DCFR News

Directorate of Coldwater Fisheries Research

Vol. 13 No. 2 July-December 2010

From the Director's Desk

Champa - 1

Directorate organized National Consultation on 'Biodiversity of High Altitude Aquatic Resources Conservation and Utilization", 29-30 Sept., 2010 and released Champa-1 and Champa-2 common carp during the consulation

Champa - 2

Dear Readers,

It's our great pleasure to bring out our half-yearly Newsletter for July - December, 2010. With the implementation of various research programmes, trainings, meetings and developmental activities, DCFR is stepping further towards augmentation of coldwater fisheries in the country. The Directorate has successfully organized the "National Consultation on Biodiversity of High Altitude Aquatic Resources, Conservation and Utilization" during 29-30 September 2010. The basic objective of the consultation was to have a holistic discussion on the issues of conservation and sustainable utilization of coldwater fisheries resources.

The Directorate has also successfully conducted two training programmes. NFDB sponsored training programme on " Three pronged fish farming technologies for hill regions" was organized at Itanagar, Arunachal Pradesh during 19-23 October 2010 and a model training course on " Breeding, incubation and rearing of rainbow trout" from 27 December, 2010 to 3 January, 2011.

Visit of distinguished dignitaries and their interaction with the scientists have always been useful to the directorate. I sincerely hope that DCFR will keep touching new heights in all endeavours in future.

(Dr. P.C.Mahanta)

RESEARCH ACHIEVEMENTS

Project- Outreach Activity: Fish Feeds

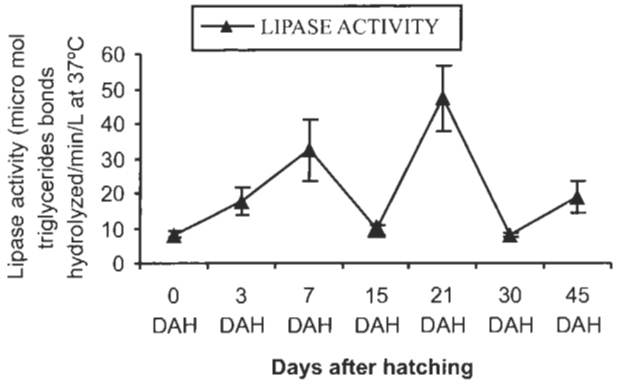
Component 1: Enhancement of larval growth and survival for production of quality seed of Himalayan mahseer

Analysis of digestive enzymes activities is an easy and reliable methodology that can be used as indicator of digestive processes and nutritional condition of fish larvae. Physiology and nutrition studies of fish in the early stages of development, as well as the evolution of the digestive enzyme activity are valuable tools to better know the nutritional capabilities of young larvae and establish feeding protocols for optimizing larval mass rearing production. A better knowledge of the physiology of nutrition during ongrowing is essential for the understanding of larval nutritional needs. The ability of larvae to assimilate the required nutrients will depend on the composition of the diet and on their capacity to modulate their digestive enzymes and metabolic processes. Consequently, the study of the ontogeny of digestive enzymes may constitute an appropriate parameter to determine which particular dietary supplies fish larvae need.

Hence, the study on ontogeny of digestive enzymes of golden mahseer (*Tor putitora*) larvae have been carried out to get an insight on the development of the larvae digestive functions in order to obtain essential data for the formulation of a compound diet adapted to larvae.

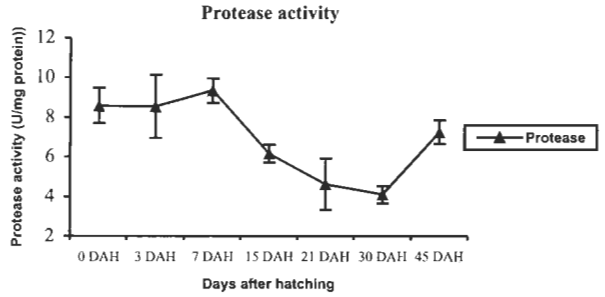
Samples of mahseer larvae of different age groups viz. 0 day after hatching (0 DAH), 3 DAH, 7 DAH, 15 DAH, 21 DAH, 30 DAH and 45 DAH had been collected from DCFR mahseer hatchery, Bhimtal. Whole larvae (till age 21 DAH) and dissected larvae (30 and 45 DAH) were homogenized with 5% chilled 0.25 M sucrose solution using a mechanical tissue homogenizer. The homogenized samples were centrifuged (6000xg for 10 min) and supernatants were collected and stored at - 20°C for subsequent enzyme assays.

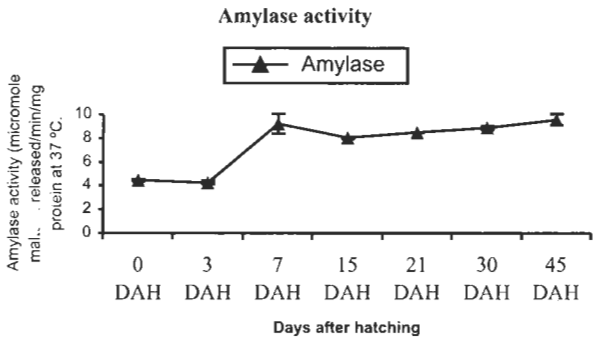
The activity of lipase in the samples of mahseer larvae of different age groups viz: 0 day after hatching (0 DAH), 3 DAH, 7 DAH, 15 DAH, 21 DAH, 30 DAH and 45 DAH has been estimated. Results revealed that the lipase activity was minimum at 0 DAH. There was a significant ($p<0.05$) linear increase ($y = 12.15x - 4.95$, $R2 = 0.98$) in its activity up to 7 DAH. The activity sharply decreased on 15 DAH followed by a significant ($p<0.05$) abrupt increase to a maximum on 21 DAH. Again, lipase activity sharply decreased to a minimum level on 30 DAH. Compared to 30 DAH, there was a slight increase in the activity of this enzyme on 45 DAH.



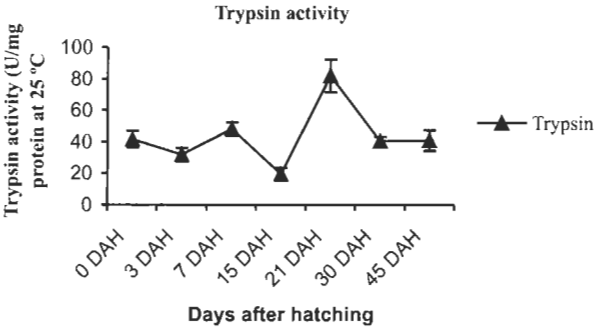
The protease activity in mahseer larvae was observed even on 0 DAH and this activity was consistent till 3 DAH. On 7 DAH, the protease activity increased by 10% and from 7 DAH onward, the activity was sharply decreased (2-fold) to a minimum on 30 DAH. Again, a sharp increase in the protease activity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

The minimum amylase activity in mahseer larvae was found on 0 DAH and 3 DAH. There was a sharp significant ($p<0.05$) increase in the activity of amylase up to 7 DAH and reached maximum. On 15 DAH,



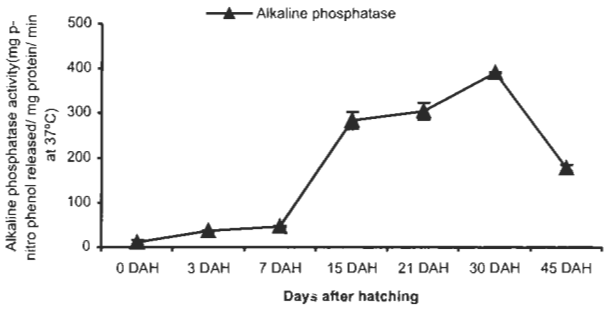


there was a slight decrease in the activity. From 15 DAH till 45 DAH, amylase activity increased linearly ($Y = 0.5053X + 7.475$, $R2 = 0.9837$).



The presence of trypsin activity in mahseer larvae was evidenced from 0 DAH and there was no significant ($p>0.05$) in trypsin activity till 7 DAH. Activity significantly ($p<0.05$) decreased and become minimum on 15 DAH and then four-fold increment was observed on 21 DAH. Again there was two-fold decrease in the trypsin activity on 30 DAH and remained similar till 45 DAH.

The minimum alkaline phosphatase activity in mahseer larvae was found on 0 DAH and activity remained lower till 7 DAH. There was a sharp (3-fold) increase in the activity of this enzyme which was



observed on 15 DAH and further gradually increased to a maximum on 30 DAH. A two-fold decrease was evidenced on 45 DAH.

The results obtained in the present study reveals the ontogenic development of the main digestive enzymes during larval development of golden mahseer. These data will be considered for the formulation of a compound diet adapted to golden mahseer larvae. Thus, a better understanding of the ontogeny of digestive enzymes could lead to a successful replacement of live feeds by formulated diet.

"Modelling of Length-Weight Relationship and Growth Pattern of Selected Important Coldwater Fish Species"

The length-weight relationship of *Tor putitora* has been developed from wild aquatic environment of Kosi River, Ramnagar, Uttarakhand, considering four different stages of its lifespan. ANCOVA results suggested the existing of two distinct stages of *Tor putitora* regarding its length-weight relationship, which do not follow isometric growth. Further, the datasets of two distinct stages are meaningfully fitted to allometric models with expected-value parameters.

Microcystins induced DNA damage in liver of Zebra fish (*Danio rerio*)

Crude extract of the *Microcystis aeruginosa* bloom collected from Bhimtal was used to test hepatotoxicity in liver of Zebra fish (*Danio rerio*). Histochemistry of liver after Forty-eight hours following the treatment with MCs, exhibited massive

intrahepatic hemorrhage. The microscopic examination of the liver revealed severe shrinkage, dissociation and detachment of hepatocytes. Nuclei was condensed and fragmentated and stained dark with nuclear stain. Sinusoidal spaces were also filled with blood.

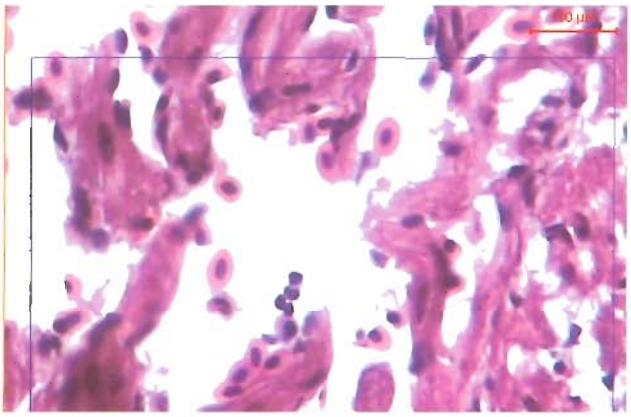


Fig 1: Sinusoidal spaces filled with blood along with mild Infiltration of mononuclear cell in hepatocyte. (100x)

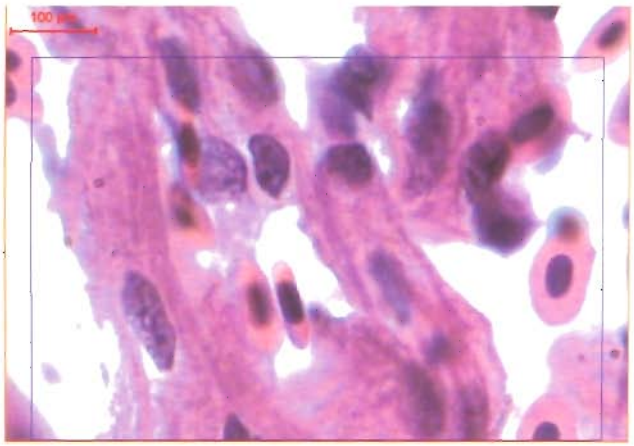


Fig 2: Section of liver showing clear apoptic bodies within liver nuclei. (Oil immersion)

Effect of Spirulina on Growth during Grow out Period of Chocolate Mahseer

Chocolate mahseer, considered as a new candidate species for hill aquaculture, was selected to assess the efficacy of *Spirulina* (*S. platensis*) fortified diets on its growth and survival.

Five isoproteic diets (with 35% protein) fortified with *Spirulina* meal @ 0 (D-1), 3 (D-2), 5 (D-3), 7 (D-4) and 10% (D-5) were tested in a totally randomized design during 90 days of experimental period, using *Neolissocheilus hexagonolepis* fingerlings obtained from the hatchery rearing pond of Directorate of Coldwater Fisheries Research, Bhimtal. Fingerlings were stocked in 100 liter capacity fiberglass tanks (provided with inlet and outlet) @ 10 fingerlings per tank in triplicates for each diet. Constant water flow (2-3 Liter/ minute) was maintained. To eliminate fecal residues and food remains, siphoning was done daily.

Water quality parameters were registered weekly following the APHA (1995) methodology before the siphoning in the morning. Total water exchange and washing of tanks with $KMnO_4$ were carried out every week to protect the fish from fungal infection.

Diets were formulated using four basic ingredients (fish meal, soybean oil cake, rice bran and wheat bran) and *Spirulina meal* as an additive. Vitamin-Mineral mixture and sodium alginate (as binder) were also added in every diet @ 2% each. Quality of different ingredients for formulation of diets was determined by Pearson-square formula. Proximate composition of diets was determined according to the procedures of AOAC (1995). Feeding was carried out twice a day (morning and evening) @ 5% (2.5% at a time) of their body weight.

Table 1. Proximate composition of ingredients (on dry matter basis) in percentage

Ingredients	Moisture	Dry matter	Crude Protein	Crude Lipid	Ash
Wheat Bran	12.8	87.2	13	2.64	5.51
Rice Bran	11	89	13	4.2	11.5
SOC*	10.1	89.9	40	5.51	9.46
Fish Meal	6.8	93.2	60	8.3	14.8
Spirulina	4.5	95.5	70	4.32	9.5

*Soybean oil cake

Table 2. Proximate composition (on dry matter basis) of different diets used in the experiment

Compositions	Diet				
	D-1	D-2	D-3	D-4	D-5
Moisture (%)	13.28	13.40	13.15	13.34	13.30
Crude protein (%)	35.21	35.32	35.10	35.20	35.09
Crude lipid (%)	7.65	7.80	7.25	7.97	7.45
Ash (%)	10.85	11.01	10.90	11.00	11.08

RESEARCH ACHIEVEMENTS

Outreach Project on Fish Genetic Stock

The population structure of *Tor putitora* was investigated with morphometric data (truss measurement). Morphometric-distance between selected landmarks on the animal are required to be measured for generating truss data, which could subsequently be subjected to multivariate analysis for comparing shape differences between groups of animals. Truss data was generated from digitized image using software tpsUtil, tpsdig, PAST, Minitab an 'SPSS. The morphometric analysis was conducted to compare specimens from six population viz. river Jiabhoreli, near Bhalukpong (Assam-Arunachal Pradesh); river Chenab, near Anji (Jammu & Kashmir); river Ravi, near Basoli (Jammu & Kashmir); river Tawi, near Jhajharkoti (Jammu & Kashmir); river Bias, near Jogindernagar, (Himachal Pradesh) and river Kosi, near Ramnager (Uttarakhand).Truss distance between 9 landmark of 170 specimens was measured. Principal Component Analysis was carried out on the multivariate morphometric data. Among them 97.1% and 1.4% of the total variation in the multivariate data was explained by first two principal components, PC1 and PCII respectively (Fig.1). The maximum variation was contributed by Variable 4 followed by Variable 5 (29.3%) and Variable 3 (29.1%). The Box Plot was

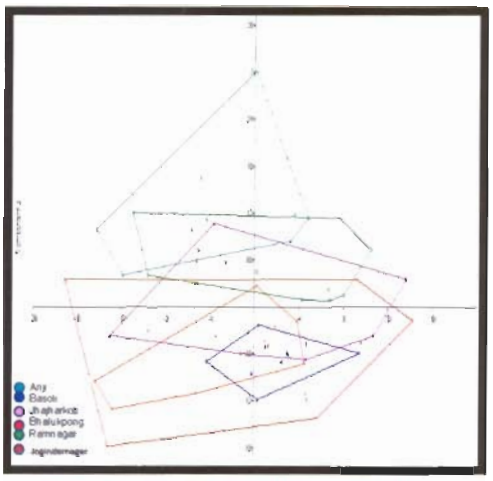


Fig Scatter Blot of Six population

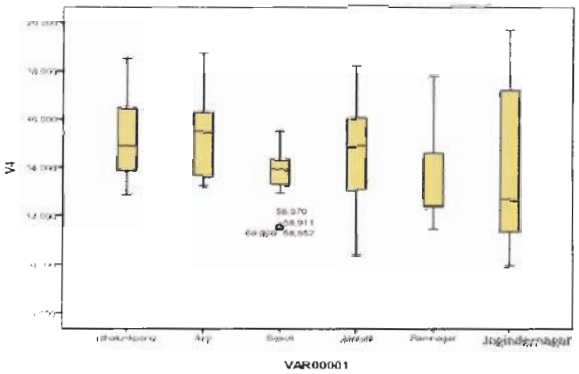


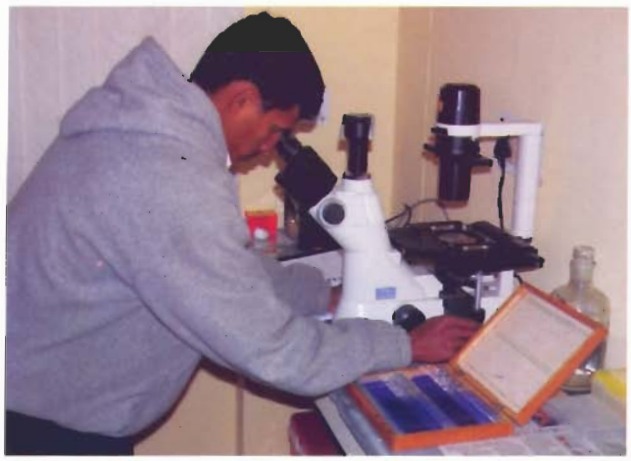
Fig. Box Plot of variable 4.

obtained using the different populations on the X-ordinate and taking Variable 4 on the Y - ordinate. Since, the length of the Box represents the variability of the population, the plot suggests that the maximum variation observed in Jogindernagar (H.P.) population while the Basoli (J & K) population had minimum variation (Fig. 2).

Study of genetic diverity between farmed rainbow trout and wild snow trout through Morphometrics, Karyotyping and Rapd Techniques

Rainbow trout (*Oncorhynchus mykiss*) and Indian Snow trout (*Schizothorax richardsonii*) are two important coldwater fish species. These two fishes are studied by the morphological and meristic characters, chromosomal analysis and applying RAPD techniques. They show morphological and meristic variations. The regression equation (Y = a + bX) is to find out for both of these fishes i.e. Y (4.75) = 0.2415 + 0.3184 X (2.62) and Y (4.77) = 1.0489 + 0.3399 X (2.43). The Karyotyping was carried out through colchicine injection method. In Rainbow trout diploid chromosome number was found to be 2n = 60, karyotypic formula was 36 M + 6 Sm + 16 T and

fundamental arm number (FN) was 208. In Snow trout diploid chromosomes number was found to be 2n = 96, karyotypic formula was 18 M + 16 Sm + 12 St + 50 T and fundamental arm number (FN) was 260. The RAPD analysis was carried out using 5 decamer primers of OPA series (OPA-01, OPA-02, OPA-04, OPA-05 and OPA-10). These bands generated 68 polymorphic loci from which 53 are polymorphic. Rainbow trout (17.65) has less percentage of polymorphic loci to that of Snow trout (35.29). The total genetic diversity in population (Hs) was found to be 0.3296 and sample genetic diversity (Hs) was 0.1043.



Microscopic observation of the chromosome slides by MFSC student Mr. Satesh Vasasve

M.F.Sc. dissertation: Mr Satesh Vasasve M.F.Sc. Student, G B Pant University of Agriculture and Technology "STUDY OF GENETIC DIVERITY BETWEEN FARMED RAINBOW TROUT AND WILD SNOW TROUT THROUGH MORPHOMETRICS, KARYOTYPING AND RAPD TECHNIQUES" at Champawat Center under Co-Guidance of Dr. S.K.Srivastava, Sr. Scientist, Champawat Field Center Champawat.

Growth performance of different strains of Common Carp

The Common carp (*Cyprinus carpio*), an introduced species is an integral component of aquaculture in the uplands. Slow growth rate and unwanted reproduction have been identified as potential constraints on yields of common carp in aquaculture and cultural based fisheries. The Institute has imported two Hungarian strains at the field centre, Champawat to ascertain traits. Existing local strains of common carp were used for study of comparative growth performance and breeding programme.

Experiment was conducted in six cemented ponds (size-75m2) of pocket "B" at the fish farm, Champawat having sand layer in the bottom (8-10cm). Experiment was designed for poly culture of common carp with silver carp and grass carp. The stocking density was 2.5 fish/m3 densities in the ratio of 30:40:30, silver carp, grass carp and common carp respectively. Hungarian mirror car, Hungarian scale carp and existing scale carp of Bangkok strain was stocked with other exotic carps in double replicates. Highest growth was recorded in Hungarian mirror carp (352gm) under poly culture system followed by Hungarian scale carp (304gm). The growth of the existing strain was low (187gm) in polyculture during the rearing period of one year.

The seeds of improved strains of Hangarian Common carp "Ropsha scaly" was named as Champa-1 and Felsosomogy mirror carp named as Champa-2. The seeds were sent to different places of North east region.

Felsosomogy Mirror carp 325 gm.

Ropsha Scaly 304 gm.

Existing Bangkok Strain Scale carp 187 gm.

TRAINING PROGRAM

Three Pronged Fish Farming Technologies for Hill Regions

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

The programme was designed for the development and cultivation of freshwater fishes esp cially of coldwater in the hill states. The training has benefited the local fish entrepreneurs and farmers to take up new fish farming technology suitable for implementation in the hill states especially of North Eastern India. In the training program various lectures on theory and practical aspects were delivered by renowned scientists across the country.

Dr. P.C. Mahanta, Director DCFR gave a brief lecture on coldwater fisheries development in India with special emphasis to North Eastern states of India. Dr. Debajit Sarma highlighted the techniques of the culture and breeding of mahseer with special note to Chocolate mahseer, which is considered to be an important candidate species for the diversification of hill aquaculture.

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

Inauguration of the training program

Distribution of Certificates by Director, DCFR

Distribution of Certificates by Director, Dept. of Fisheries, Govt. of A.P.

Model Training Course on "Breeding, Incubation and Rearing of Rainbow Trout"

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

Fisheries officers, extension officers, assistant directorate of fisheries (ADF) from various states, university lecturers and students participated in the training program.

The training program was organized to develop trained manpower to carry out the activities on rainbow trout breeding & culture in the hilly states especially at A.P., Sikkim, Uttarakhand etc.

Dr. P.C. Mahanta, Director DCFR, inaugurated and welcomed the participants of the training program.

A success story of rainbow trout breeding and culture in Himachal Pradesh was shown through a film in the auditorium of the institute. The participants visited to Bairagna trout farm to see practical demonstration of rainbow trout breeding and culture. They also exercised their hands during the process.

After that the participants proceed to Champawat field center. Farm visit and practical demonstration of rainbow trout farming at Champawat field center was organized.

Training at Champawat Field Center, DCFR

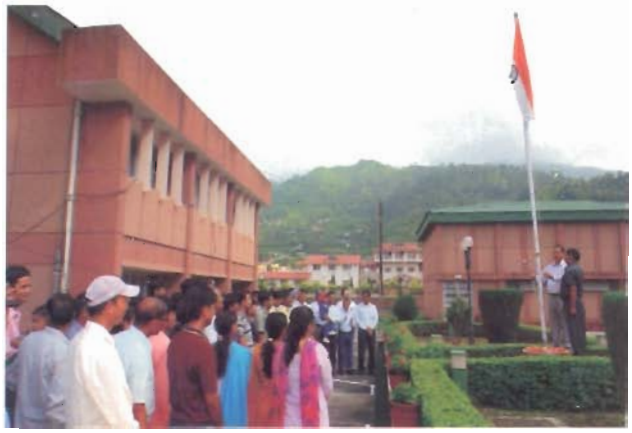
Demonstration on Incubation of Trout

Training at Hatchery Complex, DCFR

Distribution of Certificates by Director, DCFR, Bhimtal

Independence Day Celebration

Independence day was celebrated at DCFR Bhimtal and National Flag was hoisted by Dr. P. C. Mahanta, Director in presence of all the scientists, officers and staff members. It was emphasized on the occasion about the importance of institute activities and roll of each member of the institute for the upliftment of society through noble endeavour in the sector.



National Consultation on ' Biodiversity of High Altitude Aquatic Resources, Conservation and Utilization' 29-30 September 2010

The availability of fishery resources in hill regions in terms of gene pool is diverse which include large population of indigenous and exotic, cultivable and non-cultivable fish species. These available species are mainly used as food, while few of them as sport and ornamental purposes. On account of population upsurge and urbanization in the hill and adjoining regions, demand for fish has significantly increased over last decades. The coming decades are expected to pose newer and greater challenge to coldwater fishery sector both in the development of aquaculture and conservation practices in the hill regions of the country. The Directorate of Coldwater Fisheries Research, Bhimtal has played a pivotal role in development of feasible fish farming techniques for hill region.

In this background the National Consultation is scheduled to be organized to provide a suitable platform to discuss the various relevant issue of the sector.

The symposium was focused on:

- Emerging issues of high altitude fisheries and formulation of strategies
- Biodiversity of high altitude aquatic resources, conservation & utilization

Current trends in risk assessment & environmental management

Release of Common carp (Champa-1 & Champa-2) by DCFR, Bhimtal during the Consultation

The Hungarian strain of Common carp **(Champa-1 & Champa-2)** has been released by Dr. B. Meenakumari, D.D.G (Fy.), ICAR, New Delhi along with other eminent dignitaries during **National Consultation on Biodiversity of High Altitude**

Aquatic Resources, Conservation & Utilization, organized by the Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with Academy of Environmental Biology, Lucknow on 29-30 September 2010. As it is known that common carp is a major candidate species of hill aquaculture under poly culture of Chinese carp and monoculture system. The common carp presently grown in India originated from two introductions in 1939 (German strain) and 1957 (Bangkok strain). These have become mixed over many generations to give the current stock. The existing stock of common carp is characterized by early sexual maturation and slow growth rate. This is considered as a serious problem in the culture of this species in mid Himalayan region. In this context DCFR, Bhimtal has imported two improved

Champa-1

Champa-2

Hungarian strain of common carp (Ropsha scaly and Felsosomogy mirror carp) and bred at Champawat field center of DCFR. The growth performance of Hungarian strain is found to be significantly better than the existing stock. The seed produced by this Directorate has been supplied to the Department of Fisheries, Govt. of Sikkim, Arunachal Pradesh and also to the ICAR Research Complex for NEH region, Barapani, Shillong for further experimentation on growth performance under controlled conditions.

Brainstorming Session

Prof. C.S.Singh, Ex. Dean, College of Fisheries, Pantnagar, Dr. Utpal Bhowmik, Ex. Dean, College of Fisheries, CAU, Agartala, Prof. A. Borkotaki, Ex. Dean and Head, Deptt. of Zoology, Gauhati University and Dr. Balbir Singh, Ex. PS, CIFRI, Barrackpore participated in the brainstorming session at DCFR, Bhimtal on Coldwater Fisheries Management aspects.

Transportation of Mahseer seed to the Department of Fisheries, Sikkim

Hindi Saptah Samaroh

Hindi Saptah Samaroh was celebrated during 14-20 September, 2010. Competitions among the scientists and staffs of DCFR, Bhimtal was organised in a very joyful manner. The Director of DCFR, Bhimtal Dr. P. C. Mahanta inaugurated the Samaroh and Director, Birla Institute of Science and

Technology, Bhimtal Prof. Pant graced the valedictory function as a Chief Guest.

Training on SPSS was conducted at DCFR, Bhimtal for the Scientists and Technicals

Participation and presentation in workshops/ symposia/conferences

1. M. S. Akhter attended the seminar on **"Caring Wetlands & Conservation of Riverine Fisheries"** jointly organized by Central Inland Fisheries Research Institute, Barrackpore and Department of Fisheries, Govt. of West Bengal on 2nd October 2010 during National Fish Festival BENAQUA 2010 in Kolkata.
2. M. S. Akhter attended the **"National Seminar on Hindi Rajbhasa"** organized by Bhartiya Rajbhasa Parishad, New Delhi during 25-27 November 2010 in Goa.
3. One day training programme on the Uses of SPSS was organized on 13th December 2010 at the Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with SPSS South Asia, Pvt Ltd, Bangalore, India Branch and coordinated by Dr. N. Okendro Singh.
4. R. S. Haldar attended three days (25-27 Nov., 2010) National Conference on "Conservation of Aquatic Biodiversity, Development of Coldwater Fisheries, Fish Biotechnology and Emerging Trends in Freshwater Environment " at Deptt. of Zoology, Govt. P. G. College, New Tehri, Tehri Garhwal (Uttarakhand).
5. R. S. Haldar participated in short-term training on "Engineering and Management in Fisheries and Aquaculture" w.e.f. 08-16 December, 2010 at IIT, Kharagpur.

Publications

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- Geoinformatics application in assessment of fishery resources of Uttarakhand. By Askok K. Nayak, Prem Kumar, N. O. Singh, R. S. Haldar, S. Ali and P.C. Mahanta: Bulletin No. 17, 2010, DCFR, Bhimtal.

Award/Achievement

Dr. Debajit Sarma and Dr. Prem Kumar awarded fellow of Academy of Environmental Biology (FAEB), Lucknow.

Dr. Debajit Sarma receiving the Fellowship

Dr. Prem Kumar receiving the Fellowship

Visitors

The board members of AAU, Assam including former transport minister of Assam Mr. Pradip Hazarika visited the lab. and different establishment of DCFR, Bhimtal

A group of CIFE students undergone specialized 21 days training program at DCFR, Bhimtal.

A group of faculty members and students visited DCFR lab and other establishments

Visit of farmers from Afghanistan

Transfer & Joining

Transfer

Dr. N. N. Pandey, Senior Scientist transferred from Field Center Champawat to DCFR Bhimtal Headquarters on 24.10.2010. Scientists and staff members of Champawat center gave a hearty farewell to Dr. Pandey.

Joining

Dr. S.K. Gupta, Scientist (Fish & Fishery Science) joined at DCFR Field Center Champawat on 11.10.2010.

अनुसंधान उपलब्धियाँ

परियोजना – आउटरीच एक्टिबिटी : मत्स्य आकार

सुपाच्य एन्जाइमों की क्रियाओं के विश्लेषण की बहुत सरल एवं विश्वसनीय पद्धति यह है कि उसको पाचक क्रियाओं के सूचक एवं मत्स्य बीजों के पोषणिक अवस्था के रूप में प्रयोग किया जा सकता है। प्रारम्भिक विकास में मछली के शारीरिक एवं पौषणिक अध्ययन तथा उसके पाचक एजाइमों की क्रियाएँ तरूण मत्स्य बीजों की पोषकीय योग्यताओं को जानने का एक अच्छा साधन है। मत्स्य बीजों के आवश्यक पोषक तत्वों को पचाने की योग्यता आहार–संयोजन तथा उनके पाचक एंजाइमों को अनुकूलित करने की क्षमता और उपापचयी प्रक्रिया आदि पर निर्भर करती है।

फलतः, सुनहरी महाशीर की कोशिका के पाच्य एंजाइमों का कोशिका–अध्ययन यह पता लगाने के लिए किया गया कि मछली के लार्वा डाइजेस्टिव फंक्शन्स में ऐसे क्या विकास हुए कि जिसके माध्यम से महत्वपूर्ण आँकड़े प्राप्त किऐ जा सके, व लार्वा हेतु एक सम्पूर्ण आहार के रूप में प्रयुक्त हो सके। 0, 37, 15, 21, 30 व 45 दिन के उद्‌भवन के पश्चात विभिन्न आयु वर्ग के महाशीर बीजों के नमूनों को डी.सी.एफ.आर. स्थित महाशीर हैचरी

से एकत्रित किया गया। सम्पूर्ण एवं विच्छेदित बीजों (30 एवं 45 दिन तक उद्‌भेदित) को 5% होमोजिनाइज्ड तथा 0.25 मोलर सुक्रोज़ मिश्रण को यांत्रिय उतक होमोजनाइजर की सहायता से होमोजिनाइज्ड किया गया। होमोजिनाइज्ड नमूनों को 6000 x g की दर से 10 मिनट के लिए सैन्ट्रीफ्यूज किया गया तथा सैन्ट्रीफ्यूज के ऊपरी तल पर एकत्रित तत्वों को इकट्‌ठा कर उसे -20° से.ग्रे. पर एंजाइम अध्ययन के लिए संरक्षित किया गया।

विभिन्न आयु वर्ग (0, 3.7, 15, 21, 30, 45 दिन तक उद्‌भित) के महाशीर बीजों में लाइपेज की क्रियाओं का आंकलन किया गया। जिससे पता चला कि लाइपेज़ की अभिक्रिया सबसे कम शून्य दिन के उद्‌भवन की थी, लाइपेज की क्रिया में एक प्रभावशाली वृद्धि ($P < 0.05$) पायी गयी (7वें दिन तक)। यह क्रिया 15वें दिन में बहुत तेजी से घटती हुयी पायी गयी। अगर 30वें दिन की लाइपेज की क्रिया की तुलना की जाए तो 45वें दिन की लाइपेज क्रिया में थोड़ी सी वृद्धि पायी जाती है।

महाशीर बीजों में प्रोटीज की क्रिया 0 दिन से देखी गई। यह क्रिया एक जैसी तीसरे दिन तक पायी गयी और 7वें दिन के पश्चात इस क्रिया में तेजी से दोगुनी घटती हुयी पायी गयी जो कि सबसे कम 30वें दिन में देखी गयी। पुनः तेजी से प्रोटीज की क्रिया बढ़ती हुयी 45वें दिन में पायी गयी।

महाशीर में ऐमिलेज की क्रिया सबसे कम शून्य और 3 तीसरे दिन में पायी गई। 7वें दिन में इस क्रिया में तेजी से बढ़ोत्तरी पायी गयी। जो अपनी चरम सीमा तक बढ़ी। 15 दिनों के उद्‌भवन के पश्चात् इसकी क्रिया बहुत धीमी थी। 15 से 45 दिनों तक उद्‌भवन के पश्चात एमिलेज की क्रिया निरन्तर एक समान बढ़ती हुयी पायी गयी। ($Y = 0.5053 x + 7.475, R^2 = 0.9837$)

महाशीर बीजों में शून्य दिन के उद्‌भवन में ट्रिप्सिन की अभिक्रिया के लक्षण देखे गए कि वे 7 दिन के ट्रिप्सिन तक उनमें ट्रिप्सीन की कोई प्रभावकारी क्रिया नयी देखी गयी। ($P < 0.05$) यह क्रिया 15 दिन के उद्‌भवन में कम ($P < 0.05$) और फिर 21 दिन के उद्‌भवन के पश्चात यह कमी चौगुनी रही। पुनः 30 और 45 दिन के उद्‌भवन में भी यह कमी एक समान रही।

क्षारीय फास्फेट की क्रिया 0 दिन से 7 दिन के उद्‌भवन में कम रही, तत्पश्चात् 15 दिन के उद्‌भवन में बड़ी और फिर धीरे–धीरे 30 दिन के उदभवन में यह क्रिया अपने चरम तक बढ़ी। 45 दिन के उद्‌भवन में इसकी क्रिया में दो गुनी कमी रिकार्ड की गयी।

प्रमुख चुनिंदा शीतजल मत्स्य प्रजातियों की वृद्धि रूप एवं लम्बाई–भार संबंधी प्रतिरूपण

राम नगर की कोसी नदी टौर प्युटिटोरा मछली की लम्बाई–भार सम्बन्धों एवं उनके जीवन चक्र के चार भिन्न स्तरों का अध्ययन किया गया। एन्कोवा के परिणामों से ज्ञात हुआ कि तौर–प्युटिटोरा के विद्यमान दो स्तरों में लम्बाई–भार संबंधी "आइसोमिट्रिक वृद्धि," (सममितीय वृद्धि) नहीं पायी गयी।

जैब्रा मछली (डैनियो रिएरो) के यकृत में माइक्रोसेस्टीन उत्प्रेरित डी.एन.ए. का क्षरण

माइक्रोसाइटिस एइरूजिनोसा पुष्प के अर्क को भीमताल से एकत्रित किया गया तथा जैब्रा मछली के यकृत में हैपोटोटौक्सीसीटी परीक्षण के लिए उसका प्रयोग किया गया। 48 घंटों के पश्चात पता चला कि उसमें व्यापक स्तर पर हैमरेज़ हुआ। यकृत के सूक्ष्मीय परीक्षण से ज्ञात हुआ कि उसकी रक्त कोशिकाओं का विच्छेदन, पृथक्करण एवं अत्यधिक ह्रास हुआ।

प्रयोग

शीतजल मात्स्यिकी अनुसंधान निदेशालय भीमताल के तालाबों में पालित निओलिसोचिलस हैक्सागोनोलिपिज की अंगुलिकाओं को 90 दिन की प्रयोगिक अवधी के दौरान प्रोटीन की समान मात्रा युक्त आहार (35 प्रोटीन) जिसमें स्पाइरूलीना सम्मिलित है OCD-D, 3 (D-2), 5 (D-3), 7 (D-4) व 10% (D-5) की दर से दिया गया। इन अंगुलिकाओं को 100 लीटर पानी की क्षमता वाले फाइबर टैंकों में रखा गया। इन टैंकों में पानी का बहाव 2–3 ली./मिनट नियत रखा गया तथा प्रतिदिन अपशिष्ट भोजन, गन्दगी व टैंक के पानी को साइफन से बाहार निकाला गया।

जल की गुणवत्ता का प्रबन्धन

आफा (1995) की विधि के अनुसार जल की गुणवत्ता का प्रबन्धन किया गया। टैंकों में मछलियों को फँफूद के संक्रमण से बचाने के लिए टैंकों के पानी को बदला गया और साथ ही टैंकों को $KMnO_4$ से धोया भी गया।

प्रायोगिक आहार :– फिश मील, सोयाबीन की खली, चावल की भूसी एवं गेहूँ की भूसी युक्त चार अवयवों के मिश्रण से आहार का निर्माण किया गया। इस आहार में स्पाइरोलीना मील को अतिरिक्त रूप से मिलाया गया। प्रत्येक आहार में 2% की दर से विटामीन – मिनरल मिश्रण एवं सोडियम एलीनेट को भी मिलाया गया। आहार का अनुमानित मिश्रण AOAC (1995) की प्रक्रिया के आधार पर निर्धारित किया गया। दिन में दो बार आहार (प्रातः और सायं) दिया गया। ये आहार उनके शरीर के भार के बराबर 5% की दर से दिया गया।

प्रशिक्षण कार्यक्रमः

पर्वतीय क्षेत्रों के लिए त्रिस्तरीय मत्स्य पालन तकनीक दिनांक 19–23 अक्टूबर, 2010 को शीतजल मात्स्यिकी अनुसंधान निदेशलय भीमताल ने राजीव गांधी विश्वविद्यालय (RGU) ईटानगर के सहयोग से ईटानगर में एन.एफ.डी.बी., हैदराबाद के तत्वाधान में ''पर्वतीय क्षेत्रों के लिए त्रिस्तरीय मत्स्य पालन तकनीक'' शीर्षक पर पांच दिवसीय प्रशिक्षण कार्यक्रम का आयोजन किया।

रेन्वो ट्राउट पालन, प्रजनन एवं उद्भवन पर प्रशिक्षण पाठ्यक्रम :– विस्तार निदेशालय, कृषि मंत्रालय, कृषि विभाग एवं सहयोग, नई दिल्ली के तत्वाधान में दिनांक 27 दिसम्बर 2010 से 3 जनवरी, 2011 तक शीतजल मात्स्यिकी अनुसंधान निदेशालय, भीमताल में ''रेन्बो ट्राउट पालन, प्रजनन एवं उदभवन'' पर एक राष्ट्रीय स्तर पर प्रशिक्षण कार्यक्रम आयोजित किया गया। जिसमें देशभर के मात्स्यिकी अधिकारियों, विस्तार अधिकारियों, सहायक मत्स्य निदेशकों, विभिन्न विश्वविद्यालयों के लैक्चररों व शोधार्थियों ने भाग लिया।

स्वतंत्रता दिवस समारोह :– शीतजल मात्स्यिकी अनुसंधान निदेशालय भीमताल में निदेशक महोदय द्वारा 15 अगस्त को ध्वजारोहण किया गया। अपने भाषण में निदेशक ने सभी सदस्यों को एकजुट होकर कार्य करने का आहवाहन किया।

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