed after 48 hrs of treatment. Further, double stranded RNA dependent protein kinase (PKR) promoter was also cloned in the reporter vector pGL-GFP-Neo. A construct pGL-GFP-Neo-SNTPKRpro has been developed and gene reporter assay is also being standardized with this construct. To sum up, gene reporter assay has been successfully standardized with pGL-GFP-Neo-RBTMxpro and pGL3-GFP-Neo-SNTIRF3pro in CHSE-214 and EPC-2 cells. Further, selection of stable cell lines capable of expressing green fluorescent protein is being carried out.

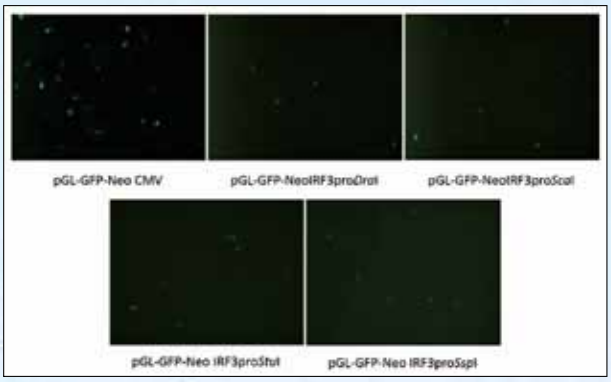


Figure showing transient transfection of cloned IRF3 promoters obtained from chromosome walking in CHSE-214 cells. CHSE-214 cells were transfected with pGL-GFP-Neo-CMV, pGL-GFP-Neo-IRF3*Dra*I, pGL-GFP-Neo-IRF3*Sca*I, pGL-GFP-Neo-IRF3*Stu*I and pGL-GFP-Neo-IRF3*Ssp*I and incubated for 24 hrs when green fluorescence was observed in cells transfected with pGL-GFP-Neo-CMV. Cells transfected with pGL-GFP-Neo-IRF3*Dra*I, pGL-GFP-Neo-IRF3*Sca*I, pGL-GFP-Neo-IRF3*Stu*I and pGL-GFP-Neo-IRF3*Ssp*I were treated with 100 µg/ml poly I:C and incubated for 24 hrs at 22°C. After 24 hrs green fluorescence was observed in poly I:C treated cells.

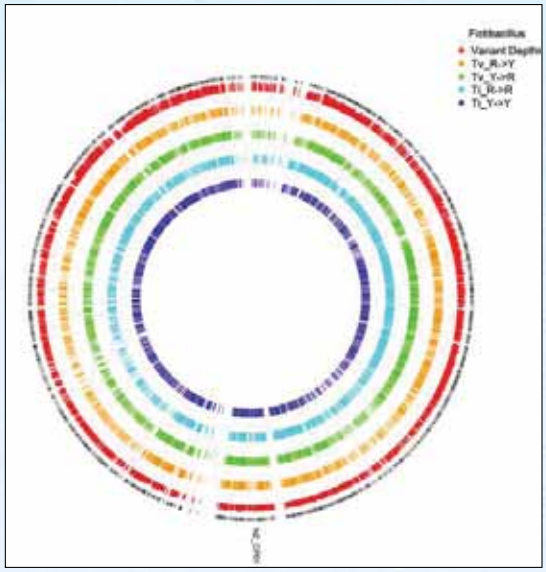
3.7.2 Development of bacterial bioremediation measures for the mitigation of microalgal blooms in freshwater aquaculture ponds

The three bacterial isolates with algicidal activity were identified as *Pantoeae ucrina* (U8; NCBI GenBank accession nos.KY426067), *Pseudomonas oryzihabitans* (U10; NCBI GenBank accession nos. KY426066) and *Fictibacillus phosphorivorans* (U12; NCBI GenBank accession nos. KY426064). Bacteria were identified by biochemical and molecular (16S rRNA gene amplification by PCR) techniques. The algicidal property of the bacteria was evaluated by clear zone formation around the Microcystis sp. lawn and also by mesocosm experiment with *Microcystis aeruginosa* as target organism.

The three bacterial cultures were lyophilized for long term storage and for any further studies in future. Pathogenicity study of all the three bacterial isolate was studied in common carp by dip treatment at various CFUs and the strains were found to be non-pathogenic by external examination and by histopathological studies.

De Novo whole genome sequencing of *Fictibacillus phosphorivorans* was carried out by IlluminaHiSeq 2500 for the genome characterization

of this bacterium and also for the identification of algicidal genes present in this strain. The G+C content of this bacterium was ~48%, which is relatively high and number of protein coding genes predicted were 4,227, among which 4,034 genes were with blast hit.

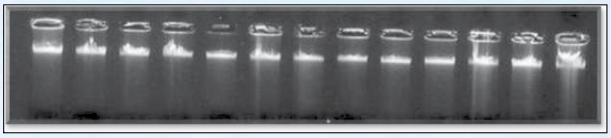


Circos plot of *Fictibacillus phosphorivorans*

3.7.3 Molecular and genetic characterization of selected important ornamental fishes of North East India

Assamese kingfish, *Semiplotus semiplotus* also known as *Cyprinion semiplotum*, is regarded as one of the important potential food and ornamental fishery resource of mountain aquaculture especially in north east India. It is native to India, Nepal, Bhutan and Myanmar. To develop novel molecular makers and study the genetic variability of geographically isolated populations of *S. semiplotus* using microsatellite markers, a total of 52 fish samples were collected from different sites of Senki river located at Jully village in the Papum pare district of Arunachal Pradesh during the month of January, 2018. Voucher specimens and live fish specimens were set down at the reference laboratory, St. Anthony's College, Shillong, Meghalaya and Fish Genetics and Biotechnology laboratory of ICAR-DCFR, Bhimtal. The total genomic DNA was extracted from fin tissue using phenol: chloroform: iso-amyl alcohol method and sent for high throughput DNA sequencing. The high throughput partial genome sequencing is underway.

Semiplotus semiplotus (also known as *Cyprinion semiplotum*) collected from Senki River



Total genomic DNA in 0.8 % agarose gel

3.7.4 Triploid rainbow trout (*Oncorhynchus mykiss*) production for aquaculture enhancement and ecological risk management

Initial success in triploidy induction in rainbow trout: An effort was made to induce triploids in rainbow trout through heat shock treatment (28°C) at village Skhras, District Anantnag, Kashmir, State trout farm, Uttarey and State trout farm, Rabum, Sikkim. Breeding trials were performed during the month of January-February, 2018 at all the three places. 40% success was observed in treated eggs with conformation by karyotyping. In treated group, three sets of chromosomes (86-90) were observed in chromosome plates. 84% survival was observed in triploid rainbow trout. Triploid stocks are being reared for the further observations.

Induction of triploidy in rainbow trout through heat shock treatment

3.7.5 Surveillance of coldwater fish diseases in Himachal Pradesh and Uttarakhand

During the period under report, active/ passive disease surveillance was carried out and baseline data was collected from 111 rainbow trout, mahseer,

snow trout and carp, farms raceways and hatcheries as per the standard procedures of sampling & data collection. Kullu, Mandi, Bilaspur and Sirmaor Districts in Himachal Pradesh and Champawat, Almora, Nainital and U.S. Nagar in Uttarakhand state were covered in the surveillance. Biological data of 34 fish farms was prepared. Passive disease surveillance was carried out at golden mahseer hatchery and rainbow trout indoor tanks at Bhimtal and snow trout hatchery, Champawat. Total 236 un-pooled and 106 pooled samples of kidney, spleen, liver, skin, intestine, brain and gills were collected and screened for VHSV, IHNV, bacterial, fungal and parasitic infections. RT-PCR was conducted using the gene specific primer of VHSV (Viral hemorrhagic septicaemia virus) and IHNV (Infectious hematopoietic necrosis virus) along with the positive controls. ITS-1 and ITS-4 primers for fungal and 16sRNA for bacterial identification were used. So far all the collected samples from surveyed sites were found negative for VHSV & IHNV in RT-PCR. Bacterial flora identified from the representative trout farms were *Aeromonas hydrophila*, *Aeromonas veronii*, *Hafnia alvei*, *Pseudomonas fluorescens*, *Plantibacter* sp., *Escherichia coli*, *Microbacterium* sp., *Morganella* sp., *Staphylococcus* sp., and *Plegiomonas* sp., *Yersinia* sp., *Corynebacterium* sp. Further, four strains of *Lactococcus garvieae* (GenBank accession no: KM 604701, KM 604702,KM 604703 and KM 604704) were recovered from diseased rainbow trout. Oomycetes *i.e. Saprolegnia parasitica* and *S. australis* were identified based on morphological and molecular techniques from golden mahseer hatchery/tanks. Ectoparasite *Argulus* sp. was recovered from indoor rainbow trout tanks at Bhimtal under passive surveillance. Nine representative fish farmer's tank soil & water were analyzed for twelve important parameters. During survey of trout and carp hatcheries in Himachal Pradesh and Uttarakhand, siltation in trout hatcheries, poor ground water quality with high iron load, water scarcity with fluctuations in water temperature, lack of fish seed sale at right time along with fry predation by birds, argulosis in brooders, black spot diseases, tail and fin rot, gas bubble disease were recorded to be the major constraints causing loss to hatchery owners. During the visit, awareness towards good management practices among state department officials & farmers were generated through group meetings, one to one interactions, demonstrations and by organizing mass awareness camps. Four pamphlets on Good Management Practices (GMP) for trout and carp farming in mid hills, White spot disease in coldwater aquaculture (Hindi & English) & Argulosis in coldwater fishes were prepared and distributed among the fish farmers & officials. Mass awareness (2) and demonstration program (2) were organized on coldwater fish health management involving about 105 hill fish farmers.

Sample collection from trout hatchery at Barot (HP)

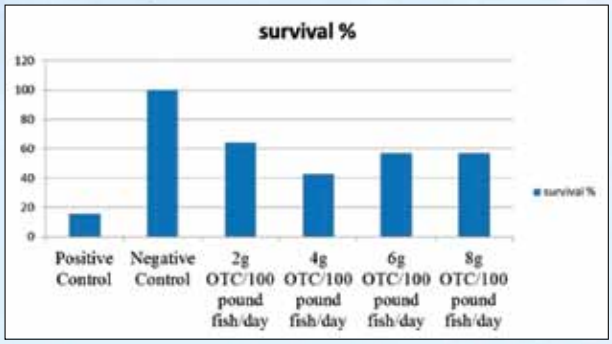
Collection of fungal samples from incubated eggs

3.7.6 All India network project on fish health-aquaculture medicine and therapeutics

Winter experimental trials were conducted to study the efficacy of Oxytetracycline (OTC) at different doses (2, 4, 6 & 8g OTC/100 pound fish/day) on fingerlings of golden mahseer, *Tor putitora* challenged with *Aeromonas hydrophila*, laboratory strain no RTS 02. Trials summarized that an experimental infection with β-hemolytic laboratory strain of *Aeromonas hydrophila,* RTS 02 followed by a prudent use of oral medications of 2-8 g OTC/100 pound fish/day through feed, fed @ 2% body weight for 10 days can effectively control the bacterial

Aeromonas hydrophila, laboratory strain RTS 02 showing β-hemolysin in sheep blood agar plate

Fingerlings anaesthetized using Ethyl-m-aminobenzoate methane Sulphonate (MS222) & challenged with *Aeromonas hydrophila*, RTS 02 intra-peritoneally @100 µl with a predetermined LD50 dose of 1.5 × 108 cells/ml



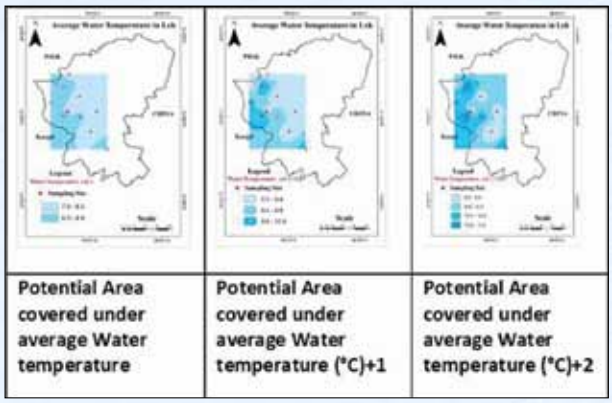
infection in laboratory conditions. OTC treatment at varied levels (2-8 g OTC/100 pound fish/day) has ensured 40-60% survivability of fingerlings in the present trial. It was also noted in the study that the extent of progression of body haemorrhage along with disease symptoms and healing could be qualitatively classified as reduced feed intake during early OTC treatment.

3.7.7 National mission for sustaining the Himalayan ecosystems - Ecosystem monitoring and sustainable development of coldwater fisheries in lower and mid Himalayan region and cold dessert of India

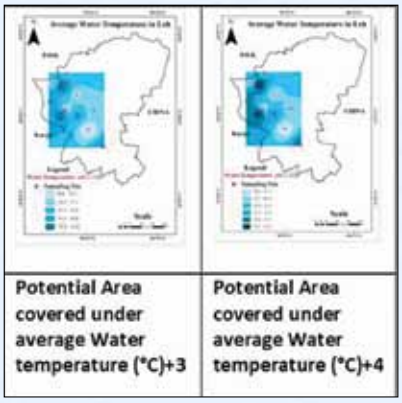
Investigation on the physiological adaptation of rainbow trout to weather extremes in high altitudinal rearing environment at Leh-Ladakh, India: Under NMSHE Cold Desert project component of ICAR-DCFR, we have conducted an experiment to test our hypothesis that the hypobaric hypoxic conditions prevalent at high altitudes (>3000 m above MSL) causes chronic stress and disturbs the normal physiological processes of rainbow trout at varying degrees dependent on the season. We have measured and documented the seasonal (summer and winter) variations in important abiotic factors such as water temperature, dissolved oxygen, carbon dioxide, pH, conductivity, pressure, hardness, alkalinity and total dissolved solids in the experimental trout raceway unit and source water. At low water pressure, the oxygen saturation in rearing water was found to be relatively less than at lower altitudes, as expected. Concomitant with seasonal changes in atmospheric temperature, water temperature was 12 degree higher in summer as compared to winter (4°C); inversely dissolved oxygen levels in rearing water were highest in winter. Other water parameters did not vary significantly between seasons. With respect to the fish, phenotypic changes in morphological/ organ indices such as condition factor, hepato-somatic index, viscero-somatic index and relative gut length was measured in both seasons. Considerable differences were evident in Kn and VSI, with higher values in summer, possibly linked to elevated growth potential. As an indication of the oxygen carrying capacity of the blood, haemoglobin and haematocrit were estimated. Further, measurement of gill ventilation rate, and oxygen consumption rate was systematically carried out to ascertain the overall changes in metabolism in weather extremes. Depending on the environmental temperature, the metabolic rate of the fish was found to linearly increase or decrease. Tissue sampling of brain, liver, muscle, intestine, gill, kidney, spleen and heart was also done for analysing transcriptional and histological changes related to season in the high-altitudes. By linking the environmental changes with phenotypic and molecular response of the fish, we are attempting to comprehensively understand the physiological adaptation of rainbow trout to hypobaric hypoxia, which is hitherto unclear. Moreover, knowledge on seasonal differences in the physiological response of trout to locally prevalent conditions will definitely enable the identification and use of a "growth window" through well-planned management practices for trout culture in high altitude regions.

Survey of trout farm at Leh-Ladakh

Site suitability maps for trout farming: Under this project, GIS based site-suitability maps were developed for trout farming using primary data collected on water source, temperature and accessibility of Leh district. Subsequently, temporal maps were also generated considering an increment of water temperature by one degree up to 4°C, according to climate change predictions of IPCC. It is observed that 190 hectares of land is fairly suitable for trout culture but degree of suitability increases with increasing of every degree of water temperature.

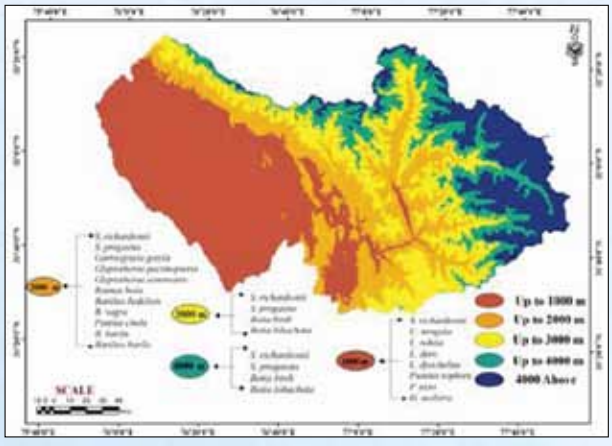


Potential Area covered under average Water temperature	Potential Area covered under average Water temperature (°C)+1	Potential Area covered under average Water temperature (°C)+2



Potential Area covered under average Water temperature (°C)+3	Potential Area covered under average Water temperature (°C)+4

Fish abundance and distribution map: Prepared abundance and distribution maps of Ichthyofaunal resources form major drainages of Himachal Pradesh and Uttarakhand using primary as well as secondary sources of data. Information is useful for the planning and biodiversity conservation.



3.7.8 Development of climate resilient rainbow trout and innovative trout farming strategies to mitigate climatic stressors (NICRA)

Under the national project on innovations in climate resilient agriculture, ICAR-DCFR has taken up the work component to develop a multi-pronged strategy to counter the climate change related challenges faced by rainbow trout farmers. Two exclusive work packages have been conceptualized and executed in the laboratory conditions and in private trout farms. The primary objective of the field study is to periodically document the abiotic and biotic changes occurring in selected trout farming clusters located in two distinct geographical or micro-climatic zones in Kullu and Mandi districts of Himachal Pradesh. In total, 12 rainbow trout farms were selected for active surveillance and monitoring, with the help of H.P. State Fisheries Department. A preliminary field survey was carried out in which basic farm establishment and management data were collected from the selected farms. The perceived challenges faced due to climate change were the sporadic mortalities in

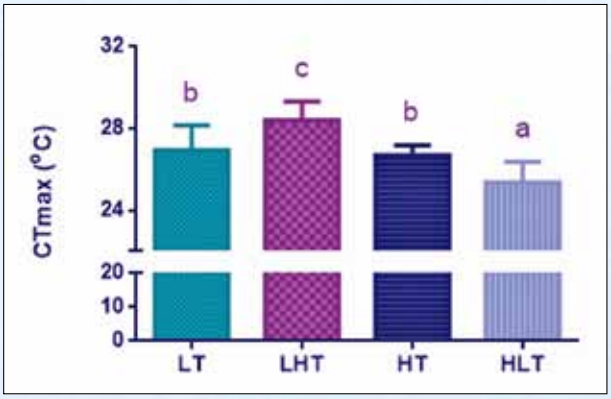
Farmer survey and water quality measurement in the trout farms

summer months due to high temperature stress and related occurrence of disease; heavy siltation with rainfall; and decrease in water flow during winter (as the water source is snow fed streams). Based on the changes in important water quality parameters during the months of October and December 2017, we identified three trout farming clusters in Joginder Nagar, Patlikuhal and Pahanallah with distinct thermal regimes.

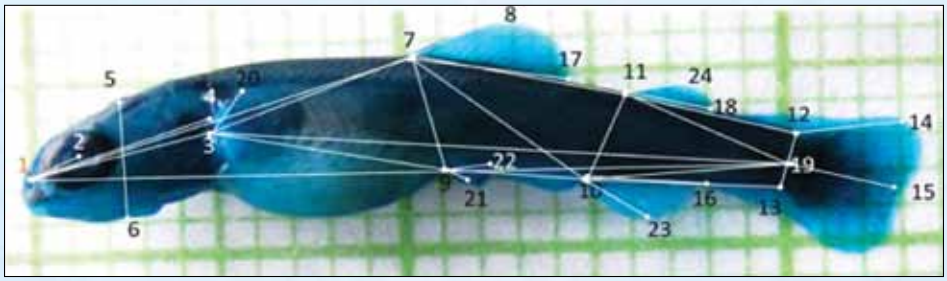
In the other laboratory-based work package, two small-scale re-circulatory aquaculture systems were indigenously designed, fabricated and commissioned to evaluate its use as a climate-resilient technology which can drastically minimize the volume of water, land and time used in rainbow trout production. The efficiency and maturation of the gravel-bed biofiltration system was ascertained by continuously examining the nitrogen cycle dynamics (ammonia to nitrite to nitrate). Further optimization of rearing conditions such as carrying capacity, feed application, water recycling methods and temperature control, as well as up-scaling of the RAS from experimental to commercial scale is in progress.

Experimental RAS units developed at DCFR, Bhimtal

Moreover, a preliminary study on thermal programming of rainbow trout using its developmental plasticity is in progress from December 2017. This study examines the appropriate development window in which thermal stimulus should be given to the fish for eliciting a positive physiological response to high temperature exposure in later life stages. Initially, eyed ova of rainbow trout from the same genetic lineage were incubated at two different temperatures, low (LT, 10±1°C) and high (HT, 18±1°C). Post-hatching, half of the LT sac fry was transferred to 18°C (LHT) and half of HT sac fry was transferred to 15°C (HLT) and reared in the respective temperature until 45 dph. At 45 dph, randomly selected individuals from all the four treatments were examined for their thermal tolerance limits and other performance indices. LHT group was found to exhibit higher upper thermal tolerance (CT_{max}:+1.5 to 3°C), weight gain and condition factor as compared to the other groups. During this stimulus phase, whole fish samples were also collected for morphometric and histological analyses at regular intervals post-hatch and for molecular analysis at the end. Subsequently, fishes in all the treatment groups were shifted to ambient temperature (17 ±1°C) and maintained for a 75 days latent period. After which, they were subjected to a high temperature challenge phase (23 ±1°C) for one month (in progress), to study the impact of the thermal conditioning during early life on their later thermal and metabolic adaptation.



CT_{max} at the end of stimulus phase



Homologous landmarks used for morphometric analysis

4 List of Research Projects

4.1 Institutional Projects

Project Code	Project title	Investigators	Year of start	Year of completion
A. Resource assessment and management				
CF-6	Ecosystem assessment and mapping of aquatic resources in Indian Himalayan regions	**D. Sarma** (Coordinator)		
	Sub-project 1: Ichthyofaunal diversity, habitat assessment and molecular characterization of important species from the selected Himalayan drainages	**S. Ali** P. Kumar N.N. Pandey S.K. Mallik	2015	2018
	Sub-project 2: Habitat assessment and eco-biological study of selected mountain lakes of central andnorth eastern regions	**D. Sarma** R.S. Patiyal D. Baruah P. Sharma R.S. Haldar	2015	2018
	Sub-project 3: Study on development of spatial database of coldwater fishery resources in Western Himalayan region.	**P. Kumar** A.K. Giri P.A. Ganie A.K. Saxena	2015	2018
	Sub-project 4: Assessment of population status, species diversity and habitat ecology of snow trout Schizothorax species in selected streams fo Indian Himalayan Region	**D. Baruah** D. Sarma P. Sharma K. Kunal P.A. Ganie	2016	2019
B. Aquaculture oriented research and development				
AQ-16	Captive management of Golden mahseer in perspective to aquaculture and conservation	**A.K. Singh** (Coordinator)		
	Sub-project 1: Photothermal manipulation of for gonadal maturity of golden mahseer in captivity	**M.S. Akhtar** D. Sarma Ciji, A. Rajesh, M.	2014	2018

Project Code	Project title	Investigators	Year of start	Year of completion
	Sub-project 2: Molecular characterization and gene expression profiles of kiss genes in golden mahseer during different gonadal development stages.	**N. Shahi** D. Thakuria	2014	2018
	Sub-project 3: Devising a feeding regimen based on return of appetite in golden mahseer (*Tor putitora*) larvae/juvenile	**P. Sharma** D. Sarma M.S. Akhtar	2016	2019
AQ-17	Decoding the constraints in growth, maturation and captive management of snow trout (*Schizothorax richardsonii*, Gray, 1832)	**A.K. Singh** (Coordinator)		
	Sub-project 1: Central and peripheral regulation of feed ingestion and nutrient uptake in snow trout, *Schizothorax richardsonii*	**B.S. Kamalam** N.N. Pandey P. Sharma	2015	2019
	Sub-project 2: Nutrient mediated metabolic regulation of growth and well being in snow trout *Schizothorax richardsonii*	**M.S. Akhtar** Ciji, A. A.K. Giri	2015	2019
	Sub-project 3: Myogenic regulation and protein turnover of muscle growth in snow trout *Schizothorax richardsonii*	**Rajesh, M.** D. Thakuria B.S. Kamalam	2015	2019
	Sub-project 4: Endocrine aspects of growth and maturity of snow trout, *Schizothorax richardsonii*	**Ciji, A.** Rajesh, M. P. Sharma P. Dash	2015	2019
	Sub-project 5: Development of captive management and seed production protocol of snow trout, *Schizothorax richardsonii*	**S. Chandra** A.K. Giri	2015	2019
AQ-19	Domestication, biology and breeding of selected species for species diversification in mid-hill aquaculture	**N.N. Pandey** (Coordinator)		
	Sub-project 1: Domestication, Biology and Captive Breeding of Indian trout *Raiamas bola* (Hamilton, 1822)	**N.N. Pandey** S. Ali P. Dash R.S. Haldar	2015	2018
	Sub-project 2: Captive rearing, breeding biology and seed production performance of *Bangana devdevi*, *Labeo pangusia* and *Osteobrama belangeri*, three endemic fishes of North Eastern Himalaya	**D. Sarma** D. Baruah P. Sarma	2016	2019

Project Code	Project title	Investigators	Year of start	Year of completion
	Sub-project 3: Domestication, biology and breeding of selected indigenous ornamental fish species of coldwater region	**S.G.S. Zaidi** N.N. Pandey	2016	2019
C. Molecular genetics and Biotechnology				
AQ-18a	Development of fish viral peptide based nano system for intracellular delivery of biomolecules	**D. Thakuria** N. Shahi K.V. Chanu R.A.H. Bhat	2015	2019
AQ-18b	Transcriptome based sex specific marker discovery in golden mahseer (*Tor putitora*)	**Siva, C.** S. Ali P. Sharma Rajesh, M.	2017	2020
D. Disease surveillance and management				
AQ-20	Development of Diagnostic & Therapeutic Measures for Rainbow trout Pathogens	**A.K. Singh** (Coordinator)		
	Sub-project 1: Development of rapid assays for detection & identification of *Saprolegnia* species	**K.V. Chanu** D. Thakuria R.S. Tandel	2017	2020
	Sub-project 2: Evaluation of antimicrobial activities of nano & polymer-based formulation against Saprolegniasis	**D. Thakuria** K.V. Chanu R.S. Tandel	2017	2020
	Sub-project 3: Evaluation of available anti-fungal agents and herbs for their efficacy against Oomycetes infection in farmed rainbow trout	**R.S. Tandel** R.A.H. Bhat S.K. Mallik	2017	2020

4.2 Outreach Activities (Fisheries Division-ICAR)

NMP-1	Fish Genetic Stock	**S. Ali** R.S. Patiyal Siva, C.	2014	2018
NMP-2	Fish Feed	**N.N. Pandey** S. Chandra M.S. Akhter B. S. Kamalam	2014	2018
NMP-3	Nutrient profiling and evaluation of fish as a dietary component	**D. Sarma** M.S. Akhtar Ciji, A P. Sharma	2014	2018

4.3 Inter-Institutional Collaborative Project (ICAR)

VPKAS-DCFR	Development and evaluation of polyhouse covered fish polytank for fish rearing in high hills of Uttarakhand	**N.N. Pandey** R. Singh	2015	2018

4.4 Externally Funded Projects

ICAR-National Fellow	Development of method for detecting the presence of any virus signal in clinical sample of fish	**Amit Pande**	2014	2019
DBT-5	Development of bacterial bioremediation measures for the mitigation of microalgal blooms in freshwater aquaculture ponds	**N. Shahi** S.K. Mallik	2014	2017
DBT-6	Molecular and genetic characterization of selected important ornamental Fishes of North East India	**Siva, C.**	2017	2020
DBT-7	Triploid rainbow trout (*Oncorhynchus mykiss*) production for aquaculture enhancement and ecological risk management	**N.N. Pandey** B.S. Kamalam	2017	2020
NSPAAD	National surveillance programme for aquatic animal disease-Surveillance of coldwater fish diseases in Himachal Pradesh and Jammu & Kashmir	**S. Chandra** S.K. Mallik R.S. Tandel R.A.H. Bhat	2014	2018
AINP- Fish Health	All India Network Project on Fish Health- Aquaculture medicine and therapeutics	**S.K. Mallik** N. Shahi R.S. Tandel	2015	2017
NMSHE	National Mission for Sustaining the Himalayan Ecosystems (NMSHE- Taskforce 6 for Himalayan Agriculture) (A) Ecosystem Monitoring and Sustainable Development of Coldwater Fisheries in Lower and mid Himalayan Regions of India.	**N.N. Pandey** S. Ali R.S. Patiyal Rajesh, M. P. Kumar	2015	2019
	(B) Ecosystem Monitoring and Sustainable Development of Coldwater Fisheries in cold desserts Himalayan Regions of India.	**P. Kumar** N.N. Pandey B.S. Kamlam A.K. Giri	2015	2019
NICRA	Development of climate resilient rainbow trout and innovative trout farming strategies to mitigate climatic stressors.	**D. Sarma** R.S. Patiyal D. Baruah B.S. Kamalam Rajesh, M. P. Sharma R.S. Tandel S.K. Mallik M.S. Akhtar N. Shahi Ciji, A., A.K. Giri Siva, C. R.S. Haldar	2017	2020

5 Important Events and Meetings

5.1 International Workshop on Mahseer Conservation

ICAR-DCFR, Bhimtal joined hands in organizing an International Workshop on Mahseer Conservation at Kochi, Kerala during 5-7 April 2017 with Bournemouth University, UK, Mahseer Trust, UK, Coldwater Fisheries Society of India, Bhimtal, Vemco and KUFOS, Kochi. Dr. A.K. Singh, Director and Dr. Debajit Sarma, Principal Scientist represented ICAR-DCFR, Bhimtal during the programme and delivered on the various conservational aspects of the endangered fish mahseer.

International workshop on mahseer conservation

Dr. D. Sarma presenting on mahseer breeding and conservation during the international workshop

5.2 Swachhta Pakhwada

The Swachhta Pakhwada under Swachh Bharat Mission was observed with great enthusiasm during 16-31 May, 2017 at ICAR-DCFR Headquarter and Experimental Fish Farm, Champawat. All the staff members, research scholars, students and contractual staff participated to achieve the goals and objectives of Swachhta Mission. During the Pakhwada, regular cleaning of campus and surrounding was taken up, awareness programme on cleanliness and proper waste disposal was organized at Naukuchiatal, road side plantation in front of the institute campus was taken up, cleaning of office premises and adjoining areas of the office was organized. A Workshop on Swachh Bharat Mission was also organized for 150 students and staff from Kendriya Vidyalaya,

Cleaning of campus by ICAR-DCFR staff

Cleaning of public and tourist places by ICAR-DCFR staff

Bhimtal. On this occasion Dr. A.K. Singh, Director addressed the gathering and explained the importance of cleanliness in our day to day life and the mission of the Government of India. Dr. N. N. Pandey, Principal Scientist delivered a lecture on the theme of Swachh Bharat Mission. Pledge was also taken by all the staff of the institute to further follow the message of the mission.

5.3 Institute Research Committee Meeting

The Institute Research Committee (IRC) meeting was held during 25-26 May 2017 under the chairmanship of Dr. A. K. Singh, Director. The Director welcomed all the scientists and briefed on the research gap in coldwater fisheries sector. Scientists of the institute presented the progress of the ongoing research programmes alongwith three concept notes on new project proposals. Discussion was also made on NEH, TSP, farm activities at Experimental Fish Farm, Champawat. Project wise critical comments, suggestions and thorough discussions on each of the presentations were made during the IRC.

5.4 World Environment Day

ICAR-DCFR celebrated World Environment Day on 5th June 2017 by planting plants in and out of the institute campus. The members of the ICAR-DCFR participated in the programme with full enthusiasm. In parallel, ICAR-DCFR in collaboration with Directorate of Fisheries, Government of Sikkim celebrated the day by ranching 5000 numbers of fingerling sized mahseer seeds in river Teesta at Dikchu, Sikkim for rehabilitation and conservation of mahseer. The programme was graced by Mr. Somnath Poudyal ji, Hon'ble Minister of Fisheries, Govt. of Sikkim as the Chief Guest along with other dignitaries. An awareness camp was also organised on the occasion to create awareness to protect the natural environment of the river to save the magnificent mahseer 'The Tiger of Water'. Dr. A.K. Singh, Dr. D. Sarma, Dr. Prakash Sharma and Dr. R.S. Haldar from ICAR-DCFR alongwith state fisheries officers, farmers and anglers witnessed the program.

Plantation on the World Environment Day at Bhimtal

Plantation on the World Environment Day at Champawat

Ranching of mahseer fish seeds in river Teesta at Sikkim

5.5 International Yoga Day

ICAR-DCFR observed the International Yoga Day on 21st June 2017 at Bhimtal and Champawat. At Bhimtal, the yoga session were guided by yoga guru Dr. Hem Chandra Kapil who explained the importance and benefits of different aasans and pranayamas. The different aasans followed by the enthusiast participants of the institute were included the vajrasana, sasankasana, setu bandhasana, alanasana, uttanpadasana, bhujangasana, salabhasana, pavanamuktasana, shavasana and two pranayamas udgeeth and bhramari. At Champawat, the staffs practiced yoga aasans and mudras under the guidance of yoga expert Mr. Chandra Prakash Punetha. He has emphasized that the regular practice of yoga would be helpful in relieving of body pains and remedy for several stress & diseases. Lectures on various aasans and their benefits to human health were delivered by Mr Punetha and Mr Gaurav Pandey.

International Yoga Day observed at ICAR-DCFR, Bhimtal

International Yoga Day observed at Experimental Fish Farm, Champawat

5.6 Fish Farmers Day

ICAR-Directorate of Coldwater Fisheries Research celebrated National Fish Farmers Day on 10th July 2017 at its Experimental Field Centre, Champawat where 31 farmers and state fishery personnel as well as scientists participated. Demonstrations on various farming activities, farm visits, interactions and fish seed distribution were arranged for participants on this occasion. Farmers of nearby villages of Champawat including farm women and tea garden workers attended the programme. Besides rainbow trout and snow trout culture practices, farmers were made acquainted with breeding, nursery rearing and seed packing techniques of different fingerlings of carp at the centre. Dr. Suresh Chandra, Principal Scientist and Scientist-in charge welcomed the farmer and briefed on the farm activities and technologies and efforts being made by the Directorate for development of coldwater aquaculture in hilly states of the country under the guidance of Director, Dr. A.K. Singh and appealed farmers to adopt integrated farming to maximize their profit and minimize crop loss. Later,

Skill development on fish farming and fish seed production techniques

Mass awareness programme for the fish farmers on the day

Seed distribution the fish farmers on the day

the farmers were taken to carp and trout farm of the centre and live demonstrations on breeding, seed rising and trout farming techniques were given. Farmers keenly took part in the farm activities. Queries raised by famers were addressed in scientist-farmers interaction meet. On this occasion improved common carp seed was also distributed to fish farmers. Mr. A.K. Giri, Dr. Raghvendra Singh, Mr. P.A. Ganie scientists and Technical officers Mr. Ravindar Kumar and Hansa Datt along with other staff members of ICAR-DCFR were present on this occasion. The programme ended with vote of thanks.

5.7 New India Manthan - Sankalp Se Siddhi

New India *Manthan-Sankalp Se Siddhi* was organized at Bhimtal in 9th August 2017 by undertaking a pledge among the staff members of the institute to work on the principle of attainment through resolve.

Likewise, New India *Manthan-Sankalp Se Siddhi* was organized at Experimental Fish Farm, Champawat along with a Mass Awareness program under NSPAAD on 20th August 2017. Chief Development Officer, Champawat Mr. S.S. Bisht graced the programme as the Chief Guest. Twenty five fish farmers including 10 women of Champawat area participated in the programme. Dr. S. Chandra, Principal Investigator of NSPAAD project welcomed the farmers and briefed on the role of good health management in fish farming practices. Participants were exposed to various

Pledge taking ceremony at ICAR-DCFR headquarters to work together on harmony

The Chief Guest distributing ornamental fishes to farmers

Fish seed distribution to farmers

Celebration of Independence Day at Bhimtal

Celebration of Independence Day at Champawat

Celebration of Republic Day at Bhimtal

Celebration of Republic Day at Champawat

activities of the farm and later healthy fish seeds of ornamental fishes were distributed to 15 selected fish farmers of the Champawat area. Dr. R.S. Patiyal spoke on the prospects of ornamental fisheries in mid hills, Mr. S.K. Malik and Mr R.S. Tandel explained on the diseases in coldwater ornamental fishes and their treatment, Mr. Kishor Kunal and Mr. P.A. Ganie educated the farmers on water quality management, Mr. A.K. Giri, Dr. Raghvendra Singh and Mr. Raja Aadil H. B. explained the farmers on fish feed management. The entire programme was coordinated by the scientists of Experimental Fish Farm, Champawat.

5.8 Independence Day and Republic Day Celebration

The Independence Day on 15th August 2017 and The Republic Day on 26th January 2018 of our nation was celebrated with flag hoisting ceremony attended by all the scientist and staff of the Directorate. Dr. A.K. Singh, Director unfurled the national flag on the Independence Day whereas Dr. Debajit Sarma, Director (Acting) unfurled the

national flag on the Republic Day. Both the leaders saluted the patriots who gave us the freedom and the opportunity to celebrate the days and addressed the gathering to work in harmony. Scientists and staff of the Directorate also expressed their pride for being the part of such a glorious nation. Likewise, Independence Day and Republic Day was celebrated at Experimental Fish Farm, Champawat with great fervour. The National Flag was unfurled by Dr. S. Chandra, Incharge on 15th August 2017 and by Mr. Raja Aadil Hussain Bhat, Scientist on 26th January 2018. All the staff (Permanent and contractual) were sensitized on the importance of celebrating the Republic day.

5.9 Sadbhavna Diwas

Sadbhavna Diwas was celebrated on 20th August 2017 at Experimental Fish Farm, Champawat with a mission to work in harmony and to maintain good fellow feelings for each other. All the staff of the fish farm took pledge to work for the emotional oneness and harmony of all the people of India regardless of caste, region, religion or language and further to resolve all differences among themselves through dialogue and constitutional means without resorting to violence.

Pledge taking ceremony on Sadbhavna Diwas

5.10 Hindi Pakhwada and Hindi Saptah Samaroh

Hindi Pakhwada was organized at Experimental Fish farm, Champawat from 14-30 September 2017.

Competitions arranged among the institute staffs during *Hindi Saptah Samaroh*

Winners of competitions held during the *Hindi Saptah Samaroh*

Events like scientific vocabulary, hindi translation, essay writing, speech and debate competition were organized during the Pakhwada. Staff of Experimental Fish Farm keenly participated in the events such as essay writing on the topic '*Rajbhasa ka virodh-kitna sahi, kitna galat*', speeches delivered on '*Badhte tapmaan ko rokne ke upay/sujhav*' and debate competition on '*Vidyut utpadan ke liye pahari kshetron me bade bandh ka nirman karna kya samayki mang hai* ?'. Prizes were also distributed to the winners under different categories.

Hindi Saptah was organized at Bhimtal during 14-20 September 2017 by conducting various competitions such as essay writing, word knowledge, Hindi to English translation, Hindi skill, computer oriented Hindi typing among the staff of the Directorate. Prizes were distributed to the winners on the Annual Foundation Day of ICAR-DCFR on 24th September 2017.

Observing Hindi Pakhwada at Champawat

5.11 Swachhata Hi Seva

The *'Swachhta Hi Seva'* campaign has been initiated under Swachh Bharat Abhiyan with great enthusiasm during from 15th September to 2nd October 2017 by the ICAR-DCFR. All the staff members, research scholars, students and contractual staff performed various activities for the *Swachhta* of the office campus and nearby places at Bhimtal. The major works performed under the programme are cleaning of the office premises and adjoining areas including various public and tourist places. The Directorate has adopted 6 villages of Champawat and Almora districts under *Mera Gaon Mera Gaurav* and also performed *Swachhta Hi Seva* in these villages with villagers to beautify surrounding areas by regular cleaning of waste materials and segregating the biodegradable and non biodegradable wastes and its use for composting. Plantation was done on road side places. Awareness programmes on cleanliness and *'Swachhta Hi Seva'* was organized at Bhimtal and Champawat. A vermi-compost pit was created at the campus to make use of the compost to manure the plants.

Address by Dr. A.K. Singh, Director to the staffs of ICAR-DCFR on *'Swachhta Hi Seva'*

Cleaning tourist places near Bhimtal lake for generating awareness among the local residents and vendors

5.12 National Seminar

ICAR-DCFR in collaboration with Zoological Society of India and Coldwater Fisheries Society of India has organized a national seminar on 'Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture' from 22-24 September 2017 at Bhimtal, Uttarakhand. The Chief Guest of the inaugural session was graced by Padma Shree Prof. R.C. Sobti, Vice Chancellor of Babasaheb Bhimrao Ambedkar University, Lucknow. The other dignitaries present

Lighting of auspicious lamp

on the occasion were Dr. Dilip Kumar, former Director of CIFE and FAO consultant; Dr. George John, former Vice Chancellor, Birsa Agricultural University; Dr. S.D. Tripathi, former Director, CIFE and CIFA; Dr. M. Sinha, former Director, ICAR-CIFRI, Barrackpore; Dr. K.K. Vaas, former Director, CIFRI and DCFR; Dr. B.N. Pandey, President, ZSI; Dr. C.N. Ravishankar, Director, CIFT; Dr. S. Raizada, Assistant Director General (Inland Fisheries), ICAR; Dr. S.K. Das, Director, Directorate of Fisheries, Govt. of Assam; Dr. J.R. Dhanze, former Dean, College of Fisheries, Tripura; Mr. Prakash Chandra, Chief Development Officer, Nainital and several other eminent scientists and academicians. Following the traditional lighting of the lamp by the chief guest and the dignitaries, Dr. A.K. Singh, Director, ICAR- DCFR welcomed the Chief Guest, Guests of Honour and an auspicious gathering of 150 scientists, officials from department of fisheries from various states, farmers, entrepreneurs and research scholars from different parts of the country, and briefed on the importance of the National Seminar. The Chief Guest addressed

Release of publications

on the rich heritage of science in India and emphasized the need to observe, learn and simulate nature for sustainable use of aquatic resources and the importance of scientific developments in reaching a common man. The other dignitaries also presented their remarks on the Status, Challenges and Opportunities in coldwater fisheries and aquaculture. On the occasion, an Abstract Book on the seminar thematic areas, Souvenir, a Newsletter by Coldwater Fisheries Society of India (CFSI) and a book entitled 'Aquatic resources and fish diversity

Presentations made by the participants during the seminar

Prize distribution to winners in various categories during the national seminar

of Himalaya' was released. Besides, several awards under the banner of Coldwater Fisheries Society of India and Zoological Society of India were conferred to the eminent scientists during the event. The three day programme witnessed scientific sessions with lead talks by known subject experts, oral and poster presentations by the participants. Exhibition stalls were installed for display of research and development activities of fisheries based ICAR institutes of the country. The various deliberations in the seminar are expected to culminate in a roadmap

to augment coldwater fisheries and aquaculture production in India.

5.13 ICAR-DCFR Foundation Day

ICAR-DCFR celebrated the 30th Annual Foundation Day on 24th September 2017 at its premises. The occasion was graced Dr. George John, former Vice Chancellor, Birsa Agricultural University; Dr. S.D. Tripathi, former Director, CIFE and CIFA; Dr. M. Sinha, former Director, ICAR-CIFRI, Barrackpore; Dr. K.K. Vaas, former Director, CIFRI and DCFR. Dr. A.K. Singh, Director briefed the gathering on the accomplishments of the Directorate and expressed his gratitude towards the efforts made by the researchers in the past and present in taking the institute to such heights. A felicitation ceremony was followed on the day whence selected staffs of ICAR-DCFR were offered a certificate for carrying out their meticulous work in the greater interest of the institute.

Dr. A.K. Singh addreesing the gathering on the Annual Foundation Day

Felicitation to staffs of ICAR-DCFR for their work performance on the foundation day

5.14 Vigilance Awareness Week

Vigilance Week was observed during 30th October to 4th November 2017 under the theme 'My vision – corruption free India' to create awareness of vigilance among the staff and scholars of the Directorate. An integrity pledge was collectively undertaken by all the staff and scholars committing to uphold highest standards of honesty and probity in all walks of life, which was later individually registered online on the website of Central Vigilance Commission. Special documentaries on the menace of corruption and the need to root it out were screened for all the staff and students. Dr. Prem Kumar delivered a lecture on 'Corruption and its impact on integrity, moral and ethics'. Dr. Biju Sam Kamalam conducted a quiz and debate on CVC, RTI, CIC and prevention of corruption acts. Outside the campus, several awareness programmes were similarly organised for students in nearby schools and for farmers of Gethia village. Students who actively participated in the debates were given appreciation certificates. Dr.

Integrity pledge taken at Bhimtal

Integrity pledge taken at Champawat

Awareness camps in different schools on Vigilance Awareness Week

Prem Kumar, Dr. N.N. Pandey, Dr. B.S. Kamalam, Mr. R.S. Tandel and Mr. A.K. Saxena coordinated the entire programme. Various programmes on a similar line were observed at Experimental Fish Farm, Champawat. Events like essay writing, speech and debate competition for students, lectures by scientists etc were organised during the week. The first awareness camp was organized at Janta Uchhtar Madhyamik Vidyalaya, Mudyani on 31st October 2017 and a total of 85 students of VI – Xth standard participated and took part in essay and debate competitions. The second vigilance awareness camp was arranged at village Mourari for the 65 villagers on 1st November 2017. The third awareness camp was organized on 2nd November 2017 for the nearby Chirrapani Tea Garden employees at their tea estate. The fourth vigilance awareness camp was conducted for the university students at Govt. P.G. College, Champawat on 3rd November 2017. In all the camps, posters were displayed to create mass awareness on the government initiatives viz., digital India movement, social media usage, transparency in work places etc in eradicating the ill-issues from the society. Integrity pledge was taken by staff members, school and university students, villagers and workers on the occasion.

5.15 Agriculture Education Day

ICAR-DCFR organized 'Agricultural Education Day' on 3rd December, 2017 at Bhimtal and Champawat by educating children and youth on the perspectives of agriculture and allied sectors and with a larger objective to create trained manpower for catering the needs of the farmers of tomorrow. A quiz competition on the topic 'Indian Agriculture' was organized in the Lakes International School, Bhimtal. Altogether, 125 students of class VI-VIII and teachers of the school alongwith scientists, staff and research scholars of ICAR-DCFR have participated in the programme. Dr. N. N. Pandey and Dr. S. Ali of the institute talked on the topics 'Role of agriculture in the development of India' and 'Agriculture education: Its role and importance' respectively. Similarly, an essay competition was organized on the topic 'Agriculture Education: Its role and importance in an agri-based country like India' at Experimental Fish Farm, Champawat for 20 students studying in class IX and X of Janta Higher

Participation of school students on Agricultural Education Day at Bhimtal

Organizing Agricultural Education Day at Champawat

Secondary School, Muryani. Mr. Abhay Kumar Giri, Mr. Ravinder Kumar and Mr. Hansa Datt Sanwal of the farm explained on the importance of celebrating this day and briefed on the prospects in agriculture and allied sciences as a professional and research career.

5.16 World Soil Day

ICAR-DCFR organized 'World Soil Day' on 5th December 2017 with participation of 50 farmers from district Nainital. The function was graced by Mr. Saurabh Rautela, President, Vyapar Mandal, Bhimtal in the presence of Mr. R.P. Tamta, Deputy Director of Fisheries and other Officers from Department of Fisheries, Govt. of Uttarakhand. The technical talk was delivered by the institute scientists. Dr. D. Sarma emphasised on the importance of soil health cards in view of doubling the farmer's income. Dr. N.N. Pandey, Dr. Prem Kumar and Dr. S. Ali highlighted on better soil productivity in aquaculture, correction of soil and organic farming. The fish farmers were further made aware of the optimum range of soil quality parameters for fish farming. It was urged to the all fish farmers in keeping the record of the soil health of their fish ponds for better management practices by taking farm advisory from ICAR-DCFR. A group

Participants interacting with the scientist during the World Soil Day at ICAR-DCFR

discussion among farmers, officers and scientists was also conducted with the focus of improvement of farmer's production. It was suggested to start-up what's app group including fish farmers, officers of State Fisheries Department and Scientists from ICAR-DCFR for prompt information and advisory for the benefit of the farmers.

5.17 Fish Farming and Planning Expert Dialogue Meet

Fish farming and planning expert dialogue meet was organised along with Environs Trust for the farmers of Pati, Champawat at Experimental Fish Farm, Champawat on 7th December 2017. 15 farmers participated in the programme and interacted with the scientists. The group discussed on various ideas and possibilities to boost fish production of Champawat district through extension of new technologies to the farmers.

Interaction among the group members during the meet

5.18 Research Advisory Committee Meeting

The Research Advisory Committee (RAC) of ICAR-DCFR was held on 29-30 December 2017 at the Directorate, Bhimtal under the chairmanship of Dr. M. Sinha, former Director, ICAR-CIFRI, Barrackpore. The meeting was attended by esteemed members Dr. Sudhir Raizada, Dr. S.C. Mukherjee, Dr. A.K. Sahoo and Dr. H.C.S. Bisht. Dr A.K. Singh, Director, ICAR-DCFR gave a brief account of the on-going research programmes, new initiatives and significant achievements during April-November 2017 and apprised the RAC on the recent development of infrastructure and facilities created at the Directorate. He also presented the action plan and progress on committed activities under approved SFCs. Based on the presentations made by the scientists, detailed review and discussion on the research outputs under different projects of ICAR-DCFR were made. RAC recommended to undertake exploration programmes of high altitude lakes, action taken initiatives for commercialization of trout feed, development of breeding technology

Briefing on the research activities of ICAR-DCFR by Dr. A.K. Singh

Farm visit of the RAC Members

for different coldwater fish species and technical support to the state fisheries departments in doubling farmers. RAC appreciated the overall progress made by the institute and congratulated Director and scientists of ICAR-DCFR for their commendable work.

5.19 Sangoshthi on 'Promotion of Mahseer Ecotourism in Kumaon Region'

ICAR-DCFR participated in one-day Sangoshthi on 'Promotion of Mahseer Eco-tourism in Kumaun Region' on 7th January 2018 at ICAR-DCFR, Bhimtal for promotion and development of ecotourism in the region considering the local issues of the people and their participation. The programme was organized by District Administration Nainital and Department of Tourism, Govt. of Uttarakhand, where 150 people of the state participated. Mr. Ram Singh Keda, Member of Legislative Assembly, Bhimtal and Mr. Ramesh Bhatt, Media Advisor, Hon'ble Chief Minister, Uttarakhand graced the occasion and highlighted the importance of people participation in the restoration of Kumaon lakes for the promotion and development of mahseer based eco-tourism and livelihood security. Other dignitaries Mr. Devendra Kumar Chaudhary, District Magistrate, Nainital; Mr. Janmjay Khanduri, SSP, Nainital; Mr. Prakash Chandra, Chief Development Officer, Nainital; Mr. Rajesh Negi, President, Nagar Panchayat, Bhimtal and Mrs. Geeta Bisht, Block Pramukh, Bhimtal along with more than 150 public representatives participated and deliberated in this Sangoshthi. Dr. Debajit Sarma, Director (Acting) of the Directorate explained the role of ICAR-DCFR in rehabilitation of golden mahseer 'The Pride of Uttarakhand' and possibilities to develop mahseer based eco-tourism in the region benefiting the local people in their economy.

Inauguration of *Sangoshthi*

Speech by Director during *Sangosthi*

5.20 Kisan Mela

ICAR-DCFR organized 1-day Kisan Mela cum Scientists-Officers-Farmers Interactive Meet at Experimental Fish Farm, Champawat on 24th

Farmers participation in the Kisan Mela

Release of trout feed developed by ICAR-DCFR during the Mela

Distribution of fish seeds to the prospective fish farmers

Distribution of soil health cards to the farmers

Visit of the Chief Guest to Experimental fish farm units, Champawat

February 2018. 250 delegates including 200 fish farmers, Govt. officers in the region, academicians, public representatives, fisheries officers, representatives from SSB and ITBP participated in the programme. Dr. Ahmed Iqbal (IAS), District Magistrate, Champawat and Mr. Prakash Tiwary, Chairman, Nagar Panchayat, Champawat graced the occasion as the Chief Guest and Guest of Honour respectively. A snow-trout hatchery was inaugurated by the dignitaries on the occasion. Fish pond soil health card was distributed to the farmers along with fish seed. A leaflet on rainbow trout starter feed was also released in Hindi for their easy understanding. In the interactive meet, issues raised by the farmers for increasing their farming income were addressed. Active participation was seen among the enthusiastic farmers in receiving knowledge and skill for improved hill aquaculture management practices during the programme.

5.21 Workshop on 'Protecting Intellectual Property Rights'

The Institute Technology Management Unit (ITMU) of ICAR-DCFR organized a 1-day workshop on 'Protecting Intellectual Property Rights' on 20th March 2018 to sensitize students, scientists, researchers and other associated members of R&D sector towards IPR issues and rights provided under the law. Prof. B.S. Bisht, Director, Birla Institute of Applied Sciences graced the occasion as the Chief Guest. The workshop was chaired by Dr. Debajit Sarma, Director (Acting), ICAR-DCFR, Bhimtal.

On this occasion, more than 60 participants from Birla Institute of Applied Sciences, Bhimtal; ICAR-DCFR, Bhimtal; VPKAS, Almora and other organization attended the workshop. Dr. R.S. Patiyal, Incharge ITMU welcoming the dignitaries and participants explained the purpose and objectives of this workshop. Invited lectures were organised for the participants with an introductory note on 'Intellectual property and its management in agriculture - An overview' by Dr. Lakshmi Kant, Principal Scientist, VPKAS, Almora. Dr. Prem Kumar, Principal Scientist and Oversee, ITMU, ICAR-DCFR talked on 'Technology Marketing'. Deliberations on 'Patents' and on 'Geographical indicators and its importance in fisheries and agriculture' was given respectively by Dr. Biju Sam Kamalam and Dr. Prakash Sharma, Scientist of ICAR-DCFR. The programme was coordinated by Dr. R.S. Patiyal, Dr. Prem Kumar and Dr. M.S. Akhtar.

Deliberations and interaction among the participants and experts on the issues of IPR

5.22 Farmers-Officers-Scientists Interactive Meet

ICAR-DCFR, Gaumco Multipurpose Cooperative Society and in association with Department of Fisheries, Govt. of Arunachal Pradesh jointly organized Farmers-Officers-Scientists Interactive Meet at Hari village, Ziro valley of Lower Subansiri district of Arunachal Pradesh on 22nd March 2018 on 'Fish farming and seed production in cold regions of Arunachal Pradesh'. Altogether, 250 participants including farmers, officers, scientists and guests attended the programme. The programme was chaired by the Hon'ble Parliamentary Secretary Food and Civil Supplies Er. Tage Taki as the Chief Guest. Other dignitaries to grace the occasion were

Participants of the interactive meet

Dr. D. Sarma explaining the operation of hatchery to the guest and dignitaries

Mr. Kemo Lollen, Deputy Commissioner, Lower Subansiri district, Govt. of Arunachal Pradesh (Guest of Honour); Mr. Hage Kobin, Zilla Parishad Chairperson, Lower Subansiri district Govt. of Arunachal Pradesh (Guest of Honour) and Er. Gyati Atto, Chaiman of Gaumco Multipurpose Cooperative Society. Progressive farmers' representatives Mr. Tilling Tadi, Mrs. Tylang Shanti and Mrs. Gyati Rinyo; Mr. James Nabam, DFDO and development officers from various departments of Lower Subansiri district; scientists from KVK Lower Subansiri and ICAR-DCFR Dr. Deepjyoti Baruah and Mr. Parvaiz Ahmad Ganie witnessed and interacted during the meet. Dr. Debajit Sarma, Director (Acting) of the Directorate briefed on the mandates of the institute and the objectives of the programme in creating awareness to make the state self sufficiency in fish seed production and expansion of diversified aquaculture practices in cold regions while incorporating new variety of fish into the farming system. A Portable FRP Fish Hatchery installed under the guidance of this Directorate was inaugurated on the occasion by the Hon'ble Parliamentary Secretary Food and Civil Supplies Er. Tage Taki in presence of other dignitaries and distinguish guests in the village at the premises of Mrs. Gyati Rinyo, an active member of Gaumco

Release of a technical bulletin

Distribution of fish seeds to the farmers

Society. The fish hatchery will be of the first kind to be operated in the region by women entrepreneurs. Critical inputs in the form of quality fish seeds were distributed free of cost for encouragement to the farmers in undertaking aquaculture as a true vocation for their livelihood. The programme successful ended with positive feedback from the farmers. Certificates were distributed to the participating farmers. Field visits were conducted to the farm premises of the Chief Guest, fish farms of many villagers to solve the questions raised by them during the meet. The programme was coordinated by Dr. Deepjyoti Baruah and Mr. P.A. Ganie of the Directorate.

5.23 Awareness Workshop on Intellectual Property Rights

An awareness workshop on Intellectual Property Rights (IPR) was organized at Experimental Fish Farm, Champawat on 28th March 2018 with an objective to create awareness among the participants on the importance and role of IPR to safeguard any technology developed by providing patent or copyright facilities. Altogether 80 participants including 60 students from Govt. PG College Champawat, officials of other line departments, scientists, technical and staffs of the farm attended the program. Former Government Advocate Mr. Amar Nath Verma chaired the occasion and addressed the gathering on the national and international laws and rights governing the intellectual property followed by information on registration process of copyright, trademarks and filing of patents. Guest of Honour Dr. Tanuja Bisht, Principal, Govt. PG College, Champawat briefed on 'IPR- Challenges and the way forward'. The program continued with deliberations from the scientists of ICAR-DCFR on 'Overview of Intellectual Property Rights in India' by Mr. Raja Aadil H.B; 'Trademark and Trade secrets in IPR' by Mr. A.K. Giri; 'Geographical indications' by Mr. Kishor Kunal and 'Copyright issues' by Mr. Parvaiz Ahmad Ganie. Discussions were made on commercialization and transfer of technologies to public domain for the benefit of the people and end users. The workshop was coordinated by Member ITMU Mr. Kishor Kunal, Mr. A.K. Giri, Mr. Raja Aadil H.B, Mr. Parvaiz Ahmad Ganie, Mr Ravinder Kumar, Mr. Hansa Dutt and Mr. T.M. Sharma of the farm.

Workshop on IPR at Champawat

Participants during the programme

Extension Activities, Consultancy and Other Services

6

6.1 Mera Gaon Mera Gaurav (MGMG)

The 'Mera Gaon Mera Gaurav' is an ICAR initiative where it has been conceptualized that the scientists of ICAR and Agricultural Universities will identify villages in the vicinity of the institutions for providing advisories and consultations to farmers for increasing farm productivity and production. In pursuance to the above, ICAR-DCFR has divided 20 scientists in 7 teams for adoption of 17 villages so far. The gist of villages adopted, teams and activities undertaken under MGMG are summarised in Tables below:

Details of MGMG Team and status of benchmark survey of selected villages

Team	Name of scientists	Name villages adopted	Name of block	Name of district	No. of villages
Team 1	Dr. D. Sarma Dr. D. Barua Mr. S. K. Mallik	Umshning, Pynhurslla, Laitkhrong, Myrang	Umshning, Pynhurslla, Laitkhrong, Myrang	Ri-bhoi, East Khasi Hills, West Khasi Hills	4
Team 2	Dr. D. Baruah Mr. S. K. Mallik Dr. R. S. Haldar Dr. S.G.S Zaidi	Chug, Sangti, Hari	Dirang, Ziro	West Kameng, Lower Subansiri	3
Team 3	Dr. N. N. Pandey Dr. Prem Kumar Mr. Biju Sam Kamalam Mr. Santosh Kumar	Todera, Dudhauli, Jyurkafun	Dwarhat, Hawal bagh	Almora	3
Team 4	Dr. Prakash Sharma Dr. N. N. Pandey	Maneybung, Sopakha, Sribadam	Dentam	West Sikkim	3
Team 5	Dr. R. S. Patiyal Dr. Prem Kumar Mr. Rajesh M.	Salmatta, Sarmoli	Sitarganj, Munsyari	U. S. Nagar, Pithoragarh	2
Team 6	Mr. S. Chandra Dr. Raghvendra Singh Mr. Kishor Kunal	Dudh pokhara	Champawat	Champawat	1
Team 7	Mr. Abhay Giri Mr. Parvaiz Ahmad Ganie Mr. Raja Adil Hussain Bhatt	Kathad	Champawat	Champawat	1

Summary of activities organized under MGMG

S. No.	Name of activity	No. of activities conducted	No. of farmers participated/ benefitted
1	Visit to village by teams	26	180
2	Interface meeting/ *Goshthies*	05	46
3	Trainings conducted	05	124

4	Mobile based advisories	12	12
5	Literature support provided	14	253
6	Awareness created	12	212
7	Linkages developed with other agencies	06	217

Details of demonstration conducted under MGMG by the Institute

S. No.	Title of demonstrations	No. of demonstration	Area covered under demonstration (ha)/ number of units, etc.)	Farmers benefitted
1	Fish farming in polytanks	16	1200 m^2	16
2	Fish farming in ponds	03	3000 m^2	03
3	Trout farming in raceways	12	480 m^2	12

Details of trainings conducted under MGMG by the Institute

S. No.	Topic of training	Duration of training (No. of days)	Farmers participated in training
1	Awareness cum training programme on fish farming in polytanks	1-day	33
2	Integrated fish farming	1-day	45

Details of awareness created under MGMG by the Institute

S. No.	Subject matter of awareness (*Swachhata*/ Crop insurance/ climate change, etc.)	Farmers benefitted
1	Soil health for fish farming	24
2	Fish farming in hills	45
3	Climate change	33
4	Fish production & seed production	45

Details of any other activity organised under MGMG by the Institute

S. No.	Name of activity	Farmers benefitted
1	Farmers-Officers-Scientists Interactive Meet at Ziro, Arunachal for Enhancing Fish Farmers Income	200

Glimpses of *Mera Gaon Mera Gaurav*


Diagnostic visits to fish farms at Changpa and Donglok villages of Arunachal Pradesh

Fish farming advices in polytanks at Jyurkafun to prevent seepage


Farm advisory services to fish farmers of Chug village, Arunachal Pradesh

Skill development in net mending


Fish hatchery development at Hari village of Lower Subansiri district

Distribution of fish seeds to farmers of Jyurkafun for start-up fish farming


Fish seed distributed to farmers at Samaltta village

Trout farm visit at Sarmoli village

6.2 Consultancy Services

6.2.1 Aquatic ecology studies under CEIA of hydroelectric projects in Sutlej basin, Himachal Pradesh

Under the Cumulative Environmental Impact Analysis of River Sutlej and its tributaries in Himachal Pradesh as an Institutional Consultancy, work has been undertaken on the study of aquatic flora and fauna. Field survey was conducted at different locations to collect primary data on aquatic flora and fauna, aquatic ecology and primary productivity in the study area. From the study, it was found that the overall primary productivity of the Sutlej basin is inherently poor. Plankton samples indicated that the phytoplankton contributes a larger proportion than zooplanktons in total plankton population of Sutlej basin. Presence of three groups of phytoplankton *viz.* Chlorophyceae, Cyanophyceae and Bacillariophyceae (diatoms) were detected where Bacillariophyceae dominated in the river reaches in terms of occurrence and abundance. The contribution of green algae and blue green algae was comparatively less in almost all reaches. The dominant phytoplankton taxa

recorded were *Cymbella, Amphora, Nitzschia, Gomphonema, Fragilaria, Melosera, Navicula, Oscillatoria* etc. The natural variability of rivers makes it difficult to describe a 'typical' seasonal succession of phytoplankton. However, the densities remained relatively low during the post-monsoon period. Macro invertebrates mainly comprised of different groups such as Ephemeroptera, Tricoptera, Plecoptera, Coleoptera, Diptera, Odonata, and Hemiptera. The remaining included oligochaetes, molluscan shells, nematodes and planarians in negligible densities. The Ephemeroptera were found most abundant which indicates good water quality as well as favourable for biotic communities. The predominant species in Sutlej basin comprised of *Schizothorax* spp. However, at few locations *Glyptothorax* spp., *Garra gotyla gotyla* were also recorded. The juveniles of *Schizothorax* and *Barilius* spp. were recorded in the shallow zones of a few lower tributaries. The flow in the upper zone remains very turbulent with heavy load of silt. Moreover, the poor

Sampling at different tributaries of River Sutlej, Himachal Pradesh

primary productivity also does not support the fish abundance. Due to this the presence of species are negligible. Fish populations are highly fragmented and are confined in the different stretch of the river. The construction of a dam on a river can block or delay upstream fish migration and thus contribute to the decline and even the extinction of species that depend on longitudinal movements along the stream continuum during certain phases of their life cycle.

6.2.2 Technical consultancy to Kanan Devan Hills Plantations Company (P) Ltd., Munnar, Kerala

The Directorate has signed a memorandum of understanding with Kanan Devan Hills Plantations Company (P) Ltd., Munnar, Kerala to provide scientific and technical guidance to improve and up-scale the operation of the rainbow trout hatchery

Consultancy services to Kanan Devan Hills Plantations Company (P) Ltd., Munnar, Kerala

at their Rajamalai Estate. This was preceded by the visit of a team of ICAR-DCFR scientists comprising Dr. A.K. Singh, Dr. Debajit Sarma and Dr. Biju Sam Kamalam on 24th November 2017, at the behest of KDHP Management. After taking stock of the limitations and challenges in the hatchery management, the team had a discussion with Mr. Mathew Abraham (Managing Director) and Mr. Utpal Lahiri (Senior Manager) on the various possibilities of reinvigorating the hatchery operation and initiating commercial rainbow trout culture. As a follow-up, Dr. B.S. Kamalam visited the hatchery again on 12th January 2018, and provided in-kind sample of ICAR-DCFR formulated and validated rainbow trout starter feed for comparative evaluation against the existing feeding practice. This was followed by detailed deliberation on the possible ways of strengthening the hatchery operation through improvement of brood fish, feed management and skill development of farm-hands with the KDHP management comprising Mr. Abraham, Mr. Lahiri, Mr. Jacob Chacko and Mr. Arun Sajeev. After the MoU, the assigned nodal officer Dr. Kamalam along with the Directorate's team of scientists have been providing consultancy

and facilitating feed procurement and management in the hatchery, with visible improvement in the growth and health of the larval and brood fishes reared in the facility. In short time, ICAR-DCFR customized rainbow trout feed will also be made available.

6.3 Exhibitions Participated

The research and development activities of the Directorate were exhibited and disseminated to scientists, farmers, students, faculty members of different universities and other stakeholders at several seminar, symposia, workshop, conference and Kisan Mela etc. organized across the country. The details of the participations are mentioned in the table below:

Name of the programme	Organizer	Duration	Place/Venue
International Symposium on Aquatic Animal Health and Epidemiology for Sustainable Asian Aquaculture (ISAAE)	ICAR- NBFGR, Lucknow in collaboration with Aquatic Biodiversity Conservation Society, Lucknow and National Surveillance Programme on Aquatic Animal Diseases	April 20-21, 2017	ICAR- NBFGR, Lucknow
29th All India Congress of Zoology (29th AICZ) & International Symposium on Culture Based Fisheries in Inland Open Waters & International Satellite Symposium on Fish Immunology	Inland Fisheries Society of India (IFSI), Barrackpore in collaboration with Zoological Society of India (ZSI), Bodh Gaya and ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore	June 9-11, 2017	ICAR-CIFRI, Barrackpore
"21st National Agriculture Exhibition" on the Theme "India Progressing Towards a Great Nation"	Central Calcutta Science & Culture Organization for Youth, Kolkata	August 24-27, 2017	Vivekananda Krirangan, New Barrackpore, Kolkata-31
National Seminar on Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture	ICAR-Directorate of Coldwater Fisheries Research, Bhimtal	Sept. 22-24, 2017	ICAR-DCFR, Bhimtal
102nd Pantnagar Kisan Mela & Agro-Industrial Exhibition	GBPUAT, Pantnagar	October 06-09, 2017	GBPUAT, Pantnagar
Kisan Mela	ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora	October 07, 2017	ICAR-VPKAS Experimental Farm, Hawalbagh, Almora
11th Indian Fisheries and Aquaculture Forum (11th IFAF)	ICAR- Central Institute of Fisheries Technology (CIFT), Kochi in association with Asian Fisheries Society Indian Branch (AFSIB)	November 21-24, 2017	ICAR- Central Institute of Fisheries Technology (CIFT), Kochi
World Fisheries Day	Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India	November, 21-23 2017	ICAR-IARI campus, Pusa, New Delhi
International Conference on Science and Geopolitics of Himalaya, Arctic & Antarctic: Focusing on Climate Change (SaGHAAIV, 2017)	LIGHTS (NGO)	November, 30 to December 01, 2017	India International Centre, Lodhi Road, New Delhi
Kisan Gosthi and *Sankalp Se Siddhi* Programme	Krishi Vigyan Kendra, Lohaghat	11th September 2017	Krishi Vigyan Kendra, Lohaghat
North Zone Regional Farmers Fair	ICAR- Indian Institute of Vegetable Research, Varanasi	23-25 February, 2017	Trade Facilitation Centre, Bada Lalpur, Chandmari, Varanasi, Uttar Pradesh

Name of the programme	Organizer	Duration	Place/Venue
103rd Pantnagar Kisan Mela & Agro-Industrial Exhibition	GBPUAT, Pantnagar	February 24-27, 2018	GBPUAT, Pantnagar
National seminar on Emerging trends in Hi-tech Hill Horticulture under changing climate	ICAR-CITH, Mukteswar	March 6-7, 2018	ICAR-CITH, Mukteswar
Krishi Unnati Mela-2018	ICAR-IARI, New Delhi	March, 16-18, 2018	ICAR-IARI, New Delhi
Kisan Mela	ICAR-VPKAS, Almora	March 23, 2018	ICAR-VPKAS, Experimental Farm, Hawalbagh, Almora

Exhibition at KVK Lohaghat under *Kisan Gosthi* and *Sankalp se Siddhi* Programme, September 2017

Exhibition at ICAR-CIFRI, Barrackpore, June 2017

Exhibition during National Seminar at ICAR-DCFR, Bhimtal, September 2017

Exhibition during *Krishi Unnati Mela*, March, 2018

6.4 Swachh Bharat Abhiyan

Various activities under Swachh Bharat Abhiyan were performed at ICAR-DCFR on weekly basis with the participation of all officers, staffs, research scholars and students. Activities such as cleaning of the office premises and adjoining areas of the office campus, beautification by plantation along the road sides, cleaning of drains in public places, removal of garbage and waste materials from tourist places etc. Programmes such as *'Swachhta Hi Seva'* campaign has been initiated under *Swachh Bharat Abhiyan* at the Directorate and Experimental Fish Farm, Champawat.

Cleaning of campus and nearby places of ICAR-DCFR by staff

6.5 Mahseer Ranching Programme under Namami Ganga

Five thousand numbers of mahseer juveniles were released in river Ganga at Laksmanjhula, Rishikesh of Uttarakhand by ICAR-DCFR, Bhimtal in collaboration with ICAR-CIFRI on 23rd May 2017 under Namami Ganga programme with an objective to enhance the mahseer population in the upper reaches of river Ganga. In the programme, Dr. D. Sarma, Director (Acting); Dr. D. Baruah, Sr. Scientist and Dr. R.S. Haldar, ACTO participated from ICAR-DCFR, Bhimtal in presence of Dr. B. K. Das, Director, ICAR-CIFRI, Barackpore and his team. Besides, representatives from Department of Fisheries, Govt. of Uttarakhand, Department of Forest, Uttarakhand also participated in the programme. The mahseer seeds were produced at the hatchery complex of ICAR- DCFR, Bhimtal and transported to Rishikesh for ranching under Namami Ganga Program.

Ranching of mahseer fish seeds under Namami Ganga at Laxmanjhula

6.6 Himani Aquarium

Himani Aquarium established at ICAR-DCFR, Bhimtal was gracefully inaugurated on 6th February 2018 by the Padma Shree Dr. Yasodhar Mathpal to unveil to the public with all its aesthetic excellence. The Director (Act.), Dr. Debajit Sarma expressed his contentment over dedicating the aquarium display to public for generating interest for aquarium keeping and also for conservation of coldwater aquatic resources. It is expected that the children will be benefited by the dissemination

Dignitaries visit at Himani aquarium of the Directorate

of knowledge on understanding aquatic life and their environment. The aquarium will serve as an information centre on various ornamental fishes and their biology to the public. The aquarium displays more than 30 beautiful and fascinating indigenous cold water ornamental fishes as well as several variants of exotic fishes. The indigenous coldwater mahseer, snow trout and Indian hill trout are one of the foremost attractions of visitors. Visitors are warmly welcomed to enjoy the aesthetic beauty of this aquarium from Monday to Saturday (closed on public holidays) from 10:00 A.M. to 05:00 P.M. with an entry fee of ₹ 10/-. Further, the people are also welcomed to purchase the ornamental seeds from the Directorate farm.

6.7 Visitors

6.7.1 Farmer visits

- A group of 6 trout farmers from district Tawang of Arunachal Pradesh along with Mr. Ajoyendu Chanda, Assistant Director, Directorate of Fisheries, Itanagar, Arunachal Pradesh visited Experimental Fish Farm, Champawat on 12-16 October 2017 to gain knowledge on rainbow trout and carp farming.
- A group of 15 progressive farmers along with tea farming officials from Himachal Pradesh visited the Experimental Fish Farm, Champawat on 19th September 2017. Farmers were given demonstration and lecture on rainbow trout farming.
- A group of 18 Tribal Farmers from Lahaul Spiti District of Himachal Pradesh along with Scientists from ICAR-VPKAS, Almora (Uttarakhand) visited ICAR-DCFR, Bhimtal on 12th March 2018 and interacted with scientists.

Demonstration on fish farming to officers of Himachal Pradesh

6.7.2 Students visits

- A group of 62 students (2nd and 4th Semester) along with 3 faculty members from Government Girls' Polytecnic, Almora, (Uttarakhand) visited ICAR-DCFR, Bhimtal on 6thApril 2017 and interacted with scientists.
- A group of 23 (7 boys and 16 girls) Post graduate students (M.Sc. Life Science) with 4 faculty members from Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.) visited ICAR-DCFR, Bhimtal from 9-15 May 2017 and interacted with scientists.
- A group of 50 students of Class VIII to XII from Air Force Station, Bhowali, Distt.-Nainital (Uttarakhand) visited ICAR-DCFR, Bhimtal on 24th May 2017 and interacted with scientists.
- A group of 30 students and staff of Holy Wisdom School, Lohaghat visited the Experimental

Fish Farm, Champawat on 19th June 2017 and interacted with the scientists. Students were given knowledge on the various aspects of fisheries and aquaculture in mid-hills.

- A group of 50 students of Primary School, Phularagaon, Champawat visited Experimental Fish Farm, Champawat on 19th June 2017. Students were explained on the future scope of coldwater fisheries in India.

Students of Primary School, Phularagaon for Champawat

- A group of 26 B.F.Sc. 3rd Year students (13 Boys and 13 girls) along with faculty members from College of Fishery Sciences, Sri Venkateswara Veterinary University, Muthukur, Nellore district (A.P.) visited ICAR-DCFR, Bhimtal during 11-13 August 2017 and interacted with scientists.

Students of College of Fishery Sciences, Sri Venkateswara Veterinary University, Muthukur, Nellore district (A.P.)

- A group of 79 under graduate students (B.Sc, Zoology Honours) with 7 faculty members from Mahishadal Raj College, Under Vidyasagar University, Purba Medinipur, West Bengal visited ICAR-DCFR, Bhimtal on 6th November 2017 and interacted with scientists.
- A group of under graduate students (B.Sc, Zoology Honours,) with 3 faculty members from Hooghly Mohsin College, Under Burdwan University, Chinsurah, Hooghly, West Bengal visited ICAR-DCFR, Bhimtal on 18th November 2017 and interacted with scientists.
- A group of 35 B.F.Sc. Final Year students (15 Boys and 20 girls) along with 2 faculty members from Fisheries College and Research Institute, Tamil Nadu Fisheries University, Nagapattinam-611001 visited ICAR-DCFR, Bhimtal during 20-21 November 2017 and interacted with scientists.
- A group of 35 B.F.Sc. Third year students (18 Boys and 17 girls) along with 2 faculty members from College of Fisheries, Babasaheb Sawant Konkan Krishi Vidyapith, Shirgaon, Ratnagiri (Maharashtra) visited ICAR-DCFR, Bhimtal during 28-29 November 2017and interacted with scientists.
- Students of Class IX and X from Janta Higher Secondary School, Mudiyani, Champawat visited Experimental Fish Farm, Champawat on 3rd December 2017. The students were given lecture on trout and carp farming practices in mid-hill Himalayan region. They were also sensitized for conservation of indigenous fish species.
- A group of 10 students of Rajkiya Ucchattar Madhyamik Vidyalaya, Salli, Champawat visited Experimental Fish Farm, Champawat on 7th December 2017. Students were briefed on the day to day farm activities at the centre and prospects of coldwater fisheries in India.

Students of Rajkiya Ucchattar Madhyamik Vidyalaya, Salli, Champawat

- A group of 40 B.Sc. final year students along with their tutors from Catalyst Coaching Centre Lohaghat were familiarised with fisheries and aquaculture perspective in cold climatic hilly regions of our country upon their visit to the Experimental Fish Farm, Champawat on 18th December 2017.
- A group of 14 B.Sc. (Fisheries) Final year students along with 3 faculty members from Agriculture and Forestry University, Nepal visited ICAR-DCFR, Bhimtal during 18th January 2018 and interacted with scientists.

Students along with faculty members from Agriculture and Forestry University, Nepal

- A group of 16 Students (11 boys and 5 girls) of MBA Agri-business along with 1 faculty member from Department of Business Management, College of Agriculture, CCS Haryana Agriculture University, Hisar visited ICAR-DCFR, Bhimtal during 2-3 February 2018 and interacted with scientists.
- A group of 15 B.F.Sc. Fourth year students along with 3 faculty members from College of Fishery Science, Maharashtra Animal and Fishery Science University, Nagpur, Maharashtra-440006 visited ICAR-DCFR, Bhimtal during 6-7 February 2018 and interacted with scientists.
- A group of 42 High school Students along with 3 faculty members from Government Inter College, Gunialekh, Nainital (Uttarakhand) visited ICAR-DCFR, Bhimtal on 8th February 2018 and interacted with scientists.
- A group of 7 students from Pithoragarh Degree College visited Experimental Fish Farm, Champawat on 15th February 2018. The students interacted with the scientists and explored the possibilities for conducting research experiments as part of their master's dissertation at the centre.

Students of Pithoragarh Degree College

- A group of 15 students (13 girls and 02 boys) of M.Sc (Fisheries & Parasitology) with 4 faculty members from Department of Zoology, Aligarh Muslim University, Aligarh-202002 (U.P.) visited ICAR-DCFR, Bhimtal on 12th March 2018 and interacted with scientists.

Students along with faculty members from Aligarh Muslim University, Aligarh (UP)

- A group of 35 students of Rajkiya Ucchattar Madhyamik Vidyalaya, Khateda, Lohaghat, visited Experimental Fish Farm, Champawat on 22nd March 2018. Students were briefed on the day to day farm activities at the centre and prospects of coldwater fisheries in India.
- A group of 30 students of Rajkiya Ucchattar Madhyamik Vidyalaya, Ijda, Barakot, Lohaghat visited Experimental Fish Farm, Champawat on 24th March 2018. Students were given an overview of Coldwater fisheries resources in the country.

Students of Rajkiya Ucchattar Madhyamik Vidyalaya, Ijda, Barakot, Lohaghat

- A group of 32 students of Rajkiya Ucchattar Madhyamik Vidyalaya, Thanta, Lohaghat, visited Experimental Fish Farm, Champawat on 27th March 2018. Students were given lecture on basics of fish and fisheries science with special emphasis on cultural fish species in mid-hill Himalayan regions.

Students of Rajkiya Ucchattar Madhyamik Vidyalaya, Thanta, Lohaghat

6.8 Coldwater Fish Breeding and Farm Production

6.8.1 Improved common carp breeding

Breeding and seed production of improved common carp was carried out at Experimental Fish Farm, Champawat by following old conventional hapa breeding method without hormone administration. Low cost twines prepared from unused gunny bags were used for collection of eggs. Generally, 150-200g of twine materials was used for collection of eggs released by 1 kg female brooder fish. Sex ratio by weight of 1.0-1.5:1.0 (Male : Female) was kept in the breeding hapa. The fecundity of improved common carp in this method was recorded @ 0.5-1.0 lakh eggs/kg body weight female. The survival percentage of egg to spawn was found for 45-50% and for spawn to fry 30-35%. A total of 7.61 lakhs fry (15dph) were produced in the farm with the use of 369 numbers of female brooders of size range 99.7 ± 20.5g to 287.2 ± 72.2g. Breeding of improved common carps were jointly coordinated by Dr. S. Chandra, Mr. A.K. Giri and Dr. Raghvendra Singh, Mr. Kishor Kunal, Mr. P.A. Ganie and Mr. Raja A.H. Bhat.

Haul of common carp

Hapa setup for common carp breeding

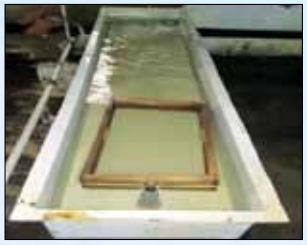
Brooders of ornamental Koi carp (130 numbers) were brought to the Experimental Fish Farm, Champawat from ICAR-DCFR, Bhimtal headquarters on 7th February 2018 for the purpose of stock improvement, research and promotion of ornamental fish farming in mid-hill regions.

6.8.2 Snow trout breeding

Breeding and seed production of snow trout (*Schizothorax richardsonii)* was carried out at Experimental Fish Farm, Champawat by dry stripping method in 2 phases without any hormone administration during November 2017. For breeding of these fishes, 11 numbers of females (size range: 205-270mm and 97-182g) and 17 numbers of


Brooders of snow trout


Fertilized eggs of snow trout


A set up for hatching of fertilized eggs


Fry of snow trout

males (size range: 160-230mm & 26-112g) with M:F sex ratio of 1.0-1.5:1.0 in body weight and 2-3:1 in numbers were selected. Water temperature of 18.8-19.1°C was maintained during the seed production cycle, which resulted into an egg incubation period of 110-125 hrs, fertilization rate of 65-72% and hatching rate of 40-45%. Yolk sac absorption was observed within 96-192 hours at water temperature 17.9-18.6°C. A total of 18,000 numbers of fry were produced during the breeding cycle. Effort has also been made in refurbish of the existing experimental stock of snow trout at the Experimental Fish Farm, Champawat for better spawning results for which snow trout (*Schizothorax richardsonii*) of adult and fry stages were collected from Chalthi, Gaudi, Ladhiya and Chhirapani streams during August-September 2017. The entire activity was coordinated by Dr. S. Chandra and Mr. Kishor Kunal with the help of Mr. A.K. Giri, Dr. R. Singh, Mr. Raja A. H. Bhat and Mr. P.A. Ganie.

6.8.3 Rainbow trout rearing and seed production

Rearing and seed production of rainbow trout has been an important activity at the farm. In the reporting year, 200 rainbow trouts with size range of 400-700g were reared in raceway systems whereas 20,000 rainbow trout fry of 2-3g weight were reared in large FRP tanks at the farm. In order to improve the existing rainbow trout stock in the farm, rainbow trout eyed ova were procured from progressive states like Jammu and Kashmir and Himachal Pradesh. In this regard, 50,000 numbers of eyed ova were imported from Kokernag trout farm, Jammu and Kashmir on 5th February 2018. It was observed that 2-5% of the imported eyed ova were hatched out at the time the consignment arrived Experimental Fish Farm, Champawat. The farmers were also benefited from the imported eyed ova. The farm raised rainbow trout advanced fry of the size 2.8-4.5cm were distributed to the tribal rainbow trout growers of Munshyari under TSP programme. The activities of rearing and seed production of rainbow trout were coordinated by Mr. P.A. Ganie, Dr. Raghvendra Singh and Mr. A.K. Giri with help of Mr. Kishor Kunal and Mr. Raja A.H. Bhat.


Hatchlings of rainbow trout


Fry rearing at fish farm

6.8.4 Fish seed sale and distribution

Farm raised 30,000 numbers of rainbow trout fry were sold from Experimental Fish Farm, Champawat to Department of Fisheries, Govt. of Uttarakhand generating revenue of Rs. 3,00,000.00. Farm produced 21780 numbers of improved common carp seeds were distributed free of cost to fish farmers and sold to Department of Fisheries, Govt. of Uttarakhand during 2017-2018. In addition, ornamental fish produced at ICAR-DCFR, Bhimtal was sold to generate revenue of Rs. 16,490.00.

6.8.5 Breeding and seed production of Kalabans, *Bangana dero* (Hamilton, 1822)

Kalabans, *Bangana dero*, an indigenous medium sized minor carp is a bottom feeder, inhabiting in streams and rivers of Gangetic belt and Indus River systems. This herbivorous fish has potential for carp polyculture at mid altitudes of hills and in plain area. The fish feeds by browsing and thus is helpful in controlling periphyton growth in the pond. The fish matures at 350-650g body-weight at an age of 3+ years and breeds usually during July-August in captivity at 18-22°C water temperature. Hormone

dose (Ovatide) of 0.6 ml/kg body wt. for females and 0.3 ml/kg body wt. for males has been found optimum for spawning. The fish has fecundity of 1, 34,600-1, 47,400/kg body-weight with average egg size of 1.6-2.8 mm. Eggs can be incubated in portable plastic carp hatchery at 18.0-22.8°C water temperature with 60-80% recovery of spawns. Usually yolk gets absorbed 70-84 hrs post hatching and swim up larvae starts external feeding at 4th day of hatching. Small polytanks with size 4-10 m^2 and 60 cm depth may be used for larval rearing with stocking density of 10 larvae per litre. Larvae attain a length of 34.2 ± 2.0 mm in 3 months. Fingerlings of the size 26-40 gm (6 months old) are suitable to be stocked in production ponds.

Male with tubercles on snout

Female without tubercles on snout

Fry of *Bangana dero*

Three months old fingerling

6.8.6 Breeding and seed production of *Bangana devdevi* (Hora, 1936)

Bangana devdevi has restricted distribution to southern and eastern countries of Asia like Thailand, Myanmar and India. In India, it has been reported from the Irrawaddy river system of Manipur. It is highly relished fish endemic to the North-eastern states of India. The species shows migratory behaviour in its natural habitat. It is bentho-pelagic in feeding habit so that feeds on the materials that are available in the whole water column. The fish grows to a maximum size of 50.0 cm. The diameter of eggs in the ovaries of *Bangana devdevi* ranges from 0.82 to 1.22 mm. An initiative has been taken by ICAR-DCFR for the culture of *Bangana devdevi* along with Chinese carp in collaborative mode with

Bangana devdevi (Hora, 1936)

Krishi Vigyan Kendra, Thoubal, Manipur in farmer's pond for the livelihood upliftment of the fisher folk community.

6.8.7 Breeding and seed production of Indian Hill Trout, *Barilius bendelisis* (Hamilton, 1807)

Barilius bendelisis (Hamilton, 1807), commonly known as Indian Hill Trout is widely distributed throughout India, Pakistan, Nepal, Bhutan, Bangladesh, Sri Lanka, Myanmar and Thailand. The fish is considered as one of the principal commercial hill stream fishes in most of the streams and rivers of eastern Himalaya, Ganga region and Arunachal Pradesh due to its high demand as food fish and potential ornamental fish. *Barilius bendelisis* is a batch spawner. Mass scale seed production of *Barilius bendelisis* is possible round the year with good brood stock management, hatching and rearing practices. For captive breeding, the brood stock of 15-20 g can be raised at temperature range of 20-25°C in concrete tanks @ 30-50 numbers/ m^2. Both sexes in this species have shown to attain sexual maturity in controlled conditions with distinct sexual dimorphism during the

Male with tubercles on snout

Female without tubercles on snout

Courtship behaviour in aquarium

breeding period. Trials at ICAR-DCFR, Bhimtal showed natural spawning in captivity and multiple breeding was observed in the month of January to May and August to December. The fertilized eggs were demersal, pale yellow in colour and have a diameter of 2.1 to 2.5 mm in size. The fertilized eggs were incubated in perforated hatching trays, placed in a glass aquarium equipped with water filtration system. Hatching took place within 50-60 hours at 20-22°C. Upon yolk sac absorption the spawn were reared in closed re-circulatory tanks @2000-3000 spawn/m^3 for 15 days. They were fed with poultry egg yolk suspension for 2-4 days and thereafter formulated wet feed until the fry stage.

6.8.8 Breeding and seed production of *Chagunius chagunio* (Hamilton, 1822)

Chagunius chagunio is distributed in the Ganga and Brahmaputra drainages of northern and Northeastern India, Nepal and Bangladesh. The fish is generally found in large rivers characterized by rocky bottom, clear and fast water with little or no vegetation. *Chagunius chagunio* has a good market demand as food fish. The fish has very low fecundity of 15,000-25,000 eggs/kg-brooder/batch. It attains a maximum length of about half a meter and reaches maturity at a size of 20-25 cm. Sexual dimorphism can be observed in this fish during the breeding season. Breeding season starts from April to June. The fish lay eggs under the gravel layer in the nest dug by the male. With good management practice, both the sexes attain sexual maturity in captivity. Fertilized eggs are pale yellow in colour and have diameter of 1.8-2.2 mm in size. Embryonic developments take 4- 5 day at temperature of 20-22°C. Eggs are hatched in floating incubation trays in a closed re-circulatory incubation tank. Yolk sac absorb within 2-3 days after hatching. Spawn can be fed with poultry egg yolk suspension as first feed.

Brood Stock of *Chagunius chagunio*

6.8.9 Breeding and seed production of chocolate mahseer, *Neolissochilus hexagonolepis* (McClelland, 1839)

Chocolate mahseer (*Neolissochilus hexagonolepis)* is a highly esteemed food and game fish, found only in Northeastern Himalayan region particularly in Meghalaya. Fish is considered as a threatened species and hence needs special attention to conserve for increasing its population in the natural water bodies. (IUCN 2016). This fish is a batch spawner with reported breeding season in January-February, May-June and July- September at ICAR-DCFR, Bhimtal. For captive breeding, the broodstock of 600-800 g can be raised at temperature range of 18-22°C in concrete tanks @ 2-3 numbers/m^2 and then stripping the females, when they show signs of ovulation, generally at intervals of 10-16 hours following hormonal injection. The fecundity of the fish is very low (3500 eggs/ kg body-weight). The fertilized eggs are demersal, white in colour and have a diameter of 2.0- 2.5 mm. The fertilized eggs are incubated in perforated hatching trays and placed in a long tub where oxygen rich water


Broodstock of chocolate mahseer


Hatchlings of chocolate mahseer


Fry of chocolate mahseer

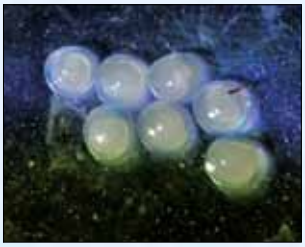

Fry of chocolate mahseer in tank

flow is maintained throughout the incubation period. Hatching usually takes place within 50- 60 hours post-fertilization at 20-20°C. Newly hatched larvae is 10.0-11.0 mm in length and transparent golden yellow in colour. Once yolk sac absorption takes place, the spawn can be reared in a closed re-circulatory tanks equipped with filtration system @2000-3000 spawn/m^3 for about 15 days, during which they can be fed with yolk suspension for 2-4 days and thereafter formulated wet feed until the fry stage.

6.8.10 Breeding and seed production of dark mahseer, *Naziritor chelynoides* (McClelland, 1839)

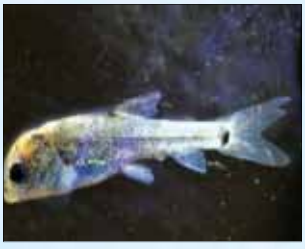
The dark mahseer *Naziritor chelynoides* inhabits fast-flowing mountain streams of Garhwal Himalayas and some parts of Nepal. It is listed as vulnerable and critically endangered category in IUCN red list. The species has very good potential as food and ornamental fish and candidate species for coldwater aquaculture. Male and female attain sexual maturity in aquarium conditions with good management practices. Breeding of this species was successfully achieved at ICAR-DCFR, Bhimtal in month of November, December, March and April in controlled conditions. Dark mahseer is a batch spawner with low fecundity of 80,000-100,000 eggs/kg brooder/batch. It lays eggs under the gravel, therefore presence of thick layer of gravel is must for obtaining natural spawning in controlled conditions. Several breeding pits can be observed during breeding in the spawning tank. Eggs are pale yellow and non-adhesive having 2-2.5 mm in size. Incubation period varies between 60-70 hours at 20-22°C. Eggs can be hatched in floating incubation trays in closed re-circulatory incubation tank. Yolk sac absorbs in 2-3 days. Hatchlings are 8-12 mm in size and after yolk sac absorption, they can be fed on poultry egg yolk suspension as first feeding for first 2-3 days, after which they accept wet formulated feed.

Brood stock of dark mahseer



Fertilized eggs of dark mahseer

Newly hatched hatchling of dark mahseer



Fry of dark mahseer

6.8.11 Breeding and seed production of golden mahseer, *Tor putitora* (Hamilton, 1822)

Golden Mahseer (*Tor putitora),* is an important cyprinid which is considered as a flagship species in upland fisheries of Himalayan sub-continent by virtue of its economic, ecological, recreational, heritage, cultural and food values. The population of golden mahseer has been greatly dwindling over the years and as a result, it has been declared as '*endangered*' by IUCN. It is a multiple spawner; spawning season coincides with the onset of rains during May to September with two peaks (May-June & August-September). Males mature at the age of 3+ years while females mature at 5+ years. For captive breeding, the brood stock of 800-1500 g can be raised at temperature range of 18-22°C in concrete tanks/ FRP tanks @ 2-3 no/m^2. The fecundity is 3375-8944 eggs/kg body weight. The brooders are stripped for egg and milt. The fertilised eggs are demersal and lemon yellow/brownish-

Flow through hatchery for golden mahseer

Fertilized eggs spreading on incubation tray

Hatchling and early fry of golden mahseer

Advance fry of golden mahseer

golden in colour with diameter 2.0 – 2.5 mm. Water flow of 1-2 L/min during incubation and 3-4 L/min after hatching is desirable. Hatching period is 80-96 hours at water temperature 22-24.0°C with 80-85% hatching success. Once the yolk-sac is completely absorbed (11-13 days) and swim up fry start moving freely, the stock can be shifted to nursery tanks and stocked @ 8,000-10,000/tank with water flow of 2-3 litres per minute. The young ones are fed with artificial feed. The survival rate observed was >95 % at ICAR-DCFR, Bhimtal. The flow through hatchery technology for captive breeding and nursery rearing of golden mahseer developed at ICAR-DCFR is the first of its kind in the country and consistently producing golden mahseer seeds.

6.8.12 Breeding and seed production of ropsha scaly and felsosomogy mirror carp (*Cyprinus carpio*, Linnaeus, 1758)

Common carp (*Cyprinus carpio*) is a very important candidate fish in mid Himalayan region and widely practiced in polyculture cement tanks/ ponds owing to hill geomorphological features and lower thermal regime. In order to obtain higher fish productivity in uplands, two improved Hungarian strains of common carp 'Ropsha scaly' and 'Felsosomogy mirror carp' were introduced at Champawat Experimental Farm in the year 2007. These species are found more suitable for hill farming due to their fast growth and wide temperature tolerance (5-32°C). Male attains maturity in 1st year, while female in 2nd year at a water temperature range of 5.0-23.0°C. Mature female show bulging belly, pinkish vent and smooth pectoral fins. Oozing milt could be seen in mature males upon slight pressure on abdomen. The species spawn twice during a year, *i.e.* March-May and July-August. Fecundity of this fish is 1.5-2.0 lakh/ kg brooder. Fertilized eggs are adhesive, yellowish in colour and have diameter ranging from 1.4-2.5 mm. Mature female and male brooders are selected for breeding at water temperature >18°C with a ratio of 1:3. Aquatic weed or nylon strips are used for egg attachment. Inducing hormones @2.0-3.0ml/ kg body weight may be injected at lower water temperature <17°C for achieving better spawning. Female start laying eggs usually after 6 -10 hours of hormone injection. Hatching takes place after 84-112 hrs post fertilization and yolk absorption takes place within 72-90 hrs at 18-22°C. Larvae start external feeding after 4-5 days and then can be kept in FRP tanks @800-1000/m^2 for15 days. Later they can be transferred to nursery tanks @ 200-400/m^2, where they can be maintained for next 2 months. Adlibitum feeding with formulated balanced feed containing rice bran, soybean cake, MOC with vitamin mineral mix (protein 28%) has delivered 30-35% higher weight gain in 'Ropsha scaly' and 'Felsosomogy mirror carp' during nursery rearing and 40-50% during grow out phase with compared to normal common carp.

Female and male of Ropsha scaly common carp

Ropsha scaly & Felsosomogy mirror carp

Ropsha scaly common carp advance fry

6.8.13 Breeding and seed production of *Labeo pangusia* (Hamilton, 1822)

Labeo pangusia is hill stream carp predominantly found in the deeper pools of upland streams. It can thrive well in lakes and fast flowing streams of hilly regions, with a preferred water temperature ranging from 10-20°C. *Labeo pangusia* has very good market value due to its taste and health benefits. The fish is detritophagus in feeding habit and thus can be an alternative to other bottom feeding fishes in composite fish farming, without compromising the yield and profit. The fish usually breeds during mid-April to end of July. The species attains maturity in the 2nd year and has fecundity of 7, 50,000 to 8, 00,000 eggs/kg body-weight. *Labeo pangusia* is a slow growing species. Although males

Brooder of *Labeo pangusia*

Spawn of *Labeo pangusia*

grow faster than females, the female attains a larger size than the male. Both male and female attain maturity at 25-30 cm length group. The maximum length recorded is 90 cm. Natural spawning occurs coinciding with monsoonal rain and fingerlings can be collected during August-September when the floodwater recedes. The brooders needs hormone induction viz. Ovatide @ 0.5ml-1ml/kg body-weight in both male and female brooders (2:1 ratio) for spawning in controlled conditions. The fishes spawn 6-8 hrs post hormonal injection. The fertilized eggs of *Labeo pangusia* were transparent white and round in shape.

6.8.14 Breeding and seed production of pengba, *Osteobrama belangeri* (Valenciennes, 1844)

The Pengba, *Osteobrama belangeri* is a medium carp belonging to cyprinid group of finfish. Pengba is considered delicacy in north-eastern states of India, especially Manipur, where it has status as 'State Fish'. The fish has high commercial value and is considered a potential candidate species for diversification of carp culture. It is an omnivorous fish, feeding mainly on zooplankton and algae in juvenile stage and macro vegetation in the adult. *Osteobrama belangeri* is a seasonal spawner. It attains sexual maturity in 2+ years (200-300g body weight) and breeds usually during June to August. Females are comparatively larger than males. No distinct

Brooder of *Osteobrama belangeri*

sexual dimorphism is observed in this fish, except the prominent secondary sexual characters like bulging abdomen and swollen genital aperture in mature females during the breeding season. The fish was recorded with the fecundity @ 2.5 lakh eggs per kilogram body weight at ICAR-DCFR, Bhimtal. The diameter of eggs was found to be ranging from 0.48 to 1.07 mm. The complete spawning was observed within 8 hours after hormonal administration and larvae hatched in 26 hours at 25-26°C with 95.0 ± 1.05 % fertilization and 88.8 ± 1.04 % hatching rate.

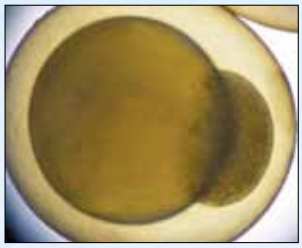
6.8.15 Breeding and seed production of snow trout, *Schizothorax richardsonii* (Gray, 1832)

Snow trout, *Schizothorax richardsonii* is an important indigenous coldwater species also known as Asaila or mountain barbel, widely distributed in India all along Himalayas from Jammu & Kashmir to Uttarakhand, Assam, Sikkim Nagaland and Bhutan within an elevation of 300-2810 MSL. The species is bottom dwelling, illiophagic herbivore having transverse inferior mouth. The species can withstand vast ranges of temperature variation, but prefers snow-fed torrential streams and pools with temperature ranging from 8°C-22°C. Asaila generally attains maturity in 3+years, spawn twice in a year during February-May and August -October. August -October is considered the best season for large scale seed production. Clear water, stony bottom of creeks composed of fine pebbles and gravel having water flow of 2.8-4 m/sec, pH 7.4-8.2 and dissolved oxygen concentrations 8-10 mg/L provide excellent spawning conditions in the natural environment. Mature males are characterized with slender shape, presence of nuptial tubercles on the snout, faint yellowish colour, reddish fins, rough pectoral fins and oozing milt during breeding season. The females are characterized by pinkish soft, enlarged and distended belly. Pectoral fins are smooth. Fully mature female releases orange and sticky eggs when gently pressed on the abdomen. The average fecundity ranged between 16,270-18,340/kg body-weight.

For breeding usually female brooders in size range of >70-80 g and males >40-50 g are selected. The dry fertilization method is followed in low-light

Brooder of snow trout

Fertilised eggs of snow trout



Fertilised eggs after 24 hours

Fry of snow trout

conditions. The eggs and milt are collected in tray for fertilization. Relatively low fertilization percentage (35-60%) have been observed in snow trout with hatching percentage of 60-75 at ICAR-DCFR, Bhimtal. For incubation, it takes 5-7 days at water temperature of 17-21°C. The yolk sac absorption completes within 84-168 hrs post fertilization. The length of the sac fry (alevins) varies from 7.5 - 9.0 mm. The free swimming larva are reared in indoor flow through hatching trays for 60 days @ 1000-2000/m^2 with a water flow of 3-4 L/m. In grow out raceways 100-150 advance fry/m^2 are stocked with water flow rate of 30-40 L/min and fed with 10% of body weight.

6.9 Farm Advisory

In continuation with the earlier crop cycle, scientific guidance was provided to Mr. Alok Naskar, a farmer-entrepreneur from Bhimtal, on integrated backyard culture of common carp and grass carp with poultry. Suggestions were given on water quality and pond management. Periodical sampling was carried out to assess the growth and health of fish. To overcome growth impairment, good quality carp feed was prepared and supplied. The above activity was monitored by Dr. Biju Sam Kamalam, Dr. R.S. Haldar and Mr. Rajesh, M.

A farm advisory on 'Fish health management of rainbow trout' was conducted on 20th June 2017 at an adopted fish farmer's pond at village Kathar, Champawat. Dr. S. Chandra, Mr. Raja Aadil HB, Mr. Ritesh S. Tandel, Mr. A.K. Giri, Dr. Raghvendra Singh, Mr. P.A. Ganie, Mr. Ravinder Kumar and Mr. Hansa Datt conducted and coordinated the program.

6.10 Awareness Programme on Avenues in Fisheries at Leh-Ladakh

Keeping in view the prolonged harsh weather conditions, limited livelihood opportunities and potential for rainbow trout culture in the cold arid zone of Ladakh, an awareness-cum-training programme on the topic 'Avenues in Fisheries to Combat Climate Change in High Altitude' was organised for the students of Eliezer Joldan Memorial College Leh, Ladakh on 12th March 2018. Dr. Prem Kumar and Dr. Biju Sam Kamalam organized the said programme and delivered lectures covering the theme. In total, 40 B.Sc. final year students belonging to different parts of Ladakh participated in the programme. The students showed keen interest in knowing the economic and livelihood importance of rainbow trout culture in the region.

Awareness programme for students of Eliezer Joldan Memorial College, Leh

Tribal Sub Plan Activities

7

In order to ensure the livelihood security of tribal community, the Directorate has undertaken various activities in high Himalayan region under TSP programme. During this reporting year, promotion of hill aquaculture for livelihood and income generation of rural tribal farmers of two states namely Uttarakhand and Jammu & Kashmir has been taken up by providing infrastructural facility, inputs as well as conducting training programmes. The detailed activities were undertaken as mentioned hereunder.

7.1 Infrastructure Developed

7.1.1 Survey in disadvantageous area

Extensive survey was undertaken by a team of ICAR-DCFR to Dharchula Block along with CPWD engineers with an objective to select sites for establishment and expansion of trout culture in this high Himalayan region of Uttarakhand. On the basis of recommendation and feasibility, 2 sites were selected for trout farming at Munshyari.

Survey for site selection at Dharchula block

7.1.2 Trout raceway construction

The high Himalayan region especially in those border areas where tribal communities inhabit remains mostly unexplored but otherwise suitable for trout culture. Under the scheme of livelihood security of tribal farmer, scientist from the Directorate explored these potential areas and identified a few selected farmers for start up trout farming on an initial basis. As an outcome of the survey, five raceways were constructed in association with CPWD in the reporting year. Four raceways were built in Munshyari block whereas one raceway was constructed at Dharchula block of Pithoragarh district, Uttrakhand. The following infrastructure were facilitated to the selected farmers for promotion of trout farming.

S. No.	Facility created	Name of place	Present status
1	Trout raceway	Munshyari	Four raceways completed from financial budget 2016-17
2	Trout raceway	Dharchula	One new raceway was constructed from financial budget 2016-17
3	Trout raceway	Dharchula	Amount released to CPWD for one new raceway construction in Dharchula block

Construction of trout raceways at Pithoragarh district

7.1.3 Ova hatching facility

In order to ensure self-sufficiency of trout farming in high altitudinal regions, seed availability is one of the major concerns for farmers. To address the problem, small Ova Hatching House of 16,000 egg capacity was established in two clusters Munshyari and Dharchula blocks in Pithoragarh

district, Uttarakhand. Two sets of hatching trays, rearing turfs and accessories were provided to these ova houses. One Ova House was also constructed at Leh in the past.

S. No.	Facility created	Name of place	status
1	Ova house	Dharchula	Temporary small ova house established in Teentola
2	Ova house	Munshyari	Temporary small ova house established in Munshyari

Temporary small ova house

Eyed ova house in Uttarakhand

7.1.4 Fish seed transportation, rearing and distribution

As an initiative to start trout culture in the state of Uttarakhand, 20,000 eyed ova of trout were transported from the neighbouring state Himachal Pradesh from Govt. Trout Farm, Patlikuhl. The eyed ova were raised to fry stage after 3 months of rearing at ICAR-DCFR Bhimtal. The farm raised 10,000 fry from the consignment were transported by road and stocked successfully in raceways of the selected tribal farmers.

Seed rearing transportation and stocking in Munshyari

The Directorate also transported 200 numbers of advanced fingerling to Experimental Fish Farm, Champawat and 1,00,000 numbers of eyed ova from Kashmir were also imported to Champawat for further rearing and distributing to farmers. 7000 numbers of carp fingerlings were provided to 16 farmers of Udham Singh Nagar district of Uttarakhand and 300 ornamental fish were distributed to different farmers. In addition, 300 kg of trout feed was distributed to 5 farmers of Pithoragarh district.

7.1.5 Successful hatching of eyed ova in Munshyari

The imported 15000 numbers of eyed ova eggs from Patlikuhl, Himachal Pradesh hatched out successfully in Munshyari ova houses in the farm premises of trout grower Mr. Bhupesh Pangti.

Introduction of hatching facilities and trout farming in Pithoragarh district

7.2 Input Distribution to Farmers

S. No.	Target	Distributed	Date	Beneficiary
1	Seed-20,000 (15 farmer)	10000 trout	6.4.17	5 farmers at Munshyari
		7000 carp	19.12.17	16 farmers at US Nagar
		180 advanced fingerling trout	23.4.17	1 farmer at Bhoopi
		50 koi carp 40 advanced trout fingerlings	7.6.17	2 farmers at Dharchula
		15000 eyed ova	8.3.18	6 farmers at Munshyari
		5000 eyed ova	-	Eyed ova reared at Bhimtal
2	Feed-300 Kg (15 Farmers)	200 kg	6.4.17	5 farmer at Munshyari
		30 kg	6.4.17	1 farmer Munshiyari
		70 kg	23.4.17	3 farmers at Munshiyari
3	Ova house-2 Nos. (15 farmer)	1	8.3.18	1 Munshiyari
		1	8.3.18	1 Teentola Dharchula
4	Raceway construction- 1 No.	Rs. 5 lakh	-	Released 5 lakh to CPWD for Chodas valley
5	Input distributed	Hatchery items: hatching tray set-2 Nos, rearing tank-2 Nos, rectangular tank-1 No, hand nets-3 Nos.	7.4.17	3 farmers Ms. Neha, Mr. Bhupendra and Mr. Mahesh Pangatey
		Rearing tank FRP-3, hatching units-2 Nos., tanks-2 Nos.	7.11.17	2 farmers

7.3 FRP Re-circulatory System for Trout Rearing

In order to minimize water usage in the experimental rearing of rainbow trout, a submerged gravel bed bio-filter was designed and developed. The characteristics of the in-built biofilter unit were as follows: depth of filter bed: 16 cm; surface to volume ratio: 800m^2/m^3; water flow rate through the filter bed: 3600L/h; turnover rate: 5 times/h; water volume in rectangular FRP tank (0.6 depth x 1 breadth x 1.5 length): 700L. For calculating the NH_3 removal efficiency of the biofilter, different known levels of ammonia source (NH_4Cl_2) were added and the dynamics of TAN, NO_2 and NO_3 were studied. Initially, after the addition of 3 ppm TAN in the unit, the biofilter removed the entire NH_3 load in 6 days and corresponding NO_2 load in 7 days. But once the biofilter was matured, it had the capacity to remove 8 ppm of NH_3 and NO_2 within a day. In the next step, 7 kg of fish biomass were maintained in 1000L circular tank with 1% feeding rate (CP 45%) without exchanging water until 3 days. As NO_3 levels were found to reach 40-60 ppm on the 4th day, 50% of water was cyclically exchanged on every 4th day to reduce the build-up of NO_3. This simple low cost biofilter prototype has potential application for rearing fishes by using limited water resource.

7.4 Trout Culture in Portable FRP Tank

Trout culture in small sized portable FRP tanks may be one of the future prospects towards domestication of trout culture in hill locked places of Himalaya region. The first trial at the Directorate observed a production of 24kg in FRP tanks of capacity 2000L, water flow @ 12-15L/m and temperature range of 15-20°C. Furthermore, the fish weight increased from 5 gm to 700 gm and 300 gm to 1980 gm in 18 months of culture period in the FRP tanks with suitable feed supplement. The observation indicated that trout culture can be suitably adapted in portable FRP setups in backyards of mountain dwellers in the Himalayas.

Growth observation in portable FRP Tanks			
Tank size-	2000 L		
Water volume	1200 L		
Water flow	12 L/m		
Temperature	18-20°C		
Initial size	**Present size**	**Period**	
Fingerling 5 g (September 2016)	700 g max (march - 2018)	18 month	
330 g (September 2016)	1980 g max (to march 2018)	18 month	

7.5 Activities at Leh, Jammu and Kashmir

Scientists visited Leh, Jammu and Kashmir during 8-12 March 2018 in order to setup one ova house of 20,000 eyed ova capacity at Chushout village and will be made functional in the coming season. An awareness programme on prospects of trout culture in Leh was also organized for 40 graduate students on 12th March 2018.

7.6 Human Resource Development

Various training and exposure visits were arranged for tribal farmers and students as start up programmes in various aspects of fish farming during the reporting year.

7.6.1 Training on ornamental fish culture for tribal farmers of Jammu & Kashmir and Uttarakhand

A 3-days hands on training programme on 'Management and culture of ornamental fishes in coldwater region' for tribal farmers of Jammu & Kashmir and Uttarakhand was organised by ICAR-DCFR in collaboration with Krishi Vigyan Kendra, Doda, Jammu & Kashmir during 5-7 September 2017 at Bhimtal. The training programme was attended by 14 tribal farmers from Doda (Jammu and Kashmir) and 4 tribal farmers from Pithorgarh (Uttarakhand). The programme was inaugurated by Dr A.K. Singh, Director of this institute. The programme included lectures, practical demonstrations and field visits on the aspects of pond preparation for ornamental fish culture in hill region, breeding and larval rearing, feed preparation, aquarium construction and management, packing and transportation techniques, preparation of submerged gravel based bio-filter systems etc. The programme was coordinated by Dr. R.S Patiyal, Nodal Officer TSP, Dr. Prem Kumar, Dr. B.S. Kamalam, Dr. D. Sarma and Mr. Rajesh M. of ICAR-DCFR, Bhimtal. Dr. Ravneet Kaur, Sr. Scientist and Dr. Ghanshyam Nath Jha, Scientist of KVK Doda Jammu & Kashmir accompanied the farmers during the programme.


Fig: Deliberations, demonstrations on ornamental fish culture practices for tribal farmers of Jammu & Kashmir and Uttarakhand

7.6.2 Training on integrated fish farming and seed distribution programme

ICAR-DCFR, Bhimtal organised 1-day training on 'Integrated fish farming and seed distribution programme' on 19th December 2017 for the Tharu tribal farmers of village Salmatta, Sitarganj of District Udham Singh Nagar, Uttarakhand under STC programme. The programme included lectures,

Distribution of fish seeds to the Tharu tribal fish farmers

Interaction of scientists and farmers during the programme

demonstrations, interaction and seed distribution for 45 tribal farmers including 7 women from the area. The programme was inaugurated by Mr. Ajun Singh, a progressive farmer and shared his experiences in fish farming and its benefits. Dr. N.N. Pandey, Principal Scientist of the Directorate presided the meeting and urged the farmers to adopt the integrated approach of fish farming for sustainability of the farmers. The fish farmers were distributed with 7000 numbers of advance fries and fingerlings of carp later in the programme. Dr. R.S. Patiyal, Nodal Officer TSP and Mr. Rajesh M, Scientist, ICAR-DCFR coordinated the programme.

7.6.3 Start-up orientation programme for tribal students

ICAR-DCFR, Bhimtal organised a 1-day start-up orientation programme on 'Ornamental Fish Aqua-gardening for Tribal Students' on 31st March 2018. The programme was inaugurated by Dr.

The tribal student participants and the scientists of the Directorate

Demonstration on various aspects of fish farming practices for the tribal students

Debajit Sarma, Director (Act.) of the Directorate in presence of Mr. H.S. Hyanki, Ex. Sr. Bank officer. Dr. Sarma urged the students for alertness upon the recent advances in fisheries and aquaculture in Himalayan region for augmenting livelihood security. Mr. H.S. Hyanki elaborated on the Bank financial schemes for any start-up programme. Dr. Prem Kumar spoke on the opportunities in fisheries sector where as Dr. R. S. Patiyal, Coordinator of the programme explained the avenues of homestays and ornamental fish aqua-gardening as a start-up venture in a tourist packed hill regions. Altogether, 47 tribal students including 16 women participated in the training. The training schedule included lectures, demonstrations and interaction on the subject. During the interaction, the tribal students showed enthusiasm in joining future programmes of the Directorate.

North East Hill Activities

8

Under the NEH programme, various research and developmental activities have been carried out in the North-eastern states namely Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Nagaland. The details of the programmes conducted in the reporting year are listed hereunder.

8.1 Promotion of Rainbow Trout Farming

Promotion and expansion of rainbow trout farming has remained a major focus area for the Directorate by providing scientific, technical and financial support to different North-eastern states under NEH programme. Directorate carried out for the first time an extensive survey programme in association with the officers of Department of Fisheries, Govt. of Nagaland for selecting suitable sites for construction of rainbow trout raceways in Nagaland. The survey resulted into selection of the site Dzuleke (N-25°36.982', E-93°57.123' and 5502 ft msl) in Kohima district for establishment of rainbow trout raceways for culture of rainbow trout. As a start up venture to popularize the rainbow trout farming in the state, three numbers of trout raceways were constructed at Dzuleke, Kohima under the technical and financial supports of ICAR-DCFR, Bhimtal. This is was followed with establishment of one rainbow trout hatchery at Dzuleke, Kohima with technical and financial support from the Directorate for breeding and culture of rainbow trout in association with the Department of Fisheries, Government of Nagaland.

Newly developed rainbow trout raceways at Dzuleke, Nagaland

8.2 Development of Captive Breeding Facilities of Mahseer

Chocolate mahseer is an important indigenous fish species for the Northeastern region of India for its food and recreational value. The major species encountered in this region are *Neolissochilus hexagonolepis*, *N. hexastichus* and *N. stracheyi*. Therefore, to popularize their artificial propagation by hatchery raised young ones and conservation in the Northeast region, necessary technical and financial support was provided from the Directorate to Department of Fisheries in the potential states of Northeast region. In this perspective, one hatchery unit each was established at Ganol Apal (Tura, West Garo Hills, Meghalaya); Suteplenden (Longkong, Mokokchung district, Nagaland) and Tamdil (Mizoram).

Newly established chocolate mahseer hatchery at Nagaland

Chocolate mahseer hatchery at Ganol Gre (Tura), West Garo Hills, Meghalaya

8.3 Establishment of Trout Feed Unit

Trout is considered as an important coldwater fish species for the natural waters in the high altitude areas of Northeast region. The rainbow trout, *Oncorhynchus mykiss* (Walbaum 1792) and brown trout (*Salmo trutta fario*), are either grown as food fish or as sport fish by the growers in the region. In order to achieve a better growth rate of these fishes, it is essential to provide the fishes with good quality feed. To fulfil the supply of trout feed demand in a hill locked areas, effort has been made on initial lines by the Directorate to join hands with various stakeholders and to build functional linkages with Department of Fisheries, Govt. of Arunachal Pradesh in establishing one Trout Feed Mill in the district of West Kameng. An Extruder Machine and Feed Drier has been procured and installed in the Yak Farm campus, Nyukmadung of ICAR- NRC on Yak, Dirang (Arunachal Pradesh) for Trout feed preparation and supply to the different Government trout farms as well as private trout growers of the area.

Installation of fish feed mill at Yak Farm, Nyukmadung of ICAR- NRC on Yak, Dirang

8.4 Angling Festival and Workshop

The 7th North-East Angling Festival and Workshop on "Connecting People, Fish and Nature" was organized by this Directorate during 15th October, 2017 at Jasingfaa Aqua Tourism Resort, Nagaon, Assam in collaboration with Coldwater Fisheries Society of India, ICAR-DCFR, Pelagic Tribe, Department of Fisheries, Assam. Mr. Shamsher Singh, Deputy Commissioner, Nagaon District, Assam graced the occasion as Chief Guest and inaugurated the angling competition. Mr.

The concept of mahseer watching at Jasingfaa

Singh emphasized on fish farming as an integral part of Northeastern region particularly for the people of Assam for food and recreation. He also pointed out that Jasingfaa Aqua Tourism Resort successfully established Fish based Eco-tourism through technical support of ICAR-DCFR which is serving as a model in NEH region of the country. About 100 delegates from Northeastern parts of the country including scientists, academicians, state fishery officials, NGO's, entrepreneur and anglers participated in the meet. Practical demonstration for the students on use of angling gears, assembling and their operation was given by an international angler Mr. Derek Dsouza. Deliberations on various

Angling competition inaugurated by Mr. Shamsher Singh, Deputy Commissioner, Nagaon District, Assam and Awardees

aspects of recreational resources and fisheries were made by Dr. A.K. Singh, Dr. Debajit Sarma and Dr. Deepjyoti Baruah from the Directorate during the workshop.

8.5 Establishment of Portable FRP Fish Hatchery

Ready availability of quality and quantity fish seeds is a major constraint in hilly terrains of Northeast region of India. The lack of fish seeds in these regions can be attributed to numerous factors such as lack of road and communication, lack of skill and knowledge among the rural mass, lack of infrastructure etc. Therefore to increase the seed

Inauguration of Portable FRP Fish Hatchery by the Chief Guest in Ziro valley

production in the region, an initial effort has been made by the Directorate to establish a Portable FRP Fish Hatchery unit at Ziro, Lower Subansiri District of Arunachal Pradesh keeping in confidence the farmers of Gaumco Multipurpose Cooperative Society Pvt. Ltd. and functional linkage with the Department of Fisheries, Govt. of Arunachal Pradesh. The Portable FRP Fish Hatchery was inaugurated on 22nd March 2018 by Er. Tage Taki, the Hon'ble Parliamentary Secretary Food and Civil Supplies in presence of Mr. Kemo Lollen, Deputy Commissioner, Lower Subansiri district, Govt. of Arunachal Pradesh; Mr. Hage Kobin, Zilla Parishad Chairperson, Lower Subansiri district; Dr. Debajit Sarma, Director, ICAR-DCFR; Er. Gyati Atto, Chaiman, Gaumco Multipurpose Cooperative Society Pvt. Ltd. and other dignitaries at the premises of Mrs. Gyati Rinyo, an active member of Gaumco Society. The fish hatchery is of first kind to be established in the region at Hari village (Ziro valley) with assistance from ICAR-DCFR, Bhimtal and to be operated solely by a women group.

Inauguration of Portable FRP Fish Hatchery at Ziro, Arunachal Pradesh by Er. Tage Taki

After the inauguration of the hatchery, the guest proceeded for Farmers-Officers-Scientist Interactive Meet in the village on the topic 'Fish farming and seed production in cold regions of Arunachal Pradesh'. The meet was attended by more than 250 participants including farmers, officers, scientists and guests. The programme was coordinated by Dr. Deepjyoti Baruah, Sr. Scientist and Mr. Parvaiz A. Ganie, Scientist of the Directorate in association with the members of Gaumco Multipurpose Cooperative Society Pvt. Ltd.

8.6 Exploration Studies on Fish Diversity of Northeast Himalaya

For exploration and study of important coldwater fish species from the selected Himalayan drainages in Northeast, the Directorate has under taken following collaborative programmes with different institutes under NEH activity.

- 'Ichthyofaunal diversity, habitat assessment and eco-biological studies of important fish species from the selected Himalayan drainages of Manipur' in collaboration with Institute of Bioresources and Sustainable Development, Department of Biotechnology, Govt. of India, Takyelpat, Imphal-795001, Manipur.
- 'Ichthyofaunal diversity, habitat assessment and eco-biological studies of important fish species from the selected Himalayan drainages of Mizoram' in collaboration with KVK, Mamit, Lengpui-796421, Mizoram.
- 'Ichthyofaunal diversity, habitat assessment and eco-biological studies of important fish species from the selected Himalayan drainages of Meghalaya' in collaboration with Department of Fisheries, St. Anthony's College, Shillong, Meghalaya.
- 'Study on resource assessment of Mahseer (*Tor* spp.) in Dikhu river of Mokokchung district and adjacent area, Nagaland' in collaboration with Department of Zoology, Nagaland University (Central University), Lumami, Nagaland.
- Domestication of snow trout for species diversification in mid-hill aquaculture in Arunachal Pradesh in collaboration with Krishi Vigyan Kendra, West Kameng, Sangti, Dirang-790101, Arunachal Pradesh.

8.7 Mahseer Seed Ranching in Teesta River of Sikkim

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with Directorate of Fisheries, Government of Sikkim celebrated the 'World Environment Day' on 5th June 2017 by ranching 5000 numbers of hatchery raised mahseer fingerlings in Teesta river of Sikkim. The fish seeds

Mahseer fish seed ranching in river Teesta, Sikkim

Participants of the meet in presence of Mr. Somnath Poudyal ji, Hon'ble Minister of Fisheries, Govt. of Sikkim

were released for rehabilitation and conservation of the declining mahseer in natural water bodies. Mr. Somnath Poudyal ji, Hon'ble Minister of Fisheries, Govt. of Sikkim graced the occasion as the Chief Guest. An awareness camp was followed to create awareness among the riverside dwellers to protect the natural habitat of the magnificent mahseer. Dr. A .K. Singh, Director, ICAR-DCFR welcomed all the dignitaries and explained the inevitability to conserve mahseer which is a keystone species in the river. On the occasion, Hon'ble minister communicated his happiness for organising such type of program in Sikkim by ICAR-DCFR to protect the riverine habitat and highlighted the significance of natural biodiversity and its importance to conserve indigenous fish fauna of the region in order to bring our river back to life. Dr. Debajit Sarma, Director (Acting) of the Directorate stated that mahseer is not just a fish, rather an aquatic tiger, so let's come together and restore this fish in Himalayan Rivers of Sikkim. Dr. Prakash Sharma, Scientist and Dr. R.S. Haldar, ACTO coordinated the program.

8.8 Training for Fisheries Officers and Progressive Farmers

A 3-days training programme was organized on 'Coldwater ornamental fish breeding and rearing technologies for Northeast states' during 7-9 March, 2018 at ICAR-Directorate of Coldwater Fisheries Research, Bhimtal for Fisheries Officers and progressive fish farmers of Northeastern States under the NEH activity of the Directorate. Altogether, 13 Fisheries Officers, Faculty members and farmers participated in the said training programme

Training for Fishery Officers of Northeastern states on ornamental fish farming

9 Training and Capacity Building Programmes

9.1 Programmes Conducted

9.1.1 Training for officers of department of fisheries, Jammu & Kashmir

ICAR-DCFR and State Agricultural Management & Extension Training Institute (SAMETI), Jammu jointly organized 3-days training programme on Fish Breeding Techniques during 24-26 July 2017 at Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Main Campus Chatha, Jammu. The programme was inaugurated by Dr. A.K. Singh, Director, ICAR-DCFR on 24th July 2017. The training was attended by 30 officers of the State Fisheries department of J&K who were given exposure to scientific techniques of mahseer and carp fish breeding. The training comprised of both theoretical and practical sessions including film shows on Hatchery management and seed production of mahseer, development of mahseer ecotourism and recreational fisheries, aquaponics, carp seed production and hatchery management, principles and component of aquaculture management, diversification of aquaculture etc. An exposure visit of the participants to Fish Farm, Anji of Reasi district was also organized on 25th July during the training programme. Dr. Debajit Sarma, Principal Scientist and Dr. Raghvendra Singh, Scientist of ICAR-DCFR were among the major resource persons of the training programme. Dr. Rama Kant, Deputy Director, SAMETI-Jammu presented the vote of thanks.

Training for officers of Department of Fisheries, Jammu & Kashmir

9.1.2 Training cum mass awareness programme on coldwater fish diseases

1-day training cum mass awareness programme on coldwater fish diseases was organised under NSPAAD at Experimental Fish Farm, Champawat on 29th July 2017. 50 farmers of Champawat district participated in the event. 14800 numbers of improved common carp seeds, 800 numbers of grass carp fry and $KMnO_4$ packets were distributed to the farmers on the occasion. The farmers were taught on disease management techniques, feed management, soil and water quality management

Training on coldwater fish diseases under NSPAAD

by scientists of the farm centre Dr. S. Chandra, Mr. A.K. Giri, Dr. Raghvendra Singh, Mr. Kishor Kunal, Mr. Raja Aadil H. B and Mr. P.A. Ganie.

9.1.3 Training cum exposure visit for fish farmers of Pouri Garhwal

Training cum exposure visit was organized for 20 fish farmers of Pouri Garhwal, Uttarakhand on 26th February 2018. The scientists of Experimental Fish Farm, Champawat interacted with them and educated them on carp fish farming practices in mid hill Himalayan region.

Training cum exposure visit for 20 fish farmers of Pouri Garhwal, Uttarakhand at Experimental Fish Farm, Champawat

9.1.4 Training programme under ATMA

A group of 18 farmers from Pithoragarh district were trained in the curriculum of a state level training programme under ATMA on 23rd March 2018. The Fisheries Inspector, Department of Fisheries, Pithoragarh visited Experimental Fish Farm, Champawat along with the farmers for interaction with the scientists.

Training programme under ATMA conducted at Champawat

9.1.5 Training programme for in-service trainees

ICAR-DCFR coordinated educational tour for 24 in-service trainees undergoing Post Graduate Diploma in Fisheries and Aquaculture Management (PGDIF & AM) at ICAR- Central Institute of Fisheries Education, Kolkata Center during 7-8 March 2018. Deliberations were made by Mr. R.S. Tandel, Mr. Siva, C., Dr. N.N. Pandey, Dr. D. Baruah and Dr. M.S. Akhtar on various aspects of coldwater aquaculture and fisheries. The trainees were exposed to the ongoing activities of mahseer hatchery operation and seed production, cage farming in lakes, carp seed production and hatchery management and ornamental fish rearing.

9.1.6 Awareness cum training programme under NFDB sponsored project 'National durveillance programme for aquatic animal diseases'

Under the NFDB sponsored project on 'National Surveillance Programme for Aquatic Animal Diseases' ICAR-DCFR organized 1-day awareness cum training programme on 'Fish health management in coldwater aquaculture' on 29th July 2017 at Experimental Fish Farm, Champawat. A total of 50 fish farmers belonging to 22 villages of Champawat District i.e. Bhumwadi, Pamtola, Kimwadi, Joladi, Kota, Toli, Pati, Rolmail, Chaukuni, Katharh, Khunari, Mudiyani, Khalkadia, Shimalta,

Mr. R.D.Morari, progressive fish farmer, Lohaghat and a fish farmer of Pati sharing their views

Majera, Khark, Bheti, Dungri Fartyal, Kathnoli, Moun Pokhri, Metti, Kharkarki, Mourari and two SSB soldiers from Patti, Lohaghat and Champawat attended the awareness camp. Live demonstration on fish health management practices in raceways and tanks followed by series of lectures on identification of fish diseases and their suitable control measures, scientific trout and exotic carp farming practices were given by scientists.

9.2 Training Programmes Participated

Scientist

- Kishor Kunal attended a training programme on 'Coldwater ornamental fish breeding and rearing technologies' at ICAR-DCFR, Bhimtal during 7-9 March 2018.
- Parvaiz Ahmad Ganie attended a training programme on 'Coldwater ornamental fish breeding and rearing technologies' at ICAR-DCFR, Bhimtal during 7-9 March 2018.
- Prakash Sharma attended 10 days CAFT training on 'Utilization of proteins extracted from leaves and non-edible seeds for preparing fish feed' organised by ICAR-Central Institute of Fisheries Education, Mumbai during 6-16 March 2018.
- Raja Aadil HB participated CAFT training on 'Advances in Nano-biotechnological tools in fisheries' at ICAR-CIFE, Mumbai during 4-13 December 2017.
- Raja Aadil HB participated CAFT training on 'Development and characterisation of fish Cell lines for biotechnological purpose' at ICAR-CIFE, Mumbai during 1-10 February 2018.
- Rajesh M attended 10 days CAFT training on 'Utilization of proteins extracted from leaves and non-edible seeds for preparing fish feed' organised by ICAR-Central Institute of Fisheries Education, Mumbai during 6-16 March 2018.
- Raghvendra Singh attended a training programme on 'Coldwater ornamental fish breeding and rearing technologies' at ICAR-DCFR, Bhimtal during 7-9 March 2018.
- Raghvendra Singh participated in short course training program on 'Broodstock improvement and quality fish seed production through genetic tools' at ICAR-CIFA, Bhubneshwar during15-24 March 2018.
- Siva C participated in the Winter School on 'Harnessing NGS data for genetic enhancement in crops' organized at ICAR-IIWBR, Karnal, Haryana during 3-12 October 2017.

Technical staff

- Amit Kumar Saxena participated in 1-day training on 'GeM' at DGS&D, New Delhi on 1st August 2018.
- B.C. Pandey participated in 1-day training on 'GeM' at DGS&D, New Delhi on 1st August 2018.
- Baldev Singh attended 5-days training programme on 'Koha' for Library staff of ICAR, organized by ICAR-NAARM, Hyderabad during 5-9 February 2018.
- Harish Ram participated in 1-day training on 'GeM' at DGS&D, New Delhi on 1st August 2018.
- Manoj Kumar Yadav attended 5-days training on 'Automobile maintenance road safety and behavioural skill', organized by ICAR-CIAE, Bhopal during 27 November to 1 December 2017.
- R.S. Haldar participated in 1-day training on 'GeM' at DGS&D, New Delhi on 1st August 2018.
- R.S. Negi participated in 1-day training on 'GeM' at DGS&D, New Delhi on 1st August 2018.
- Susheela Tewari attended 7-days training on 'Enhancing efficiency and behavioural skills for stenographer Grade-III, Pas, PSs and PPs' organized by ICAR-NAARM, Hyderabad at ICAR-NBSS&LUP, Regional Center, Kolkata during 5-11 January 2018.

9.3 Students Guided

- Amir Bashir from H.N.B. University, Srinagar is pursuing his PhD under the supervision of Dr. R.S. Patiyal on the topic 'Molecular characterization of fish species of family Cyprinidae, Balitoridae and Sisoridae from Kashmir valley, India.
- Amrita Rani from West Bengal University of Animal and Fishery Sciences, Kolkata is pursuing her PhD on the topic 'Thermal induction of triploidy and growth assessment of *Schizothorax richardsonii* upto fry stage' under the supervision of Dr. N.N. Pandey.
- Ankit Barola from HNB Garhwal University, Srinagar completed his M.Sc. Biotechnology dissertation on the topic 'Primary Cell Culture of *Schizothorax richardsonii* from fin explants' under the supervision of Dr. Amit Pande.
- Annu Sharma from Department of Biotechnology, Kumaon University, Uttarakhand is perusing her PhD under the supervision of Dr. D. Sarma on the topic 'Changes in fatty acid profile with seasonal changes in environmental factors, natural food and thyroid endocrine system of golden mahseer (*Tor putitora*) in lacustrine ecosystem'.
- Anupam Pandey is pursuing his PhD from Kumaun University under the supervision of Dr. D. Sarma, Dr. B.S. Kamalam and Dr. M.S. Akhtar on the topic 'Molecular and phenotypic investigation of thermal adaptation in a coldwater fish, rainbow trout (*Oncorhynchus mykiss*)'.
- Harmanpreet Singh from ICAR-Central Institute of Fisheries Education, Mumbai is pursuing his MFSc on the topic 'Comparative growth performance of rainbow trout, Oncorhynchus mykiss, Walbaum, 1792 in recirculatory aquaculture system and flow through system' under the supervision of Dr. N.N. Pandey.
- Kanika Phartiyal from Department of Biotechnology, Graphic Era University, Dehradun completed her B. Tech dissertation on the topic 'Amplification of toll like receptor-3 (TLR-3) ectodomain from *Schizothorax richardsonii*' under the supervision of Dr. Amit Pande.
- Krishna Kala from Department of Biotechnology, Kumoan University, Nainital Uttarakhand is perusing his PhD under the supervision of Dr. R.S. Patiyal and Dr. Neetu Shahi on the topic 'Study on efficacy and biosafety level of Oxytetracycline in selected coldwater fish species'.
- Kushagra Pant from Kumaun University, Nainital, Uttarakhand is pursuing his PhD on the topic 'Evaluation of antimicrobial potency and immune response of selected plants from Kumaun region against bacterial pathogens of Rainbow trout, *Onchorynchus mykiss* (Walbaum, 1792)' under the supervision of Dr. Neetu Shahi.
- Lata Sharma from Department of Biotechnology, Kumoan University, Nainital Uttarakhand is pursuing her PhD on the title 'Studies on genetic vaiability of different wild populations of chocolate mahseer (*Neolissochilus hexagonolepis*) using molecular markers' under the supervision of Dr. Shahnawaz Ali.
- Mahija Jettiboina from G.B. Pant University of Agriculture and Technology completed her M.F.Sc. dissertation on the topic 'Effect of different seasons and temperature regimes on thermal tolerance of snow trout, *Schizothorax richardsonii*' under the supervision of Dr. B.S. Kamalam.
- Mridula Bisht from Kumaun University, Nainital is pursuing her PhD on the topic 'Molecular characterisation of key components of adaptive immune system in Indian snow trout (*Schizothorax richardsonii*) against *Ichthyopthirius* infection' under the supervision of Dr. Amit Pande.
- Pragyan Dash is pursuing her PhD from ICAR-Central Institute of Fisheries Education, Mumbai on the topic 'Growth and reproductive performance of *Neolissochilus hexagonolepis* in

biofloc based system in mid Himalayan altitude' under the supervision of Dr. D. Sarma.

- Preeti Chaturvedi from Kumaun University, Nainital submitted her PhD thesis on the topic 'Molecular cloning and characterization of important anti-microbial peptide genes of golden mahseer (*Tor putitora*)' under the supervision of Dr. Amit Pande.
- R. S. Tandel from ICAR-CIFE, Mumbai is persuing his PhD on the topic 'Evaluation of antifungal potential of selected Himalayan herbs & peptides against Oomycetes infections in rainbow trout' under the supervision of Dr. N.N. Pandey and Dr. Dimpal Thakuria.
- Rajesh, M is pursuing his PhD from ICAR-Central Institute of Fisheries Education, Mumbai on the topic 'Nutritional regulation of muscle growth related genes in *Schizothorax richardsonii* (Gray, 1832)' under the supervision of Dr. A.K. Singh, Dr. N.N. Pandey and Dr. M.S. Akhtar.
- Rathod Vishalbhai Jodhabhai from G.B. Pant University of Agriculture and Technology is pursuing his M.F.Sc on the topic 'Effect of thermal regimes on growth and immune-biochemical responses of Golden Mahseer (*Tor putitora)*' under the supervision of Dr. D. Sarma and Dr. M. S. Akhtar.
- Renu Kotiya from Kumaun University, Nainital, Uttarakhand submitted her M.Sc. dissertation on the topic 'Study of laboratory efficacy of Oxytetracycline for the control of *Aeromonas hydrophila* infection in fry of Golden Mahseer, *Tor putitora* (Hamilton 1822)' under the supervision of Dr. Neetu Shahi.
- Shaikhom Inaotombi Singh, SERB (DST), New Delhi pursued his National Post-Doctoral Fellowship under the supervision of Dr. D. Sarma on the topic 'Variant of cyanobacterial metabolites and their significance on aquatic environment in a Western Himalayan lake'.
- Surabhi Rawat from Kumaun University, Nainital, Uttarakhand is pursuing her PhD on the topic 'Characterization of bacterial isolates from coldwater bodies of Himalayan region of Uttarakhand for their algicidal property against *Microcystis* spp.' under the supervision of Dr. Neetu Shahi.
- Uzma Siddiqui from Kumaun University, Nainital, Uttarakhand is pursuing her PhD on the topic 'Hematological profile and its relation to age, sex, health status and sexual maturity of snow trout, *Schizothorax richardsonii*' under the supervision of Dr. N.N. Pandey.
- Vineeta Joshi from Department of Biotechnology, Kumaun University submitted her PhD thesis on the topic 'Nutrient profiling of snow trout (*Schizothorax* spp.) distributed in Indian subcontinent region' under the supervision of Dr. D. Sarma.
- Yogesh Pathak from GBPUA&T, Pantnagar completed his MFSc dissertation on the topic 'Phytoplankton community analysis in artificially aerated Lake Naukuchiyatal' under the supervision of Dr. Prem Kumar.

Linkages

10

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal has developed functional linkages with different National-level Organizations, Agricultural Universities, State Department of Fisheries, Financial Agencies, Registered Societies for promotion of R&D in collaborative programmes.

10.1 ICAR Institutes

- ICAR-National Bureau of Fish Genetic Resources, Lucknow
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-Central Institute of Fisheries Education, Mumbai
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Central Inland Fisheries Research Institute, Barrackpore
- ICAR-Central Inland Fisheries Research Institute, Regional Centre, Guwahati
- ICAR Research Complex for NEH Region, Barapani
- ICAR-Indian Institute of Soil and Water Conservation, Dehradun
- ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora
- ICAR-Indian Veterinary Research Institute, Izatnagar
- ICAR-Directorate of Foot and Mouth Disease, Mukteswar
- ICAR-Indian Agricultural Statistics Research Institute, New Delhi
- ICAR-Indian Agricultural Research Institute, New Delhi
- ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru
- ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur

10.2 Central Agencies/Departments

- National Fisheries Development Board
- Department of Biotechnology
- Department of Science & Technology
- Science and Engineering Research Board
- State Agricultural Management & Extension Training Institute (SAMETI), Jammu
- Sashastra Seema Bal (SSB), Ministry of Home Affairs, Govt. of India, Champawat

10.3 State Agencies/Departments

- Department of Fisheries, Sikkim
- Department of Fisheries, Uttarakhand
- Department of Fisheries, Himachal Pradesh
- Department of Fisheries, Jammu & Kashmir
- Department of Fisheries, Arunachal Pradesh
- Department of Fisheries, Meghalaya
- Department of Fisheries, Mizoram
- Department of Fisheries, Nagaland
- Department of Fisheries, Tamil Nadu
- Uttarakhand Council for Biotechnology

10.4 Universities & Colleges

- GB Pant University of Agricultural Science & Technology, Pantnagar
- GB Pant Institute of Himalayan Environment and Development, Almora
- College of Fisheries, SKUAS&T, Jammu & Kashmir
- College of Fisheries, Assam Agricultural University, Raha
- College of Fisheries, Central Agricultural University, Lembucherra
- Tamil Nadu Fisheries University
- Kerala University of Fisheries & Oceanography
- CSKHP Agricultural University, Himachal Pradesh
- Kumaun University, Nainital
- HNB Garhwal University, Srinagar
- Guwahati University, Assam
- Rajiv Gandhi University, Arunachal Pradesh
- Bhimrao Ambedkar Central University, Lucknow

10.5 Krishi Vigyan Kendras (KVK)

- KVK Lohaghat
- KVK Almora
- KVK West Kameng
- KVK Tawang
- KVK Lower Subansiri
- KVK Upper Subansiri
- KVK Lower Dibang valley
- KVK Mamit
- KVK Thoubal
- KVK Deomali

10.6 Registered Societies

- Devan Hills Plantations Company (P) Ltd, Munnar, Kerala
- Gaumco Multipurpose Cooperative Society (P) Ltd, Ziro, Arunachal Pradesh
- Coldwater Fisheries Society of India, Bhimtal, Uttarakhand
- Zoological Survey of India, Bodh Gaya, Bihar
- Assam Bhoreli Angling and Conservation Association, Nameri, Assam

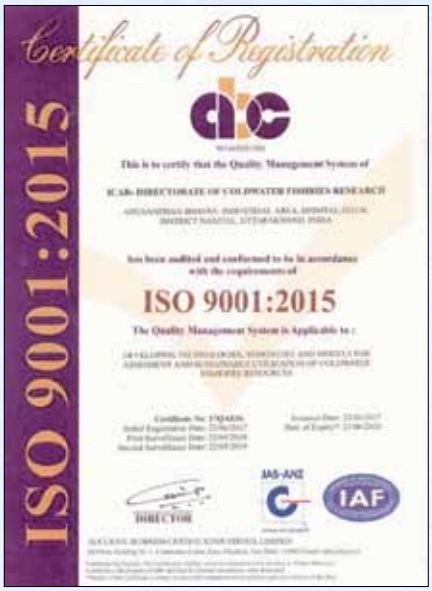
Coldwater Fisheries Society of India (CFSI)
Bhimtal, Uttarakhand

CFSI was established in the year 2012 under the presidentship of Late Dr. P.C. Mahanta, Former Director, ICAR-DCFR, Bhimtal. The society was formed with an objective to implement and expand the research and developmental activities for the benefit of various stakeholders of coldwater fisheries sector of India. The society was registered under Societies Registration Act XXI of 1860 (Reg. No. 128/2012-2013) and the first executive committee was formed with its headquarter at ICAR-DCFR, Bhimtal. At present, the society has registered 100 life members comprising of scientist, academicians, entrepreneurs, students and farmers all over the country.

Awards, Honours and Recognitions

11

- ICAR-Directorate of Coldwater Fisheries Research (ICAR-DCFR), Bhimtal has been awarded ISO 9001:2015 certificate on 22.6.2017



- ICAR-DCFR was awarded ICAR's "Ganesh Shankar Vidhyarthee Patrika Puruskaar" 2015-16 for its hindi magazine 'Himjyoti 2016' edited by R.S .Patiyal and Amit Kumar Joshi on the occasion of ICAR Foundation Day on 16.7.17 at New Delhi .

Dr. A. K. Singh, Director and editors of Himjyoti Dr. R. S. Patiyal and Mr. Amit Joshi receiving the award from Mr. Radha Mohan Singh, Union Minister of Agriculture and Farmers' Welfare, Govt. of India

- ICAR-DCFR received best Hindi Magazine award for publishing its hindi magazine, Himjyoti 2016 at 32nd *Hindi Sammelan Evem Karyashala* organised by *Rajayabhasha Evem Karyashala Vikash Sanstha*, Delhi at Portblair during 16-18 May, 2017.

- Dr. A.K. Singh, Director was awarded "Dr. K L Sehgal Medal" on 22nd September 2017 for his outstanding services in coldwater fisheries sector by Coldwater Fisheries Society of India.

Dr. A K Singh receiving medal from Dr. R. C. Sobti, VC, DR. BR Ambedkar University, Lucknow

- Dr. D. Baruah was awarded "Best Poster Award" (category wise) in Post harvest Technology

(PHT-02) at National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

- Dr. Debajit Sarma, Director (Act.) received Certificates of Appreciation form SAMETI (SKUAS&T-J), Department of Fisheries, Govt. of Mizoram, Department of Fisheries, Govt. of Sikkim, Jasingfaa Aqua Tourism Centre, Nagaon, Assam, and Gaumco Multipurpose Co-operative Society, Hari Village, Ziro, Arunachal Pradesh in 2017.

Dr. D. Sarma receiving certificate of appreciation at Aruranchal Pradesh

- Dr. Debajit Sarma, Principal Scientist was awarded Fellowship of Zoological Society of India in recognition of his outstanding research contribution in the field of coldwater fisheries during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

Dr. D. Sarma receiving the Fellow of the Zoological Society of India (FZSI) award

- Dr. M. S. Akhtar, Scientist (Senior Scale) was awarded Fellow of Zoological Society of India (Registration Act 21, 1860; Regd. No. 302/2002-2003) in recognition of his outstanding research contribution in the field of fish and fisheries during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

Dr. M. S. Akhtar receiving the Fellow of the Zoological Society of India (FZSI) award

- Dr. N.N. Pandey, Principal Scientist was conferred Prof. M.C. Dash Medal for outstanding Research & Academic contribution in the field of Fish & Fisheries on 9th June 2017.
- Dr. D. Thakuria, Scientist was awarded "Best Paper Award" at 11th Indian Fisheries and Aquaculture Forum organized during 21-24 November 2017 by ICAR-CIFT, Kochi.
- Dr. D. Thakuria, Scientist was bestowed "Gold Medal" by Zoological Society of India for his performance in young scientist presentation during National Seminar on "Strategies,

Dr. D. Thakuria receiving Gold Medal

Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

- Dr. D. Baruah was awarded "Fellow of Zoological Society of India" (Registration Act 21, 1860; Regd. No. 302/2002-2003) during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

Dr. D. Baruah receiving the Fellow of the Zoological Society of India (FZSI) award

- Dr. D. Baruah won "Third Prize" in M.C. Nandeesha Photo Competition in Kochi during the GAF-India event at the 11th Indian Fisheries and Aquaculture Forum from 21-24 November 2017 at ICAR-CIFT, Kochi.

Dr. D. Baruah receiving the award

- Dr. D. Sarma and Dr. Raghavendra Singh received "Certificate of Appreciation" by SAMETI, Jammu on 26th July 2017
- Dr. Neetu Shahi received "Certificate of Appreciation" by Zoological Society of India during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.
- Dr. Prem Kumar was conferred "Prof. B.N. Pandey Medal" by Zoological Society of India for outstanding research and academic contribution in the field of fish and fisheries.
- Dr. R.S. Haldar was conferred "Fellow of Society of Life Sciences (FSLSc)" Satna, (M.P.) during May, 2017.
- Dr. R.S. Haldar was conferred "Fellow of Zoological Society of India (FZSI)" during the 29th All India Congress of Zoology (29th AICZ) & International Symposium on Culture Based Fisheries in Inland Open Waters & International Satellite Symposium on Fish Immunology organized by Inland Fisheries Society of India (IFSI), Barrackpore in collaboration with Zoological Society of India (ZSI), Bodh Gaya and ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore.

Dr. R S Haldar receiving the Fellow of the Zoological Society of India (FZSI) from the DDG (Fy), ICAR, New Delhi.

- Dr. R.S. Haldar was awarded "Best Poster Award" during National Seminar on Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture organized by ICAR- Directorate

of Coldwater Fisheries Research, Bhimtal in collaboration with Zoological Society of India (ZSI), Bodh Gaya and Coldwater Fisheries Society of India, Bhimtal during September, 22-24, 2017.

Dr. R. S. Haldar receiving Best Poster Presentation award

- Dr. R.S. Patiyal was conferred "Fellow of Zoological Society of India" during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.

Dr. R. S. Patiyal receiving the Fellow of the Zoological Society of India (FZSI) award

- Prerna Sharma, student of Dr. Neetu Shahi was awarded "Dr. S.S. Gupta Award" by Coldwater Fisheries Society of India during National Seminar on "Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture" from 22-24 September, 2017 held at ICAR-DCFR, Bhimtal.
- Dr. D. Baruah received Young Scientist Award by the Society of Krishi Vigyan during the 1st National Conference on 'Improving income of farmers through agriculture and aquaculture through development interventions', jointly organized by Society of Krishi Vigyan and Association of Aquaculturists, ICAR-CIFA at ICAR-CIFA, Bhubaneswar during 5-7th January, 2018.
- Dr. D. Baruah received Letter of Appreciation from Gaumco Multipurpose Cooperative Society Pvt. Ltd., Ziro, Lower Subansiri district, Arunachal Pradesh on 22nd March, 2018.

Dr. D. Baruah receiving Letter of Appreciation from the Parliamentary Secretary Food and Civil Supplies, Govt. of Arunachal Pradesh at Ziro, Lower Subansiri district.

Publications

12

Research Papers

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- Joshi, V., Akhtar, M.S., Sharma, P., Kushwaha, S.S., Baruah, D., Ciji, A., Das, P., Pande, V. and Sarma, D. (2017). Protein and amino acid composition of Indian Himalayan snow trout and their dietary significance. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences.* (DOI 10.1007/s40011-017-0889-1).
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- Kumar, P., Pandey, N.N., Patiyal, R.S. and Singh, A.K. (2017). Prospects of low density polyethylene film lined ponds in mid hill aquaculture. *Ecology, Environment and Conservation,* 23: S292-S296.
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- Pandey, N.N., Gupta, M., Singh, R., Ali, S., Haldar, R.S., Kumar, P. and Singh, A.K. (2017). Breeding performance of indigenous carp, *Labeo dero* in captivity under cold water condition of Uttarakhand, India. *Journal of Environmental Biol*ogy, 38: 771-775.
- Pandey, N.N., Gupta, M., Singh, R., Ali, S., Haldar, R.S., Kumar, P. and Singh, A.K. (2017). Breeding performance of indigenous carp, *Labeo dero* in captivity under cold water condition of Uttarakhand, India. *Journal of Environmental Biology,* 38: 1-5.
- Patiyal, R.S. and Mir. J.I. (2017). Length–weight relationships of 21 fish species from the upland

Ganga River Basin tributaries of Central Indian Himalaya. *Journal of Applied Ichthyology*, DOI:10.1111/jai.13386.

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- Shahi, N., Mallik, S.K., Sahoo, M. and Singh, A.K. (2017). *Lactococcus garvieae* infection causes hyperacute haemorrhagic septicaemia In farmed rainbow trout, *Oncorhynchus mykiss* (Walbaum) in India: Characterization, antimicrobial susceptibility and pathogenicity study. *National Seminar on National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Sharma, P., Sarma, D., Akhtar, M.S., Baruah, D., Das, P. Sharma, A. and Singh A.K. (2017). Screening and identification of appetite markers in golden mahseer (*Tor puttora*) juveniles within 24 hours of feeding. *11th Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety*, 21-24th November, ICAR-CIFT, Kochi.

- Sharma, A., Sarma, D., Sarma, P., Baruah, D., Das, P. and Singh, A.K. (2017). Study of seasonality of gonadal status and renal thyroid follicles in sexually mature golden mahseer (*Tor putitora). 11th Indian Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety*, 21-24th November, ICAR-CIFT, Kochi.
- Sharma, A., Sarma, D., Sharma, P., Das, P. and Singh, A.K. (2017). Evaluation of seasonal gonadal status and renal thyroid follicle in sexually matured golden mahseer (*Tor putitora). National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Sharma, P., Sarma, D., Akhtar, M.S., Sharma, A., Das, P., Baruah, D. and Singh, A.K. (2017). Screening and identification of appetite markers in golden mahseer (*Tor putitora)* juveniles within 24 hours of feeding. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture,* 22-24th September, ICAR-DCFR, Bhimtal.
- Sharma, P., Shahi, N., Pandey, J., Mallik, S.K. and Bisht, I. (2017). Antimicrobial susceptibility of *Chryseobacterium scophthalmum* recovered from gill disease of golden mahseer, *Tor putitora* (Hamilton, 1822). *National Seminar on National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture,* 22-24th September, ICAR-DCFR, Bhimtal.
- Singh, A.K. (2017). Innovative research strategies for assessing aquatic resources and augmenting fisheries in Himalayan region, India. *11th Indian Fisheries And Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety,* 21-24th November, ICAR-CIFT, Kochi.
- Singh, A.K. and Kamalam, B.S. (2017). Scientific approaches towards rainbow trout farming in Indian uplands for entrepreneurship development. *8th International Conference on Fisheries and Aquaculture*, 2-4th October, Toronto, Canada.
- Singh, R., Pandey, N.N., Gupta, M. and Singh, A.K. (2017). Advancement in spawning period of *Labeo dyocheilus* using ovatide in mid Himalayas. *11th Indian Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety*, 21-24th November, ICAR-CIFT, Kochi.
- Singh, R., Pandey, N.N., Tiwari, V.K., Prakash, C., Babitha, R.A.M., Gupta, M. and Singh, A.K. (2017). Optimization of stocking density for successful rearing of *Chaunius chagunio* larvae. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Singh, R., Pandey, N.N., Tiwari, V.K., Gupta, M. and Singh, A.K. (2017). Breeding and embryonic development of *Chagunius chagunio* (Hamilton- Buchanan, 1822)- way towards conservation and aquaculture diversification. *29th all India congress of zoology, International Symposium on Culture based fisheries in Inland Open Waters and Satellite Symposium on Fish Immunology*, ICAR-CIFRI, Barrackpore, Kolkata.
- Siva, C., Sharma, L., Kumar, R., Ali, S., Sahoo P.K., Barat, A. and Singh A.K. (2017). High throughput development of novel microsatellite markers for brown trout (*Salmo trutta fario*). *11th Indian Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety*, 21-24th November, ICAR-CIFT, Kochi.
- Tandel, R.S., Chadha, N.K., Pandey, N.N., Chandra, S., Sawant, P.B., Thakuria D., Kallingapuram, K., Bhat, R. and Singh, A.K. (2017). Molecular characterization of *Saprolegnia* species from rainbow trout farms and hatcheries of Himachal Pradesh & Uttarakhand. *11th Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and*

Aquaculture Focus on Sustainability and Safety, 21-24th November, ICAR-CIFT, Kochi.

- Tandel, R.S., Kallingapuram, K., Bhat, R., Mallk, S.K., Chandra, S., Sharma, P., Giri, A.K. and Singh, A.K. (2017). Skeletal deformities in cultured rainbow trout at early stage of development. *National Seminar on Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Tandel, R.S., Kallingapuram, K., Mallik, S.K., Chandra, S., Shahi, N., Pandey, N.N. and Singh, A.K. (2017). Morphological and molecular characterization of *Saprolegnia* species infecting different life stages of rainbow trout and golden mahseer of Himachal Pradesh and Uttarakhand. *International symposium on Aquatic Animal Health and Epidemiology for Sustainable Asian Aquaculture*, 20-21st April ICAR-NBFGR, Lucknow.
- Tandel, R.S., Kallingpuram, K., Bhat, R., Mallik, S.K., Chandra, S., Sharma, S., Giri, A.K. and Singh, A.K. (2017). Skeletal deformities in cultured rainbow trout at early stage of development. *International symposium on Aquatic Animal Health and Epidemiology for Sustainable Asian Aquaculture*, 20-21st April, ICAR-NBFGR, Lucknow.
- Thakuria, D., Chanu, K.V., Saxena, A., Pande, A., Shahi, N., Das, P., Sarma, D. and Singh, A.K. (2017). Gene Delivery into fish cells by a fish virus derived hybrid peptide nanosystem. *National Seminar on National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Thakuria, D., Shahi, N., Singh, A.K. and Chanu, K.V. (2017). Conformational study of synthetic KISS1 peptide of golden mahseer (*Tor putitora*) in membrane mimicking environments. *11th Indian Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on sustainability and Safety,* 21-24th November, ICAR-CIFT, Kochi.
- Zaidi, S.G.S. Sarma, D. and Singh, A.K. (2017). First record of multiple natural spawning of Chocolate Mahseer (*Neolissochilus hexagonolepis* Mcclelland, 1839) in aquarium condition. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Zaidi, S.G.S. and Singh, A.K. (2017). First record of natural spawning, breeding and seed rearing of critically endangerd fish species dark mahseer *Naziritor cheelynoides* (Mcclelland, 1839) in controlled aquarium condition. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Zaidi, S.G.S., Baruah, D. and Singh, A.K. (2017). Prospectus of breeding and culture of commercially important coldwater ornamental fish of Kumaun and Northeast region towards livelihood security of rural people. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture,* 22-24th September, ICAR-DCFR, Bhimtal.
- Zaidi, S.G.S., Pandey, N.N. and Singh, A.K. (2017). Zero water exchange device: Sucessful hatching and larval rearing of climate resilient minor carp, *Labeo dyocheilus. 11th Indian Fisheries And Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety*, 21-24th November, ICAR-CIFT, Kochi.
- Zaidi, S.G.S., Pandey, N.N. and Singh, A.K. (2017). First record of Hatching and rearing of rainbow trout (*Onchorhynchus mykiss)* eyed ova in a closed re-circulatory glass tank. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.

- Zaidi, S.G.S., Pandey, N.N. and Singh, A.K. (2017). First record of natural spawning and breeding of *Barilius bendelisis* (Hamilton) in controlled aquarium condition. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Zaidi, S.G.S., Pandey, N.N. and Singh, A.K. (2017). Incubation of eggs and larval rearing of *Labeo dyocheilus* an important cold water minor carp under closed re-circulatory system. *National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.
- Zaidi, S.G.S., Pandey, N.N. and Singh, A.K. (2017). Zero water exchange system for successful hatching and larval rearing of minor carp, *Labeo dyocheilus. National seminar on Strategies, Innovation and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture*, 22-24th September, ICAR-DCFR, Bhimtal.

NCBI Submissions

- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S. and Singh, A.K. *Schizothorax richardsonii* fatty acid synthase mRNA partial cds. (MF289408).
- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S. and Singh, A.K. *Schizothorax richardsonii* glucokinase mRNA partial cds. (MF289410).
- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S. and Singh, A.K. *Schizothorax richardsonii* hydroxy acyl-CoAdehydrogenase mRNA partial cds. (MF289411).
- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S. and Singh, A.K. *Schizothorax richardsonii* pyruvate kinase mRNA partial cds. (MF289412).
- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S. and Singh, A.K. *Schizothorax richardsonii* peroxisome proliferator-activated receptor-alpha (PPAR-α) mRNA partial cds. (MF289413).
- Akhtar, M.S., Rajesh, M., Ciji, A., Kamalam, B.S., Giri, A.K. and Singh, A.K. *Schizothorax richardsonii* glucose-6-phosphatase mRNA partial cds. (MF289409).
- Saxena, A., Belwal, K. and Pande, A. *Schizothorax richardsonii* clone SspI PKRpro Snt plasmid pTZ57R-PKRpro-Snt. 791 bp linear DNA. (MF678851).

Participation in Conference, Symposia, Workshop and Meetings

13

Participation in Conference/Symposia/ Workshop

- A. Ciji participated and presented a research paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st-24th November, 2017.
- A. Ciji participated and presented two research papers in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.
- A. Giri participated in awareness workshop on intellectual property rights on 28th March, 2018 at ICAR-DCFR, EFF, Champawat.
- A.K. Singh attended 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- A.K. Singh attended international workshop on 'Mahseer conservation' at Kerala University, Kochi, Kerala on 5th April, 2017.
- A.K. Singh attended meeting/conference convened by Ministry of Environment & ZSI at Kolkata during 14-15th December, 2017.
- A.K. Singh conducted centralized evaluation of M.F.Sc. dissertation and viva-voce examination at ICAR-CIFE, Mumbai during 18-19th July, 2017.
- A.K. Singh participated in international conference on the 'Status and future of the world's largest rivers' at New Delhi on 19th April, 2017.
- A.K. Singh participated in international symposium on 'Aquatic animal health and epidemiology for sustainable Asian aquaculture' at ICAR-NBFGR, Lucknow during 20-22nd April, 2017.
- A.K. Singh participated in Mahseer awareness, rehabilitation and seed ranching programme at Maka fish farm and Teesta barrage near Dikchu (Sikkim) organized by ICAR-DCFR on world environment day in association with the Department of Fisheries, Government of Sikkim.
- A.K. Singh participated in the collaboration training programme on 'Fish breeding techniques at SKUAST-J, Chatha, Jammu' and discussed the collaborative project with the university on 24th July, 2017.
- A.K. Singh participated in the ICAR Foundation day, Award ceremony 2017 & Director's conference at NASC complex, New Delhi on 16th July, 2017.
- A.K. Singh participated in the international symposium on 'Culture based fisheries in inland open waters' and satellite symposium on 'Fish immunology' organized by Inland Fisheries Society of India, Bodh Gaya and ICAR-CIFRI Barrackpore Kolkata, West Bengal during 9-10th June, 2017.
- A.K. Singh participated in the workshop on 'Stakeholder consultation for formulation of national inland fisheries and aquaculture policy' at Bilsapur, Himachal Pradesh during 3-4th July, 2017.
- A.K. Singh participated in the workshop on conservation policy of Hilsa & Mahseer organized by NAAS at NASC, New Delhi on 7th November, 2017.

- A. Pande participated in 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR--CIFT, Cochin during 21-24th November, 2017.
- A. Pande participated in national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22-24th September, 2017.
- A. Pande participated in the Indian Science Congress on 'Reaching the unreached through science and technology' held at Manipur University, Imphal from 16 to 20th March, 2018.
- B.S. Kamalam participated and presented two research papers in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.
- B.S. Kamalam participated and presented two research papers in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- C. Siva attended the workshop on 'Applications on Single Molecule Real Time (SMRT) sequencing and bioinformatics analysis' organized at ICAR-NBFGR, Lucknow during 25-26 July, 2017.
- C. Siva participated in the winter school on "Harnessing NGS data for genetic enhancement in crops" organized at ICAR-IIWBR, Karnal, Haryana during 3-12th October, 2017.
- D. Baruah participated and presented a paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- D. Baruah participated as resource person in fish farmer's day at Chug village, West Kameng district, Arunachal Pradesh in association with KVK West Kameng, Dirang, Arunachal Pradesh on 10th July 2017.
- D. Baruah participated in 1-day mahseer ranching programme under Namami Ganga at Laxmanjhula, Rishikesh, Uttarakhand and released 500 numbers of mahseer seeds on 23rd May 2017.
- D. Baruah participated and presented a poster in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24th September, 2017 at ICAR-DCFR, Bhimtal.
- D. Baruah participated in 1-day workshop on 'Connecting people, fish and nature' conducted by Jasingfaa Aqua Tourism Centre, Nagaon, Assam on 15th October 2017.
- D. Baruah participated in 3-days Pre conclave meet on 'Perspective planning for resurgent agriculture and allied sector in Arunachal Pradesh' at Itanagar during 5-7th February 2018.
- D. Baruah participated in Kisan Mela at Experimental Fish Farm Unit, Champawat of ICAR-DCFR as member of registration committee on 24th February 2018.
- D. Sarma participated and presented a poster in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin during 21-24th November, 2017.
- D. Sarma participated in national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22-24th September, 2017.
- D. Thakuria participated and presented a research paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- D. Thakuria participated and presented a research paper in the national seminar on

'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.

- H.B. Raja Aadil attended and presented a research paper in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24th September, 2017 at ICAR-DCFR, Bhimtal.
- K. Kunal participated and presented a poster in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24th September, 2017 at ICAR-DCFR, Bhimtal
- K. Kunal participated in awareness workshop on intellectual property rights on 28th March, 2018 at ICAR-DCFR, EFF, Champawat.
- Kh. Victoria Chanu participated and presented a research paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture' Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- Kh. Victoria Chanu participated in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.
- M. Rajesh participated and presented a research paper in national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22-24th September, 2017.
- M. Rajesh participated and presented a research paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' organized at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- M.S. Akhtar participated and presented a research paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- M.S. Akhtar participated and presented a research paper in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24thSeptember, 2017 at ICAR-DCFR, Bhimtal.
- N.N. Pandey participated in the 3rd ARRW international symposium on 'Frontiers of rice research for improving productivity, profitability and climate resilience' at ICAR-NRRI, Cuttack, Odisha, India.
- N.N. Pandey participated in the Kisan Mela, organised by ICAR-VPKAS, Almora on 23rd March, 2018.
- N.N. Pandey participated in the one day brainstorming workshop on 'Converting extreme rainfall events into opportunities' in collaboration with Indian society of water management at ICAR-IIWM, Bhubaneswar.
- N.N. Pandey participated in the workshop on 'Emerging trends in Hi-tech hill horticulture under changing climate organised by CITH, Mukteswar during 6-7th March, 2018.
- P. A. Ganie participated in awareness workshop on intellectual property rights on 28th March, 2018 at ICAR-DCFR, EFF, Champawat.
- P. Kumar participated in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.
- P. Sharma participated and presented a research paper in 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' organized by ICAR-CIFT, Kochi during 21-24th November, 2017.
- P. Sharma participated and presented a research paper in the national seminar on 'Strategies,

innovations and sustainable management for enhancing coldwater fisheries and aquaculture' organized by ICAR-DCFR, Bhimtal during 22-24th September, 2017.

- P.A. Ganie participated and presented a poster in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24thSeptember, 2017 at ICAR-DCFR, Bhimtal.
- P. Dash participated and presented a paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' organized by ICAR-CIFT, Kochi during 21-24th November, 2017.
- P. Dash participated in multi-disciplinary international conference on 'Integration of science, social science, humanities and technology in current scenario: The global perspectives' organized by Vikas College of Arts, Science & Commerce, Mumbai on 22nd April 2017.
- P. Dash participated in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' organized by ICAR-DCFR, Bhimtal during 22-24th September, 2017.
- R. A. H. Bhat participated in awareness workshop on intellectual property rights on 28th March, 2018 at ICAR-DCFR, EFF, Champawat.
- R. Singh participated and presented a poster in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st-24th November, 2017.
- R. Singh participated and presented a poster in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24th September, 2017 at ICAR-DCFR, Bhimtal.
- R. Singh participated in the 29th AICZ and presented a paper in the international symposium on 'Culture based fisheries in inland open waters' & satellite symposium on 'Fish immunology' held at ICAR-CIFRI, Barrackpore during 09-11th June, 2017.
- R.S Haldar participated in the international symposium on 'Aquatic animal health and epidemiology for sustainable Asian aquaculture (ISAAE)' organized by ICAR- NBFGR, Lucknow in collaboration with Aquatic Biodiversity Conservation Society, Lucknow and National Surveillance Programme on Aquatic Animal Diseases during April 20-21, 2017 at ICAR- NBFGR, Lucknow.
- R.S Haldar participated in the 29th All India Congress of Zoology (29th AICZ) & International Symposium on Culture Based Fisheries in Inland Open Waters & International Satellite Symposium on Fish Immunology organized by Inland Fisheries Society of India (IFSI), Barrackpore in collaboration with Zoological Society of India (ZSI), Bodh Gaya and ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore during June 9-11, 2017 at ICAR-CIFRI, Barrackpore.
- R.S Haldar participated in the national seminar on 'Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture' organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with Zoological Society of India (ZSI), Bodh Gaya and Coldwater Fisheries Society of India, Bhimtal during September 22-24, 2017 at ICAR-DCFR, Bhimtal.
- R.S Haldar participated in the 11th Indian Fisheries and Aquaculture Forum (11th IFAF) organized by ICAR- Central Institute of Fisheries Technology (CIFT), Kochi in association with Asian Fisheries Society Indian Branch (AFSIB) during November 21-24, 2017 at ICAR- Central Institute of Fisheries Technology (CIFT), Kochi.
- R.S. Patiyal attended 94th foundation day of ICAR- VPKAS Almora on 4th July, 2017.
- R.S. Patiyal attended ICAR Foundation day on 16th July, 2017 at NASC complex, New Delhi.

- R.S. Patiyal participated in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st to 24th November, 2017.
- R.S. Patiyal participated in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24th September, 2017 at ICAR-DCFR, Bhimtal.
- R.S. Tandel participated in international symposium on 'Aquatic animal health and epidemiology for sustainable Asian aquaculture' at ICAR-NBFGR, Lucknow during 20th to 21st April 2017.
- R.S. Tandel participated and presented a paper in the 11th Indian fisheries and aquaculture forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at ICAR-CIFT, Cochin, Kerala during 21st- 24th November, 2017.
- R.S. Tandel participated and presented a paper in the national seminar 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' from 22nd to 24thSeptember, 2017 at ICAR-DCFR, Bhimtal.
- S. Ali participated and presented a research paper in the national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22nd - 24th September, 2017.

Participation in Meeting

- A.K. Singh attended 53rd meeting of academic council of ICAR-CIFE Mumbai on 14th October, 2017.
- A.K. Singh attended assessment committee meeting at ASRB, New Delhi on 11th September, 2017.
- A.K. Singh attended meeting at Babasaheb Bhimrao Ambedkar Central University, Lucknow on 29th May, 2017.
- A.K. Singh attended meeting of Uttarakhand State Coordination Committee for Doubling of Farmers' Income at ICAR-IISWC Dehradun under the Chairmanship of Hon'ble Secretary (DARE) & Director General (ICAR) during 7-8th April, 2017.
- A.K. Singh attended review meeting of ZMC (NMSHE) at Leh, J& K during 8-9th September, 2017.
- A.K. Singh participated in Annual State Level Joint Review Meeting (SLJRM) of ICAR Regional Committee No. 1 for Uttarakhand organized by VCSG-UUHF, Ranichauri at ICAR-IISWC Dehradun on 2nd July, 2017.
- A.K. Singh participated review meeting at Scope complex, New Delhi organized by Chairmanship of Secretary (ADF), DAHD&F, Govt. of India, New Delhi on 4th September, 2017.
- A.K. Singh visited Sr. Venkateswara Veterinary University (SVVU), Tirupati as a member of PRT for accreditation during 28th August to 2nd September, 2017.
- B.S. Kamalam attended the review workshop of Fisheries Institutes under NICRA for the period 2017-18 which was convened at ICAR-CMFRI, Kochi on 1st March 2018, and presented the progress made under the project.
- N.N. Pandey attended review meeting and workshop on NMSHE organized by ICAR-VPKAS Almora.
- N.N. Pandey participated in meetings for doubling the farmers Income by 2022 at G.B. Pant University of Agriculture & Technology, Pantnagar.
- P. Kumar attended meeting at SMD, ICAR Headquarters and ICAR-CIFRI, Barrakpore for finalization of EFC documents during 8-9th September, 2017.
- P. Kumar attended Zonal Monitoring Committee (ZMC) meeting of National Mission on Sustaining Himalayan Ecosystem (NMSHE) Task Force-6 (Himalayan Agriculture) held at RRS ICAR-CAZRI, Leh during 8-9th September, 2017.
- R.S. Patiyal participated as a Cheif-DE-Mission

in North Zone sports meet held at IISR Lucknow.

- P. Kumar and B.S. Kamalam attended the NMSHE project Zonal Monitoring Committee meeting for cold arid region convened by ICAR-CAZRI at DIHAR, Leh during 8-9 September 2017, and presented the progress made under the project.

Lectures/Talks Delivered

- A. Pande delivered a lead lecture on 'Development of a method for detecting the presence of any virus signal in clinical samples of fish' during national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture, held at ICAR-DCFR, 22-24th September, 2017.
- A.K Giri delivered a lecture on 'Benefit of integrated fish farming' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Thanta, Lohaghat on 27th March, 2018.
- A.K Giri delivered a lecture on 'Exotic carp propagation and farming in coldwater regimes' to the farmers of Pithoragarh on 23rd March, 2018.
- A.K Giri delivered a lecture on 'Fish culture diversities of our country, particularly in cold water regions' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Khateda, Lohaghat on 22nd March, 2018.
- A.K Giri delivered a lecture on 'Integrated agriculture practice in mid-hills with fish as a base component & significance of polylined and polyhouse tanks for fish farming in areas with lower thermal regime' to the students of Janata Higher Secondary School, Muriyani, Champawat on 3rd December, 2017.
- A.K Giri delivered a lecture on 'Introduction of exotic species and their role in coldwater sector for boosting livelihood and farm Income' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Ijda, Barakot, Lohaghat on 24th March, 2018.
- A.K Giri delivered a lecture on 'Overview of candidate fish species in cold ambience of hilly province' to students of Catalyst Coaching Centre Lohaghat on 18th December, 2017.
- A.K Giri delivered a lecture on 'Site selection and construction of fish ponds' to the farmers of Pauri Garhwal, Uttarkhand on 26th February, 2018.
- A.K Giri delivered a lecture on 'Trademark and trade secret in IPR' during an awareness workshop on 'Intellectual Property Rights' on 28th March, 2018.
- B.S. Kamalam delivered a lecture and practical demonstration on 'Live transportation of ornamental fish' in the Tribal Sub-Plan training 'Management and culture of ornamental fishes in coldwater region' organized at ICAR-DCFR, Bhimtal during 5-7 September 2017.
- B.S. Kamalam delivered a lecture on 'Intellectual property rights and patents: basics and examples' in the IPR workshop organized at ICAR-DCFR, Bhimtal on 20th March 2018.
- B.S. Kamalam delivered an invited lecture on 'Advances in aquaculture nutrition research' in the SAP international symposium on 'Key Topics in Aquaculture Nutrition' organized at Chennai on 1st February 2018, and took part in the subsequent panel discussion.
- B.S. Kamalam delivered an invited talk on 'Rainbow trout nutrition in India: developments and challenges' in the DBT brainstorming session on 'Nutrition and Live Feed for Aquaculture Species' organized at Fakir Mohan University, Balasore during 21-22 February 2018, and participated in the deliberations.
- D. Baruah delivered five lectures on (i) Coldwater fisheries resources of India (ii) Culture, induced breeding & seed production of indigenous trouts (iii) Culture & breeding of mahseer (iv) Rearing practices, hatchery management and seed production of exotic trouts (v) Sport fisheries and aqua tourism, as adjunct faculty for BFSc, MFSc and PhD students at GADVASU, Ludhiana.
- D. Baruah delivered a talk as resource person on 'Recreational fisheries resources in ecotourism' on 15th October 2017 at Jasingfaa Aqua Tourism Centre, Nagaon, Assam.

- D. Baruah delivered a talk as resource person on 'ICAR-DCFR Initiatives towards Sustainable Development of Coldwater Aquaculture & Fisheries' during 3-days Pre conclave meet on "Perspective Planning for Resurgent Agriculture and Allied Sector in Arunachal Pradesh" at Itanagar during 5-7 February 2018.
- D. Sarma and R. Singh delivered lectures as resource persons in the training programme on 'Fish breeding techniques' held at SAMETI-J SKUAST-J, Jammu J&K during 24-26th July, 2017.
- D. Sarma delivered a lecture 'Present scenario of fish production practice and use of chemicals in hill aquaculture' in national workshop on 'Antimicrobial resistance and alternatives to antibiotics use in aquaculture (AMR-2018)' during 12-13th March 2018 at ICAR-CIFA, Bhubaneswar.
- D. Sarma delivered a lecture on 'Ecology and fish diversity of Indian Himalayan region' during the 4th international workshop on 'Environment and Ecology' on 12th February 2018 at Gauhati University, Assam in Association with Confederation of Indian Universities.
- D. Sarma delivered an invited talk on 'Existing knowledge on artificial propagation and culture of mahseer in India' during 'Policy workshop on conservation of Hilsa and mahseer' on 7th November 2017 at NAAS, ICAR, New Delhi.
- D. Sarma delivered an invited talk on 'Mahseer eco-tourism' during the workshop on 'Connecting people, fish and nature' on 15th October 2017 at Jasingfaa Aqua tourism centre, Nagaon, Assam.
- H.B. Raja Aadil delivered a lecture on 'Diseases in Coldwater sector and their remedial measures' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Thanta, Lohaghat on 27th March, 2018.
- H.B. Raja Aadil delivered a lecture on 'Fish health management in Coldwater aquaculture' to the farmers of Pauri Garhwal, Uttarkhand on 26th February, 2018.
- H.B. Raja Aadil delivered a lecture on 'Health management in trout and carps farms' to the farmers of Tawang district, Arunachal Pradesh on 14th October, 2017.
- H.B. Raja Aadil delivered a lecture on 'Highlight of Fish farming status in Uttarakhand' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Khateda, Lohaghat on 22nd March, 2018.
- H.B. Raja Aadil delivered a lecture on 'Introduction to IPR with special focus on Patents' during an awareness workshop on 'Intellectual Property Rights' on 28th March, 2018.
- H.B. Raja Aadil delivered a lecture on 'Lecture on Operational and functional aspects of RAS of Champawat farm' to students of Catalyst Coaching Centre Lohaghat on 18th December, 2017.
- H.B. Raja Aadil delivered a lecture on 'Prospects of integrated farming in high upland coldwater regions' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Ijda, Barakot, Lohaghat on 24th March, 2018.
- H.B. Raja Aadil delivered a lecture on 'Rainbow trout breeding and culture in low thermal mid hills regions' to the farmers of Pithoragarh on 23rd March, 2018.
- K. Kunal delivered a lecture on 'Diversity of fish species in high altitudinal coldwater regions and their importance' to the students of Rajkiya Ucchattar Madhyamik Vidyalaya, Thanta, Lohaghat on 27th March, 2018.
- K. Kunal delivered a lecture on 'Geographical Indications' during an awareness workshop on 'Intellectual Property Rights' on 28th March, 2018.
- K. Kunal delivered a lecture on 'Soil and water quality management in aquaculture' to the farmers of Pauri Garhwal, Uttarkhand on 26th February, 2018.
- K. Kunal delivered a lecture on 'Trout farming: A Profitable practice for livelihood and income' to students of Catalyst Coaching Centre Lohaghat on 18th December, 2017.
- N.N. Pandey delivered a theme lecture on 'Status of rainbow trout farming in India' in

national seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22-24th September, 2017.

- N.N. Pandey delivered an invited lecture on "Role of small tributaries in the ichthyofaunal diversity of rivers in Uttarakhand" in the International symposium on 'Culture based fisheries in inland open waters at ICAR-CIFRI, Barrackpore during 9-11th June, 2017.
- P.A Ganie delivered a lecture on 'Breeding and seed production of rainbow trout' to the farmers of Tawang district, Arunachal Pradesh on 14th October, 2017.
- P.A Ganie delivered a lecture on 'Copyright Issues in IPR' during an awareness workshop on 'Intellectual Property Rights' on 28th March, 2018.
- P.A Ganie delivered a lecture on 'Fisheries and conservation prospects of indigeneous snow trout' to students of Catalyst Coaching Centre Lohaghat on 18th December, 2017.
- P.A Ganie delivered a lecture on 'Potential candidate species for mid hill aquaculture practices' to the farmers of Pauri Garhwal, Uttarkhand on 26th February, 2018.
- R. Singh delivered a lecture on 'Carp pond and feed management' to the farmers of Pauri Garhwal, Uttarkhand on 26th February, 2018.
- R.S. Patiyal delivered a lecture on 'Copy right issues' during the workshop on 'Protecting Intellectual Property Rights' on 20th March, 2018 at ICAR-DCFR, Bhimtal.
- R.S. Patiyal delivered a lecture on 'STARTUP INDIA- STAND UP INDIA' in start-up orientation programme on 'Ornamental fish aqua-gardening for tribal students' on 31st March, 2018 at ICAR-DCFR, Bhimtal.
- R.S. Patiyal delivered a talk to the officials of Tehri Hydroelectric Development Corporation (THDC) on 'Techniques and tools for mahseer conservation in lakes and reservoirs of Uttarakhand' at ICAR-DCFR, Bhimtal on 6th February, 2018.
- R.S. Patiyal delivered two lectures on 'Gold fish breeding and rearing for aqua gardening' and 'Importance of live fish transportation in fishery' on 7th March, 2018 during the training programme on 'Coldwater ornamental fish breeding and rearing technologies' organized at ICAR-DCFR, Bhimtal.
- S. Chandra delivered a lecture on 'An overview of trout farming' to the farmers of Tawang district, Arunachal Pradesh on 14th October, 2017.
- S. Chandra delivered a talk on "Fish health management in coldwater aquaculture" for the fish farmers of Champawat District on 29th July, 2017 at Champawat Trout Farm.
- S. Chandra delivered a talk on fish farm management on 24th February, 2018 during the Fish farmer Day at ICAR-DCFR, Field Centre, Champawat, Uttarakhand.
- S. Chandra delivered a talk to fish farmers on fish health management in mid hill fish farm on 20th August during the *Sankalp Se Siddhi* awareness programme organized under the NSPAAD project at ICAR-DCFR, Field Centre, Champawat, Uttarakhand.
- S. Chandra delivered two talks on Culture and Hatchery Management of Snow trout (*Schizothorax richardsonii*) and Health management of live stocks in hatchery and fish farm on 6 & 7th February, 2018 at ICAR-DCFR Bhimtal, Uttarakhand.
- S. Chandra delivered two talks to 16 trainees of CIFE Kolkata (07.12.2018) and 22 students of Aligarh Muslim University (12.03.2018) on rainbow trout culture, breeding and seed production and parasitic diseases of trout and carp in upland farms respectively at ICAR-DCFR Bhimtal, Uttarakhand.
- S. Chandra gave a talk on large scale breeding, seed production, nursery rearing and fish seed transportation of improved common carp on 10th July, 2017 during the Fish farmer Day at ICAR-DCFR, Field Centre, Champawat, Uttarakhand.

Library and Information Services

14

Library & Information Services

The ICAR-DCFR library and documentation unit acts as a repository of literature and provides latest information in the field of fisheries and allied aspects.

During the year 2017-18, the Directorate subscribed 3 Indian journals and procured 475 scientific and 45 hindi books of both Indian and foreign authors through book exhibition by empanelled book suppliers/vendors. The current holding of the library includes 6761 books, 1693 volumes of foreign journals, 543 volumes of Indian journals and more than 9000 other publications. The library provides services to the scientists and other staff members of the institute apart from scholars, researchers, student and other persons from local organizations interested in scientific literature on coldwater fisheries and allied subjects. The total expenditure incurred by the library during the financial year 2017-18 was Rs. 24.99 lakhs. The total revenue generated through selling of in-house publications was 0.45 lakh.

Book exhibition at ICAR-DCFR on 14.03.2018

Library Automation

Various activities of library have been computerized using TLS software. The records of books, journals, bulletins etc. were entered in the database. The barcoding of books and periodicals are actively being done. The digitization work of the institute's in-house publications has been completed.

Information Services

The library also provides platform to access free online downloads of publications and articles of many international and national journals through www.cera.jece.in. The library is further continuing its efforts in collection, processing and disseminating scientific/technical information to the potential users. The library has provided many scanned reprints of offline/back volume research articles to various distant users/researchers of NARS through DDR (document delivery request), an online document deliver service of J-gateplus under CeRA of ICAR.

Reprography Services

The library maintained active reprography services by producing departmental publications and supporting required photocopies black and colours to the scientists, research scholars as well as research organizations.

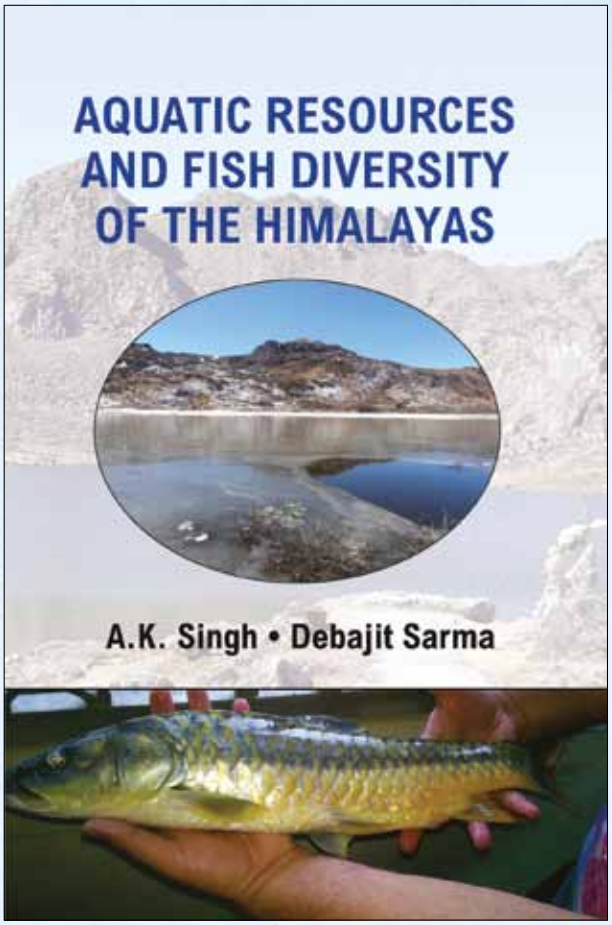
Exchange Services

The library maintained exchange relationship with various research organizations and institute of national and international repute. The annual reports, newsletters, special publications and technical bulletins published from time to time have been mailed to more than 250 organizations, institutions and fishery agencies.

Inhouse publications of ICAR-DCFR during 2017-18

Documentation Section

The documentation section of the library is entrusted with responsibility of publications of scientific bulletins, brochures, pamphlets, annual reports, newsletters, monographs etc. During the period, this section published two annual reports of 2016-17 (Hindi and English), two bulletins, two newsletters of the Directorate, one souvenir and one abstract book.



Priced publication of ICAR-DCFR

Distinguished Visitors

15

Distinguished Visitors

- Dr. J.K. Jena, Deputy Director General (Fisheries Sciences & Animal Science, ICAR), New Delhi visited the Directorate on 24th June, 2017. Dr. Jena first visited various facilities available at the Directorate including laboratory facilities, ornamental fish unit and fish farm ponds. Later, he inaugurated the newly established "Fish Parasitology & Mycology Laboratory". An interactive session was also convened along with the scientists, technical and administrative staffs and addressed the core issues of the Directorate and gave valuable suggestions.

Dr. J.K. Jena, DDG (Fy.) inaugurating 'Fish Parasitology & Mycology Laboratory'

- During the national seminar on 'Strategies, Innovations and Sustainable Management for Enhancing Coldwater Fisheries and Aquaculture' from 22 to 24 September, 2017 many stalwarts including Padma Shree Prof. R.C. Sobti, Vice Chancellor of Babasaheb Bhimrao Ambedkar University, Lucknow, Dr. Dilip Kumar, former Director of ICAR-CIFE and FAO consultant, Dr. George John, former Vice Chancellor, Birsa Agricultural University, Dr. S.D. Tripathi, former Director, ICAR-CIFE and CIFA, Dr. B.N. Pandey, President, Zoological Society of India, Dr. C.N. Ravishankar, Director, ICAR-CIFT, Dr. K.K. Vaas, former Director, ICAR-CIFRI and DCFR, Dr. S. Raizada, Assistant Director General (Inland Fisheries), ICAR and Dr. S.K. Das, Director, Assam State Fisheries Department visited the Directorate.

Dr. S. D Tripathi and other dignitaries visiting the Directorate's ornamental fish culture unit

- Padma Shree Dr. Yasodhar Mathpal, visited the Directorate on 6th February, 2018 and inaugurated the Himani Aquarium of the Directorate for public.

Padma Shree Dr. Yasodhar Mathpal inaugurating the Himani Aquarium of the Directorate for public

- Dr. M. Sinha, former Director, ICAR-CIFRI, Barrackpore and Chairman, RAC visited the Directorate during 29-30 December, 2017.
- Dr. S. Raizada, Assistant Director General (Inland Fisheries), ICAR, New Delhi and Member, RAC/IMC visited the Directorate during 29-30 December, 2017.
- Dr. S.C. Mukherjee, former Joint Director, ICAR-CIFE, Mumbai and Member, RAC visited the Directorate during 29-30 December, 2017.
- Dr. A.K. Sahu, former Principal Scientist, ICAR-CIFA and Member, RAC visited the Directorate during 29-30 December, 2017.
- Dr. H.C.S. Bisht, Professor, Department of Zoology, Kumaon University, Nainital and Member, RAC visited the Directorate during 29-30 December, 2017.
- Mr. R.P. Singh, Hon'ble Member, Governing Body, Indian Council of Agricultural Research, New Delhi along with Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer visited ICAR-DCFR, Bhimtal during 8-9 January, 2018. The Hon'ble member visited different facilities including farm, aquarium unit and laboratories of the Directorate. He interacted with different scientists and farmer beneficiaries of the Directorate and inquired about the ongoing research work.

RAC members visiting the farm facility at Bhimtal

Mr. R.P. Singh, Member, Governing Body, ICAR, New Delhi interacting with scientists and farmers

Important Committees

16

16.1 Members of Research Advisory Committee

Dr. M. Sinha, former Director, ICAR-CIFRI & former Advisor, Department of Fisheries, Tripura Raghubir Sadan, District Judge's Compound, Civil Lines, Gorakhpur-273001, Uttar Pradesh.	Chairman
Mr. I. P. Chhetri, former Director (Fisheries), Dept. of Animal Husbandry, Livestock & Fisheries Services, Government of Sikkim, Krishi Bhawan, Tadong, Sikkim.	Member
Dr. S.C. Mukherjee, former Joint Director, ICAR-CIFE, 187 A, Sahid Nagar, Bhubaneswar-751007, Odisha.	Member
Dr. A.K. Sahu, former Principal Scientist, ICAR-CIFA, 16, Bhimpur Duplex Colony, Bhubaneswar-751020, Odisha.	Member
Dr. H.C.S. Bisht, Professor, Department of Zoology, Kumaon University, DSB campus, Nainital-263001, Uttarakhand.	Member
Dr. S. Raizada, Asst. Director General (Inland Fisheries), ICAR, Krishi Anusandhan Bhawan-II, New Delhi-110012.	Member
Dr. A.K. Singh, Director, ICAR-DCFR, Bhimtal.	Member (till 31.12.2017)
Dr. N.N. Pandey, Principal Scientist, ICAR-DCFR, Bhimtal.	Member Secretary

16.2 Members of Institute Management Committee

Dr. Debajit Sarma, Director (Act.)	Chairman (from 01.01.2018)
Dr. A.K. Singh, Director, ICAR-DCFR, Bhimtal.	Chairman (till 31.12.2017)
Dr. S. Raizada, Asst. Director General (Inland Fisheries), ICAR, KAB II, New Delhi.	Member
Mr. G.B. Oli, Secretary & Director of Fisheries, Govt. of Uttarakhand, Secretariat, Subhash Road, Dehradun-248001, Uttarakhand.	Member
Mr. R.P.S. Bali, Director, Directorate of Fisheries, Govt. of Jammu & Kashmir, Nowabad Canal Road, Jammu, Jammu & Kashmir.	Member
Dr. R.S. Chauhan, Head of Department (Aquaculture) College of Fisheries, GBPUAT, Pantnagar, Uttarakhand.	Member

Dr. A.B. Pandey, Principal Scientist, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh.	Member
Dr. Raj Narayan, Principal Scientist & Head, Directorate of Mushroom Research, Solan, Himachal Pradesh.	Member
Dr. J.K. Bisht, Principal Scientist, ICAR-VPKAS, Almora, Uttarakhand.	Member
Dr. S.K. Verma, Principal Scientist & Head, NBPGR Regional Station-Bhowali, Niglat, Nainital-263132, Uttarakhand.	Member
Mr. Kunal Kalia, F&AO, ICAR HQ, Krishi Bhawan, New Delhi-110001.	Member
Mr. Vipin Pandey, M/s Shilpi photo studio, Haldwani-263139, Uttarakhand.	Member
Mr. Pradeep Bisht, 416, Hiranagar, Haldwani-263139, Uttarakhand.	Member
Mr. R.S. Negi, Administrative Officer, ICAR-DCFR, Bhimtal.	Member Secretary

16.3 Members of Prioritization Monitoring & Evaluation Cell

Dr. N.N. Pandey, Principal Scientist	In-charge
Dr. Shahnawaz Ali, Scientist	Member
Dr. Kh. Victoria Chanu, Scientist	Member
Sh. Amit Kumar Saxena, Sr. Technical Assistant	Technical support
Smt. Susheela Tewari, Private Secretary to Director	Secretarial assistance

16.4 Members of Prioritization Monitoring & Evaluation Committee

Dr. Debajit Sarma, Director (Act.)	Chairman (from 01.01.2018)
Dr. A.K. Singh, Director	Chairman (till 31.12.2017)
Dr. A. Barat, Principal Scientist & In-charge, Molecular Genetics & Biotechnology	Member (till 24.6.2017)
Dr. D. Sarma, Principal Scientist & In-charge, Resource Assessment & Management, Extension & Training	Member (till 31.12.2017)
Dr. Prem Kumar, Principal Scientist & In-charge, Agricultural Knowledge Management Unit	Member
Dr. S. Chandra, Principal Scientist & In-charge, Field Centre, Champawat	Member
Dr. R.S. Patiyal, Principal Scientist & In-charge Institute Technology Management Unit	Member
Dr. N.N. Pandey, Principal Scientist & In-charge, Aquaculture and Nutrition & PME cell	Member Secretary

16.5 Members of Institute Technology Management Committee

Dr. D. Sarma, Director (Act.)	Chairman (from 01.01.2018)
Dr. A.K. Singh, Director	Chairman (till 31.12.2017)
Dr. A. Barat, Principal Scientist	Member (till 24.6.2017)
Dr. P.K. Sahoo, Principal Scientist	Member (till 24.6.2017)
Dr. Laxmi Kant, Principal Scientist, ICAR-VPKAS, Almora	External Member
Dr. Prem Kumar, Principal Scientist	Member
Dr. Shahnawaz Ali, Scientist	Member
Dr. M.S. Akhtar, Scientist	Member
Dr. R.S. Patiyal, Principal Scientist	Member Secretary

16.6 Members of Institute Technology Management Unit

Dr. Prem Kumar, Principal Scientist	Overseer
Dr. R.S. Patiyal, Principal Scientist	In-charge
Dr. Shahnawaz Ali, Scientist	Member

16.7 Members of Agricultural Knowledge Management Unit

Dr. Prem Kumar, Principal Scientist	In-charge
Sh. S.K. Mallik, Scientist	Member
Dr. M.S. Akhtar, Scientist	Member
Sh. R.S. Tandel, Scientist	Member
Sh. A.K. Saxena, Sr. Technical Assistant	Technical support

16.8 HYPM, PERMISNET, PIMS, MIS & FMS

Dr. Prem Kumar, Principal Scientist	Nodal Officer
Sh. A.K. Saxena, Sr. Technical Assistant	Technical support

16.9 Library Advisory Committee

Dr. D. Sarma, Director (Act.)	Chairman (from 01.01.2018)
Dr. A.K. Singh, Director	Chairman (till 31.12.2017)
Dr. D. Sarma, Principal Scientist	Member (till 31.12.2017)
Dr. N.N. Pandey, Principal Scientist	Member
Dr. Deepjyoti Baruah, Senior Scientist	Member (till 02.01.2018)
Dr. Shahnawaz Ali, Scientist	Member (from 19.01.2018)
Dr. M.S. Akhtar, Scientist & I/c Library	Member Secretary
Sh. R.S. Negi, Administrative Officer	Member
Sh. Baldev Singh, Senior Technical Officer	Member (from 03.01.2018)
Sh. B.C. Pandey, Asst. Fin. & Acc. Officer	Member

16.10 Institute Joint Staff Council

Official side	
Dr. A.K. Singh, Director	Chairman (till 31.12.2017)
Dr. A. Barat, Principal Scientist	Member (till 24.6.2017)
Dr. Suresh Chandra, Principal Scientist	Member
Sh. R.S. Negi, Admin. Officer	Member
Sh. B.C. Pandey, Asst. Fin. & Acc. Officer	Member
Smt. Khilawati Rawat, Asst. Admin. Officer	Member Secretary
Staff side	
Sh. P.C. Tewari, Admin. Assistant	CJSC Member
Sh. J.C. Bhandari, Admin. Assistant	Member
Sh. R.K. Arya, Technical Assistant	Member
Sh. Manoj Kumar, Skilled supporting staff	Member
Sh. Mangla Prasad, Skilled supporting staff	Member

16.11 Institute Biosafety Committee

Dr. A. K. Singh, Director, ICAR-DCFR, Bhimtal.	Chairman (till 31.12.2017)
Dr. D. Sarma, Director (Act.) ICAR-DCFR, Bhimtal.	Chairman (from 01.01.2018)
Dr. A. K. Tiwari, Principal Scientist & Head, Division of Standardization, ICAR-IVRI, Izatnagar.	DBT Nominee
Dr. A. B. Pandey, Principal Scientist & Head, Division of Virology, ICAR-IVRI, Mukteshwar.	Outside Expert
Dr. A. K. Sharma, Principal Scientist, ICAR-IVRI, Mukteshwar.	Outside Expert
Col. (Dr.) C. S. Rawat, MBBS, DPH, FRIPHH	Biosafety Officer
Dr. A. Barat, Principal Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Neetu Shahi, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Dimpal Thakuria, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Amit Pande, ICAR National Fellow, ICAR-DCFR, Bhimtal.	Member Secretary

16.12 HRD Unit

Dr. D. Sarma, Principal Scientist	Nodal Officer (till 31.12.2017)
Dr. Neetu Shahi, Scientist	Co-nodal Officer

Staff News

17

17.1 Promotions

Dr. Suresh Chandra was promoted to the post of Principal Scientist (Fish Pathology) under CAS of ICAR, with effect from 10th March, 2017.

Dr. R.S. Patiyal was promoted to the post of Principal Scientist (Fish Genetics & Breeding) under CAS of ICAR, with effect from 17th March, 2017.

17.2 Transfers

Dr. Ashoktaru Barat, Principal Scientist was transferred to ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, by the Council. He was relieved from the Directorate on 24th June, 2017.

Dr. P.K. Sahoo, Principal Scientist was transferred to ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, by the Council. She was relieved from the Directorate on 24th June, 2017.

Sh. Harish Ram, Assistant Administrative Officer was promoted to the post of Administrative Officer and transferred to ICAR-Central Institute for Research on Cattle, Meerut by the Council. He was relieved from the Directorate on 30th December, 2017.

17.3 Retirement

Dr. A.K. Singh, Director, ICAR-DCFR, retired from ICAR services on superannuation on 31st December 2017.

17.4 Joining

Dr. D. Sarma, Principal Scientist took charge as Director (Act.) on 1st January 2018.

Dr. D. Sarma, Director (Act.)

18 DCFR in News

Personnel

19

Staff list as on 31.03.2018

18.1 Research Management

	Dr. Debajit Sarma	Director (Act.)

18.2 Scientific Staff

1.	Dr. Amit Pande	ICAR National Fellow (Biotechnology-Animal science)
2.	Dr. Nityanand Pandey	Principal Scientist (Aquaculture)
3.	Dr. Prem Kumar	Principal Scientist (Fish & Fishery Science)
4.	Dr. Suresh Chandra	Principal Scientist (Fish Pathology)
5.	Dr. R.S. Patiyal	Principal Scientist (Fish Genetics & Breeding)
6.	Dr. S.G.S. Zaidi	Senior Scientist (Aquaculture)
7.	Dr. Deepjyoti Baruah	Senior Scientist (Fish & Fishery Science)
8.	Dr. Shahnawaz Ali	Scientist (Aquaculture)
9.	Sh. Sumanta Kumar Mallik	Scientist (Aquaculture)
10.	Dr. Neetu Shahi	Scientist (Biotechnology-Animal Science)
11.	Dr. Md. ShahbazAkhtar	Scientist (Fish & Fishery Science)
12.	Dr. Dimpal Thakuria	Scientist (Biochemistry-Animal science)
13.	Dr. Kh. Victoria Chanu	Scientist (Biochemistry-Animal science)
14.	Dr. Ciji Alexander	Scientist (Fish Nutrition)
15	Dr. Biju Sam Kamalam, J.	Scientist (Fish Nutrition)
16.	Sh. Rajesh M	Scientist (Fish Nutrition)
17.	Sh. Tandel Ritesh kumar Shantilal	Scientist (Fish Health)
18.	Sh. Abhay Kumar Giri	Scientist (Aquaculture)
19.	Smt. Pragyan Dash	Scientist (Aquaculture)
20.	Dr. Prakash Sharma	Scientist (Fish Nutrition)
21.	Sh. Siva, C.	Scientist (Fish Genetics & Breeding)
22.	Dr. Raghvendra Singh	Scientist (Aquaculture)
23.	Sh.Kishor Kunal	Scientist (Fisheries Resource Management)
24.	Sh.Parvaiz Ahmad Ganie	Scientist (Fisheries Resource Management)
25.	Sh. Raja Aadil Hussain Bhat	Scientist (Fish Health)

18.3 Technical Staff

1.	Dr. R.S. Haldar	Assistant Chief Technical Officer
2.	Sh. Amit Kumar Joshi	Sr. Technical Officer
3.	Sh. Baldev Singh	Sr. Technical Officer
4.	Sh. Santosh Kumar	Technical Officer
5.	Sh. Ravinder Kumar	Technical Officer
6.	Sh. Amit Kumar Saxena	Sr. Technical Assistant
7.	Sh. Gopal C. Arya	Sr. Technical Assistant
8.	Sh. HansaDutt	Sr. Technical Assistant
9.	Sh. T.M. Sharma	Technical Assistant
10.	Sh. R.K. Arya	Technical Assistant
11.	Sh. Partha Das	Sr. Technician
12.	Sh. Manoj Kumar Yadav	Driver (Sr. Technician)

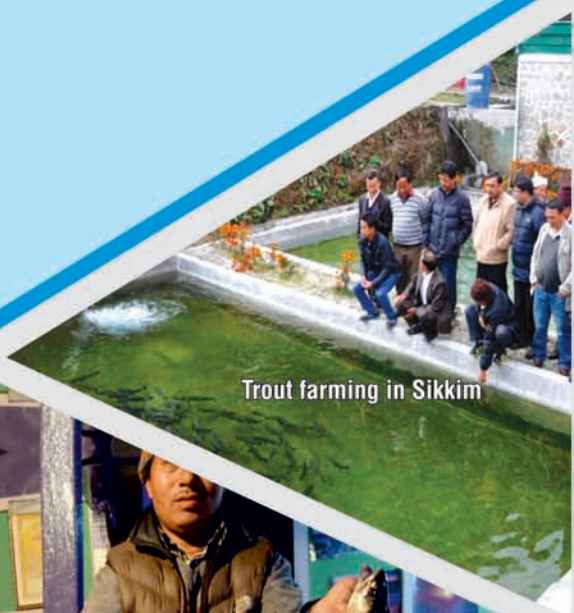
18.4 Administrative Staff

1.	Sh. Ravindra Singh Negi	Administrative 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	Assistant
7.	Sh. Arun Khulbe	Assistant
8.	Sh. Ankesh Kumar Sinha	Assistant
9.	Sh. Pratap Singh Bisht	UDC
10.	Smt. Munni Bhakt	UDC
11.	Sh. Hansa Singh Bhandari	LDC

18.5 Skilled Supporting Staff

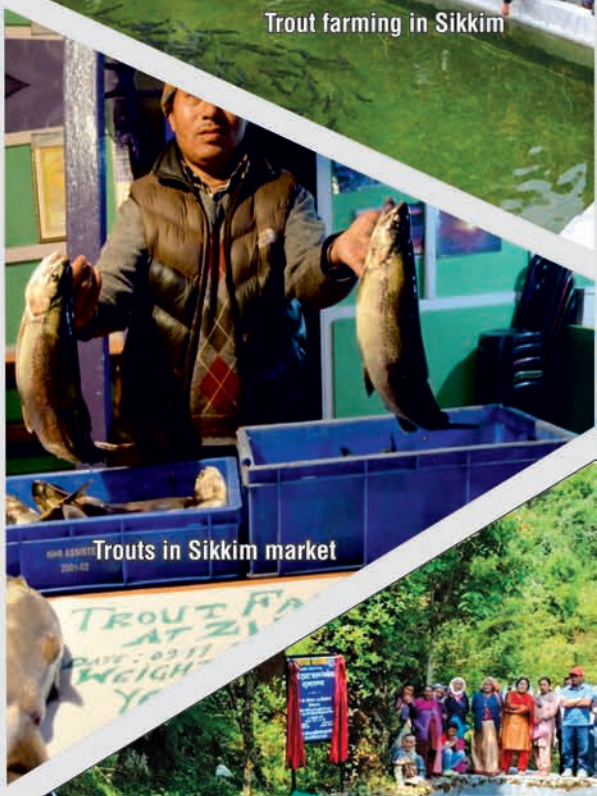
1.	Sh. Ravinder Kumar	Skilled Supporting Staff
2.	Sh. Om Raj	Skilled Supporting Staff
3.	Sh. Sunder Lal	Skilled Supporting Staff
4.	Sh. Dharam Singh	Skilled Supporting Staff
5.	Sh. Pooran Chandra	Skilled Supporting Staff
6.	Sh. Manoj Kumar	Skilled Supporting Staff
7.	Sh. Kuldeep Kumar	Skilled Supporting Staff
8.	Sh. Bhola Dutt Mouni	Skilled Supporting Staff
9.	Smt. Basanti Devi	Skilled Supporting Staff
10.	Sh. Mangla Prasad	Skilled Supporting Staff
11.	Sh. Sushil Kumar	Skilled Supporting Staff

Trout farming in raceways of Himachal Pradesh

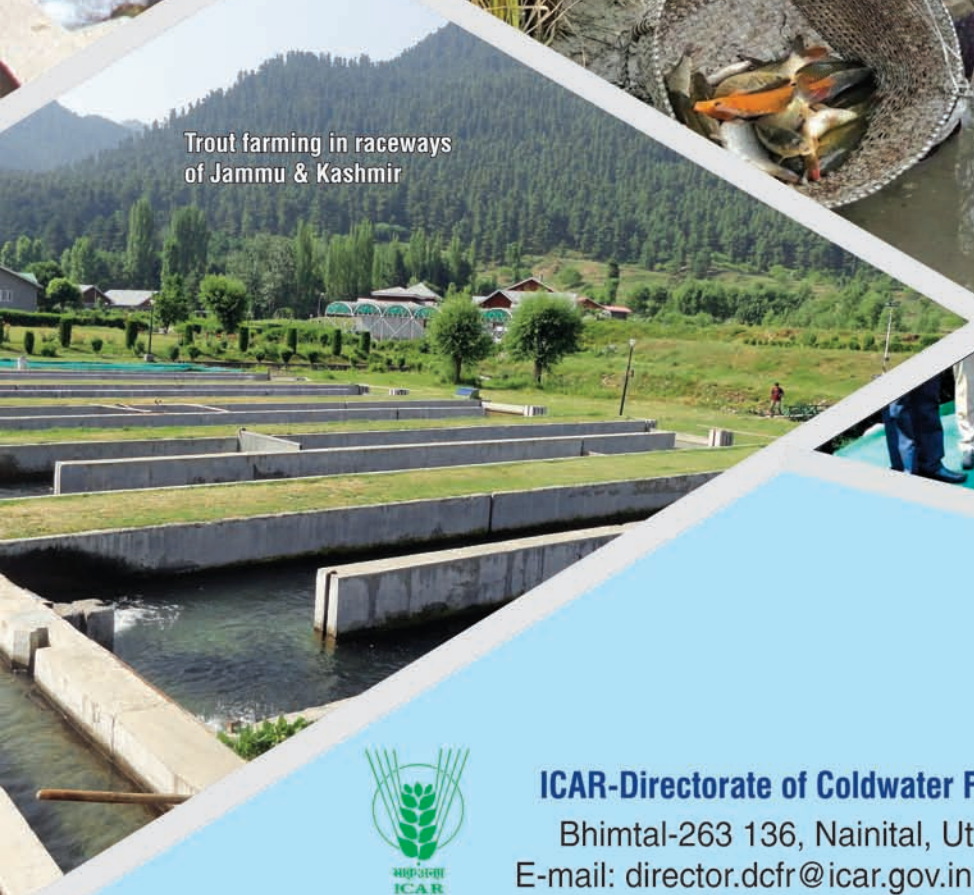


Trout farming in Sikkim

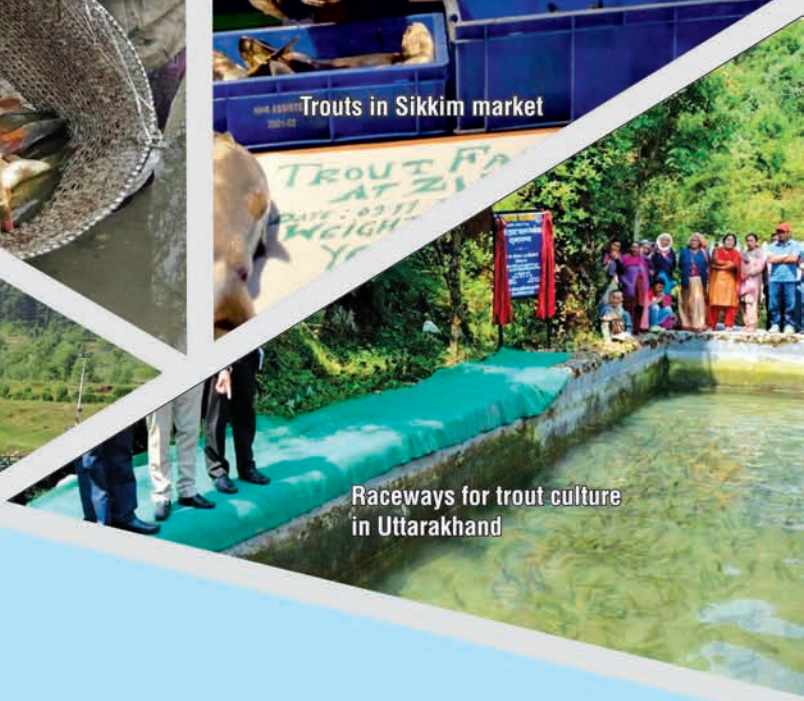
A haul of common carp from rice-fish plots of Arunachal Pradesh



Trouts in Sikkim market



Trout farming in raceways of Jammu & Kashmir



Raceways for trout culture in Uttarakhand

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