

NATIONAL SEMINAR

Strategies, innovations and sustainable management for
enhancing coldwater fisheries and aquaculture

22-24 SEPTEMBER, 2017

ICAR-DCFR, Bhimtal, Nainital, Uttarakhand



ABSTRACT BOOK



Indian Council of
Agricultural Research



ICAR-Directorate of
Coldwater Fisheries Research



Zoological Society
of India



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FOREWORD

The coldwater region covers a wide geographic area of the country with diverse climatic regimes, cultures practices, livelihood pattern and socio-economic values where sustained aquaculture production is a challenging task. Alleviation of major impediments such as inadequate aquaculture inputs, infrastructure facilities and better scientific interventions alongwith existing natural resource management will definitely lead to the growth and development of fisheries and aquaculture in the made by ICAR-DCFR to formulate and prioritize research activities which need to be strategically implemented for sustainable management and enhancing coldwater fishery productivity and profitability.

On the special occasion of the National Seminar being organized at ICAR-DCFR, Bhimtal during 22-24 September, 2017, the ICAR-DCFR has taken up the effort to bring out an 'Abstract Book' in collaboration with Coldwater Fisheries Society of India, Bhimtal and Zoological Survey of India, Bodh Gaya covering the aspects of resource assessment and management; taxonomy and ichthyology; aquaculture and nutrition; aquatic biodiversity, water management and conservation; fish physiology and biochemistry; fish health management; fish genetics and biotechnology; post harvest technology and value addition; inter disciplinary approaches and policy framework. It is hoped that the outcome of the National Seminar will be highly useful to the scientists, teachers, students, policy makers and other stakeholders in bringing up qualitative and quantitative improvement in coldwater fisheries sector.

I take the opportunity to thank all benevolent contributors, participants and knowledge experts to provide a multidimensional perspective of the various developments taking place in the coldwater fisheries sector through the National Seminar. The enthusiastic support received from all of my colleagues is truly magnificent to bring out this publication in time with zeal.

I wish the National Seminar a great success.

15 September, 2017

Dr. A.K. Singh
Director, ICAR-DCFR
& Convener
National Seminar

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(RAM-01) DECLINING COLDWATER FISH SPECIES IN DAL LAKE KASHMIR – CAUSES AND ENHANCEMENT STRATEGIES

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The fish fauna of the Dal Lake is one of the earliest local fish fauna known to science. The fishing industry in Dal Lake is the second largest industry in the valley and livelihood for number of people directly and indirectly associated with this trade. During the past few decades anthropogenic activities in the catchment and within the lake has resulted in water quality deterioration and extinction of several flora and fauna species especially fish. The shift in vegetational regime and change in the amiable water quality has tilted the ecology in favour of hardy fish, *Cyprinus carpio* (common carp), thereby affecting the diversity and species richness of endemic coldwater fish especially *Schizothorax* and *Triplophysa* in the lake. As a result carp constitutes 70% of all the fish caught from the lake while *Schizothoracines* and other species constitute 20% & 10% respectively. The work carried during 2014-15 revealed that a total of nine (9) fish species are present in the Dal Lake in descending order as: *Cyprinus carpio var. communis* > *Cyprinus carpio var. specularis* > *Schizothorax niger* > *Schizothorax esocinus* > *Carassius carassius* > *Crossocheilus diplochilus* > *Schizothorax curvifrons* > *Puntius conchonius* > *Schizothorax labiatus* > *Gambusia holbrooki* with average fish catch/day/fisherman during spring, summer, autumn and winter was 6.3, 7.07, 6.32 and 5.81 kg/day respectively. Eutrophication, fishing and anthropogenic pressures, abstraction of sand and water, siltation, agricultural run-off, inflow of uncontrolled large volume of untreated sewage, destruction of breeding grounds, climate change driven hydrological regime transformation of lake tributaries and streams are few major causes responsible for decline in the endemic coldwater fish stock within Dal Lake. The paper presents in detail about the targets and strategies for achieving self-sustaining native and endemic coldwater fish population in this Himalayan Lake.

Keywords: Dal lake, eutrophication, *Schizothorax*.

**(RAM-02) PRESENT STATUS OF FISH BIODIVERSITY OF WULAR LAKE-A RAMSAR SITE IN
KASHMIR HIMALAYAS**

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Himalayas, a part of which is also included in the world's hotspot regions, are one of the most important ecological properties of the country. The aquatic ecosystems in the Himalayas are facing an ever increasing threat from anthropogenic activities which necessitate a better understanding of the freshwater biodiversity. Wanton destruction of the water bodies in the Kashmir valley has been a major cause of the progressive loss of rich biological diversity associated with these habitats. A typical example of a water body which is facing tremendous pressure at present is Wular Lake, a wetland of international importance in the Kashmir Himalayas. In order to assess the present status of fish species diversity, an investigation was carried out at five different sites of Wular Lake, for a period of one year from December, 2014 to November, 2015. Sampling was done on a monthly basis using cast net with the help of local skilled fishermen. During the entire study period, a total of 738 fishes were sampled. Cyprinidae was observed to be the most dominant family followed by Cobitidae. The study revealed that there was a drastic decline in the fish population in general and native *Schizothorax* in particular due to the introduction of exotic common carp, pollution, willow plantation along the catchment of the lake, and conversion of lake area into agricultural land. Many fish species that had been reported in the lake in the earlier studies were not reported in this study, indicating their disappearance from the lake. Keeping in view the progressively worse situation, there is an urgent need to take remedial steps to conserve the endangered native fish fauna of the lake in order to preserve its biodiversity from further ecological degradation.

(RAM-03) CATCH COMPOSITION IN SELECTED FISHING GEARS OPERATED IN MANASBAL LAKE, KASHMIR

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Seven commercially important fish species namely *Schizothorax esocinus*, *S. curvifrons*, *S. niger*, *S. plagiostomus*, *Tryplophysa sp.*, *Cyprinus carpio var. communis* and *Cyprinus carpio var specularis*) and *Ctenopharyngodon idella* were recorded in the present study. *Schizothorax* species dominated the catches in the winter season (January and February) contributing 71% to the total catches while the exotic carps viz., *Cyprinus carpio* and *C. idella* contributed about 69% of total catch in the months of March and April. The mean catch per unit effort (CPUE) was recorded at 645.7 g/man-hour. The highest CPUE of 849 g/man-hour was recorded in January while the lowest CPUE of 471 g/man-hour was recorded in April.

Keywords: catch composition, fishing gear, Manasbal lake, CPUE

(RAM-04) COMPARATIVE MORPHOMETRIC STUDY OF *SCHIZOTHORAX NIGER* FROM DAL LAKE AND RIVER JHELUM IN KASHMIR

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Morphometric characters of *Schizothorax niger*, commercially one of the most important snow trout in Kashmir, were studied from Dal Lake and River Jhelum in Kashmir. Thirteen morphometric characters, analysed in the present study, showed high co-efficient of correlation (R^2) values ranging from 0.51 to 0.96 for Dal Lake stocks and 0.51 to 0.85 for Jhelum stocks indicating that the characters were highly correlated to each other and also that there existed a homogeneity within the populations.

Keywords: Snow trout, *Schizothorax niger*, morphometry, Dal lake, Jhelum, Kashmir

**(RAM-05) CATCH COMPOSITION, MORPHOMETRY AND LENGTH-WEIGHT RELATIONSHIP
OF *CARASSIUS CARASSIUS* LINNAEUS IN DAL LAKE, KASHMIR**

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Carassius carassius Linnaeus is one of the important cyprinids found in Dal lake, Kashmir. The fish is locally known as “gang gad”. Catch composition of the fish indicated that it contributed 32.09% by number and 20.5% by biomass to the total catch in the Lake. A total of 180 specimens of *Carassius carassius* were studied during December, 2016 to May, 2017. The total length of the fish specimens ranged from 88.62 mm to 177.45 mm with the corresponding weight of 8 gm and 86.5 gm respectively. The various morphological characters of the body parameters showed high co-efficient of correlation (r) values, indicating they are highly correlated to each other. The length-weight relationship was recorded separately for both males and females. The regression equation for males was expressed as $\text{Log } W = 0.283 + 1.673 \text{ Log } L$ ($R^2 = 0.855$) and for females as $\text{Log } W = 0.290 + 1.658 \text{ Log } L$ ($R^2 = 0.872$). The length weight equation for pooled data was obtained as $\text{Log } W = 0.284 + 1.670 \text{ Log } L$ ($R^2 = 0.868$). The ‘b’ value of 1.670 obtained for the pooled data was found to be significantly different from 3 indicating negative allometric growth in the fish.

Keywords: Dal lake, *Carassius carassius*, length-weight relationship

**(RAM-06) ICHTHYOFAUNAL DIVERSITY ALONG ALTITUDINAL GRADIENT IN RIVER
WESTERN RAMGANGA, KUMAUN HIMALAYA, UTTARAKHAND, INDIA**

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River Western Ramganga is one of the principal rivers of Kumaun Himalaya which drains into River Ganges. It inhabits diverse ichthyofauna and known for the breeding ground of important coldwater species including Golden mahseer (*Tor putitora*), an endangered and a popular sport fish of India. The river provides subsistence fisheries to the people inhabiting in the area and is also exploited for other purposes. The natural fish population of various hill streams are declining and therefore need adequate attention for their conservation. The fish diversity is known to vary along the altitudinal gradient due to various biotic and abiotic factors. The present study aimed to assess the variation in quantitative diversity of fish fauna along the altitudinal gradients (1100-700m MSL) in the mountain stretch of this river using different indices. Data on species abundance were collected for a period of one year (October 2015-September 2016) from seven different locations from high to low altitude. A set of physical characteristics (depth, width, stream velocity, stream order) were also recorded. Species richness, diversity and evenness were measured using Margalef, Shannon-weaver and Simpson diversity indices respectively. One-way ANOVA was employed to find the mean difference between the variables. A total of 27 species belonging to 16 genera were recorded from the studied stretch. Richness and diversity varied from 1.060 ± 0.14 to 2.55 ± 0.18 and 1.27 ± 0.11 to 1.95 ± 0.12 (Mean \pm SE) respectively, from high to low altitude. While evenness varied from 0.91 ± 0.09 to 0.88 ± 0.08 . The results of ANOVA revealed a significant difference ($p < 0.01$) in species richness and diversity while species evenness did not vary between high and low altitude. It was found that with decreasing altitude changes in geomorphology and moderating environmental conditions in the stream could influence fish communities. Understanding the factors determining the spatial segregation of species is immensely important for the conservation and management of aquatic resources.

Keywords: Western Ramganga, altitudinal gradient, species richness, diversity, evenness

(RAM-07) A STUDY ON PROFILE OF THE FISHERS OF KARANG ISLAND, MANIPUR

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A study on the livelihood status of the fishers of the Karang Island was conducted for the present research programme. Livelihood indicates the capabilities of assets and activities determining the gain by the community while living. The Karang is an island in the Loktak lake of Manipur, Moirang sub-division, Bishnupur district, about 50 km from Imphal. The study was carried out to understand the present status of the fishers in this island for this particular fishing community. The study covered the problems faced by the fishers. The work is totally based on the field visit, interviews, discussions, questionnaires, etc. Fishing is the major source of income as situated in heart of the Loktak Lake – the largest Freshwater Lake in the North-East State. About 5% got Government jobs. 70% of the community worked as full time fisher without licence. Their fishing gears almost depended on traditional methods but 10% used motorised boats. They used fishing techniques based on different types of nets, traps, hooks and lines, spear, etc. Large sized family (7-10 members) occupied 50% of all households. 89% of houses were kutcha. Fishers in the middle age (31-40 yrs) dominantly performed fishery activities. Their monthly income ranged from Rs. 1000-10000 and above. The villagers were mostly in elementary level of education. Their health and sanitation is somewhat low. The study, so far, revealed that their socio-economic status is below average and income from fishing maintains their family. Transport and communication was performed through water route. Some commercial species caught are *Channa sp.*, *Cyprinus sp.*, *Labeo sp.*, *Cirrhinus mrigala*, *Amblypharyngodon mola*, *Puntius sp.*, *Ctenopharyngodon idella*, shrimps, etc. This study will help to make proper solutions and considerations for the welfare of the villagers. They need support from both Govt. and civil organisations so that they could establish their own society and improve the socio- economic conditions in particular and fishery in general. Organising extension programmes would help them to develop their self-confidence.

Keywords: traditional, socio-economic, livelihood, Karang Island.

(RAM-08) ABUNDANCE, DIVERSITY AND ALTITUDINAL DISTRIBUTION OF CYPRINID FISH RESOURCES IN MEGHALAYA OF NORTHEAST INDIA

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Abundance, diversity and altitudinal distribution of Cyprinid resources from twin drainage basin viz., Brahmaputra and Barak-Surma- Meghna drainage basin of Meghalaya, a state from Northeast India were studied. A total 26 cyprinid fish species belong to 14 genera were recorded by sampling in 10 different water bodies of Brahmaputra and Barak-Surma-Meghna drainage at the elevation ranging from 100 to 1500 msl. The relative abundance of cyprinid population recorded highest for *Danio* (20.4%), followed by *Devario* (16.4%), *Neolissochilus* (11.5%), *Systemus* (8.2%), *Labeo gonius* (6.6), *Pethia shalynius* (6.6). Low percentage of relative abundance was found for *Tor putitora* (0.33%), *Tor tor* (0.33%) *Labeo dyocheilus* (0.33) indicates the rarity of the species. High value of Shannon Weiner index (H) 3.12 and low value Simpsons dominance index (D) 0.1 indicates richness and evenness of cyprinids in Meghalaya. The altitudinal distribution analysis revealed that commercially important food fishes under genus *Labeo*, *Systemus*, *Cirrhinus*, *Tor* were mainly restricted to at elevation below 500 m above MSL and restricted only in Umngot river of Barak-Surma-Meghna drainage basin except *Neolissochilus hexagonolepis* exhibits wide range in altitudinal distribution at 1500 m- 200m above msl in twin drainage basins. Minnows such as *Danio rerio* and *Pethia shalynius* shows wide distribution (1500 - 200m above msl) but species *Pethia conchoniensis*, *Pethia ticto*, *Puntius sophore*, *Rasbora daniconius*, *Salmostoma bacaila* and *Labuka labuka* exhibits distribution below 500 m. Altitudinal distribution of *Garra sp* and *Barilius bendelisis* were restricted above 500 m msl.

Keywords: Cyprinid, diversity, relative abundance, altitude, Meghalaya

(RAM-09) STDY ON THE FISHERY RESOURCES OF NAMBOL RIVER, MANIPUR

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Nambol river is one of the important water system to the people of surrounding and in the history of Manipur. It is originated from the Kangchup Hill, Senapati District which flow through Nambol Town and finally flows into Loktak Lake. This river has good fishery resources and different kinds of fishes are also available such as *Anabas testudinus* (Ukabi), *Anguilla begalenis* (Ngarilleina), *Acantophthalmus punctatus*, *Acantophthalmus pangia* (Nganap), *Channa orientaties* (Meitei ngamu), *Botia historionica* (Sarengkhoibi), *Bagarius bagarius* (Ngarel), *Puntius ticto ticto* (Ngakha), *Cyprinus carpio*, *Ctenopharyngodon idellus*, *Cirrhinus mrigala*, *Catla catla*, *Notopterus notopterus*, *Hypophthalmichthys molitrix*, *Amblypharyngodon mola*, *Labeo rohita* etc. The availability of fishes are highly dependent on the physico-chemical parameters of water. Some of the water qualities are water temperature, dissolved oxygen, pH, turbidity, carbon dioxide, alkalinity, calcium, magnesium, sodium, chloride, total hardness. The quality of water is degrading due to anthropogenic activities, sewage disposal, agricultural drainage etc. Many people are able to survive by the river system as they earn their livelihood by catching fishes and selling them to the market. So there is need to maintain the river system by the concerned department, NGO's and surrounding people.

Keywords: physico-chemical, fishes, Nambol, river, parameters, Loktak lake.

**(RAM-10) A STUDY ON ICHTHYO-DIVERSITY OF ARJUN DAM DISTRICT MAHOBA (U.P.)
INDIA**

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The fishes are not only used as good source of food for mankind, having economic importance from medicinal point of view but also play a crucial role in the second trophic level of the aquatic ecosystem. Fish diversity is a good index of healthy, growing dynamic and economically efficient water body. An attempt was made to find the ichthyo-diversity of Arjun dam district Mahoba (U.P.) India. Systematic studies were conducted during a period of one year. A total of 22 species of fishes belonging to 17 genera, 9 families and 5 orders were identified. Cypriniformes order is represented by 1 family, 7 genera and 9 species while Siluriformes order by 4 family 6 genera and 7 species and Perciformes order by 2 family 2 genera and 4 species. Each of the order Osteoglossiformes and Synbranchiformes is represented by single family, single genus and single species.

Keywords: ichthyo-diversity, Arjun dam, Mahoba (U.P.), India

(RAM-11) CATCH STATISTICS OF *BANGANA DERO* FROM GOBIND SAGAR RESERVOIR DURING YEARS 2006 -2012

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Gobind Sagar reservoir has been created in 1963 by damming Sutlej River at village Bhakra. This reservoir is one of largest reservoirs in Himachal Pradesh, India (31° 25' N and 76 ° 25' E) created by constructing 226 meter high, straight gravity dam. Average water spread area of this reservoir is 10,000 hectare. Fishermen have organized themselves into fisheries co-operative societies. Twenty six fisheries co-operative societies were working in this reservoir up till year 2012. June and July months were observed as "Closed season" when no fishing was done for the purpose of fish conservation. Fish catch data was obtained from state fisheries department. Gill nets (80 m x 5 m) having mesh size not less than 5 cm were used to catch fish. Total catch of all species by all co-operatives from this reservoir remained 5637108.9 kg during these years. Total catch of *Bangana dero* remained 100637.4 kg. During years 2007 to 2009, increase in total yearly catch of *B. dero* was recorded. During year 2007 catch was 1545.8 kg it got increased to 5089.2 kg during year 2008, 9740 kg during year 2009. This catch remained 17140 kg in 2012. Yearly catch of *B. dero* from all co-operative societies was 32343.5 kg (maximum) in year 2011 and was 1545.8 kg (minimum) in year 2007. Fisheries co-operative society wise, *B. dero* catch was maximum (5593 kg) from Berrian Wala in the year 2012 and minimum from Piungali and Beri Darolan (2 kg, each) in the year 2007 and 2008 respectively. Maximum catch of this species was recorded from landing centre with co-operative societies operating in an area (Jyor area, 65.31 percent) having more streams. There was shifting of operations from areas having more fluctuations in water level to other adjoining areas of the reservoir.

Keywords: *Bangana dero*, reservoir, fish catch, co-operative societies.

**(RAM-12) A PRELIMINARY INVESTIGATION ON THE FRESHWATER SHRIMPS OF
MANIPUR, NORTH EAST INDIA**

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Manipur has large areas of water bodies viz lakes, rivers, wetlands etc. It also has rich biodiversity. A preliminary study on local fresh water shrimps is conducted in Manipur to draw its importance and utility in the state. Many people depends their livelihood from the fishery activities. Capture and culture fisheries are widely practiced in and around the Loktak lake, the largest freshwater lake in the North-East India. Aquaculture farms are widely distributed around the Loktak lake. Among the non-fish groups, shrimps are one of the most important foods as it is widely available in the water bodies, its suitability in the ecology and people's high demand and its high protein content. Besides, it possesses a fabulous taste. It is reported that 50-65% of protein is found according to the size, sex and season. So far, commercial farming for the species is not practiced yet in the State. It has all the potential to produce in a commercial way to earn more revenue for the fishers and to meet the demand of people as well. The samples were collected from different parts of the state by using dip net (Nupi el) and scoop net (Longthrai). The present study showed that most of the shrimps bear large second cheliped , first cheliped much smaller; carapace with a projecting rostrum; first pair of periopods chelate slender and as long as the carapace; second pair chelate; posterior three pairs of pereopods simple; telson triangular, terminating in a single tip. Most of the shrimps available in the State are *Macrobrachium* sps.

Keywords: shrimps, non-fish groups, culture fishery, *Macrobrachium* sps.

(RAM-13) CURRENT STATUS OF FISHERY AND ABUNDANCE OF FISH FAUNA IN THE HYDROPOWER AFFECTED ALAKNANDA RIVER, UTTARAKHAND

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Dams alter river hydrology upstream and downstream, affecting aquatic ecology. The river Alaknanda is modified by hydroelectric projects at Vishnuprayag (2500 m) in the upper and at Srinagar (560 m) in its lower stretch. This study examines the current status of fishery in the stretch between these dams specifically between Birahi and Srinagar. In order to assess total catch and abundance of various fish species, experimental fishing was conducted in the middle stretch of the Alaknanda at Langasu (800m; 65km below Vishnuprayag HEP) during September and December and just below Srinagar HEP powerhouse (560m) during January and March. Fishing was carried out once in a month with the help of local fishermen using indigenous traps. A catch of 2 kg and 15 kg was obtained in respective months at Langasu, while 17 kg and 16 kg at Srinagar respectively. The catch obtained from regular fishing during a week in April at Langasu and Srinagar ranged from 5.5-15 and 15-22 kg respectively. Observations on abundance reveal that *Schizothorax richardsonii* (43-64%) was the most abundant species followed by *Schizothorax plagiostomus* (14-50%) and *Schizothorax progastus*. The abundance of *S. progastus* and *S. richardsonii* increased from Langasu to Srinagar while the abundance of *S. plagiostomus* decreased from Langasu to Srinagar. In the stretch downstream of Srinagar dam during September *Schizothorax richardsonii* (62.5%) continued to be abundant. Other species included *Tor putitora* (25%) and *Pseudecheneis sulcatus* (12.5%). The total catch at Srinagar is low compared to pre HEP's period (50-63 kg in a day during January). Among the snow trout, *S. richardsonii* is the most dominant element in the fish fauna. The no. of individuals per unit area (=density; 0.006/m²) was also higher for this species compared to other elements of the fish assemblage.

**(RAM-14) IMPACT OF CLIMATE CHANGE AND POLLUTION ON DIVERSITY AND
DISTRIBUTION PATTERN OF FISH FAUNA IN KASHMIR HIMALAYA**

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Anthropogenic influences on the biosphere are increasingly causing global changes. In the freshwater environments, climatic change, pollution and spread of alien species have been responsible for the loss of fish diversity viz-a-viz fish production. The unusual melting of glaciers and incessant rains have affected the discharge of the rivers of the Kashmir valley. During early spring and summer, the rivers during this period are fully discharged while as for the rest of seasons these resources in most of the places become dried. This has drastically affected the ecology of these rivers and ultimately has resulted in the loss of the fishes. Aquatic resources of Jammu and Kashmir are huge; length of rivers and canals is 27,781 kms, area of the reservoirs is 0.07 lakh ha, ponds and tanks form 0.17 lakh ha, flood plain lakes & derelict water bodies form 0.06 lakh ha but we are able to produce just less than 1% (about 20,000 tonnes) of the total Inland fish production of the India. The total fish production in the state has decreased over the years. In the year 1997-98, the fish production was about 0.76% and in the year 2011-12, it has decreased to 0.54%. Presently in Kashmir valley we have just twenty three (23) species of fishes but the number has been reported up to about forty two (42) species. Some fishes like *Botia birdi* and *Schizothorax plagiostomus* and loaches like *Triplophysa kashmirensis* once abundant in the Dal and other lakes of the valley are presently extirpated from the systems likewise *Glyptothorax kashmirensis* which was abundant in river Jhelum four decades before have declined tremendously (Bhat et al, 2010). Exotics like *Cyprinus carpio* presently forms more than 70% of the catch of fishes in Dal Lake while as indigenous Schizothoracids which were once the dominant fishes of the lake formed less than 30% of the catch (Shafi et al, 2005). Constructions of dams, weirs and barrages have further worsened the situation as they have become the obstacles on the fish ways, and have degraded the river biota and environs. Conservation and management of the natural aquatic resources and culturing of the economically important fishes in the region for fish production with the changing environs and climate is the need of the hour.

Keywords: *Schizothorax*, climate change, pollution, diversity, production

(RAM-15) FISHERY RESOURCES OF LEH (JAMMU AND KASHMIR) INDIA: A GIS APPROACH

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District Leh is located between 32 to 36°N and 75 to 80° E with altitude ranging from 2300 to 5000 m asl. Topographically, the whole district is mountainous with three parallel ranges of the Himalayas, the Zaskar, the Ladakh and the Karakoram. Between these ranges, the Shayok, Indus and Zaskar rivers flow across and harbour important fish species. Most of the population lives in valleys of these rivers besides these the region is also bestowed with numerous freshwater and brackish water resources. Due to weather extremities and access hindrance to these water resources, due attention was not given to fishery perspective. In the present study, fishery resources of the region were assessed and resource maps were prepared using remote sensing and GIS. The total lentic and lotic water resources estimated were 132484.7 km² and 5192.7 km² respectively. A total of 27 fish species were recorded from the rivers of Ladakh division, of which, 23 fish species belonging to 4 families and 14 genera from Indus, 11 fish species belonging to 3 families and 10 genera from Zaskar and 12 fish species belonging to 2 families and 9 genera from Shayok river. It was also observed that variation in water quality parameters influence the distribution and abundance of fish species. *Schizothoraichthys*, *Diptychus* (Cyprinidae) and *Triplophysa* (Nemacheilidae) constitute the major fishery of the rivers.

Keywords: fishery resources, ichthyofaunal diversity, Leh

(RAM-16) THE STATUS AND POTENTIAL OF FISHERIES IN NALBARI DISTRICT OF ASSAM, INDIA

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The zoo-geographical features of Assam and the adjoining states have endowed the entire North-East region with a good numbers of fish genetic resources. The state Assam has only occupied beel fisheries, pond and tank fisheries about 1.4 lakh hectares area where beel fisheries play an important role in the state's fish production. Studies revealed that the number of fish species of North-East India vary which is put between 172 to 267. In Assam alone, there are 185 species belonging to 98 genera under 34 families; of these 33 are endemic.

Nalbari is one of the northern most district of Assam, has an area of 1999 sq. km. and harbour rich aquatic biodiversity in the good number of wetlands present in this region. The wetlands are providing ecological services to the fringe villages mostly in the form of fishery, rivers, rivulets, ponds, Wetlands etc. has helped to flourish such a rich biodiversity of fish but in recent years changing situations has posed a serious threat to most of the indigenous species which is a matter of concern. With the rapid expansion of mainland, changing the direction of river flowing, siltation, establishment of industries encroachment etc. at some part of Nalbari District, wetlands are vanishing in a fast rate.

The present study reveals 45 fish species belonging to 27 genera, 10 orders and 20 families including many threatened fish fauna during the study period (April 2015 to August 2017) in the wetlands of Nalbari District, Assam. The documentation of fish diversity and habited analysis is most important to framing out management strategies of beel for the better production of fish resources.

Keywords: wetland, fish resources, Nalbari district.

**(RAM-17) POPULATION DYNAMICS OF MAHSEER IN NARMADA RIVER IN A STRETCH OF
OMKARESHWAR TO KHALGHAT, MADHYA PRADESH**

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Rivers played a critical role in the growth of human civilization across the globe and have been well known as habitats of thousands of biota including many rare, endangered, threatened, endemic and charismatic species of great interest. Biodiversity of rivers is characteristic as by high species richness disproportionate to the area. The Narmada has been the cradle of MP civilization. We carried the investigation in the river with the stretch of around 150 kms for mahseer population from 2011 to 2015. Sampling was carried in upstream and downstream during pre and post monsoon periods. Results revealed that mahseer population has been reduced to great extent ranging from 0.8% to 7.0%. The minimum percentage was observed during 2015. Although the results show constant decrease in the population from 2011. By creating and restoring some part of the river shores, a significant increase was observed from 1.00% to 6.00%.

Keywords: mahseer, Narmada river, biodiversity, conservation

**(RAM-18) THE CONTRIBUTION OF SMALL STREAMS AND SIDE TRIBUTARIES FOR
ICHTHYOFAUNAL DIVERSITY IN RIVER NETWORK OF HIMACHAL PRADESH**

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Himalayan ecosystem is unique in its biodiversity having 5 major rivers in Himachal Pradesh namely Spiti, Sutlej, Beas, Ravi and Chenab along with many small streams and tributaries. The estimated total length of the main river course in Himachal Pradesh is about 1431 km, while it is 10464.3 km along small streams, tributaries and rivulets. These small streams & tributaries differ widely in physical, chemical and biotic attributes, thus, providing habitat for aquatic biodiversity. In terms of ichthyofaunal diversity, upland water of Himachal Pradesh possess 56 species belonging to 27 genera, 13 families out of which 24 species have food value, 21 species are of ornamental value and 9 species have both food and ornamental value including world famous sport fish, Golden Mahseer and exotic brown trout. Conservation and restoration efforts on large rivers often focus on the main streams, but not for small streams and side tributaries, which occur across or in sides of the river and remain differ from the main steams for temperature gradient, water chemistry, hydrological regime, substrate type, food resources and riparian pools all of which affect the abundance and diversity of the biota. The confluence of these resources form a unique habitat required for residents and migratory fish species, which serve as a source of colonists, providing spawning sites and rearing area having rich food sources. These small water sources also contribute in environmental flow in the downstream of the dams. Despite their abundance on the landscape and importance as habitat and as recharge sources, they are ignored in commonly used cartographic depictions. Small streams are neither named nor adequately indicated on standard topographic maps, but play an important role in the ichthyofaunal diversity of the river networks.

Keywords: small streams, side tributaries, ichthyofaunal diversity, conservation, restoration.

(RAM-19) MAINSTREAMING BIODIVERSITY IN COLD WATER FISHERIES

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The cold water fishery resource in India is spread across Himalayan range extending from Jammu & Kashmir to Arunachal Pradesh in the north and Western Ghats in the south, comprising an overall area of 5,33,604 km². The cold-water resources are distributed in the form of upland streams and rivers (8,243 km), lakes (20,500 ha.) and reservoirs (50,000 ha.) located in high and low altitudes of different hill states such as Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram Tripura, Meghalaya, Assam and West Bengal. These cold-water resources harbours diverse group of fishes belonging to 258 species, 76 genera and 21 families, constituting approximately 17 percent of the total fish fauna of the country, out of these, 203 species have been recorded from the Himalayas. Presently, cold-water sector contribute about 75,000 MT which is about 1.5% of total inland fish production. Cold water fishes namely rainbow trout, snow trout, golden and chocolate mahseer, and common carp etc are important food in the rural and urban upland population in India. The loss of cold water fishery resources in these regions is due to the reduction of land holding, diminished flow of rivers, injudicious abstraction of water, Climate change, eutropication, spread of Invasive Alien Species and excessive fishing.

Mainstreaming is an important policy tool which helps in strengthening the linkages between biodiversity and fisheries. The United Nations Convention on Biological Diversity has urged parties to develop national and regional targets, using the Strategic plan and its global Aichi targets. Accordingly, India has developed 12 National Biodiversity Targets and these needs to be achieved by 2020. The targets 5, 6 & 8 related to inland fisheries emphasise achieving sustainable fisheries, conservation of ecologically representative areas and to safeguard areas of ecosystem importance. Author of this paper carried out a policy analysis and this will be presented.

Keywords: cold water fisheries, biodiversity, governance.

(RAM-20) STUDY ON THE DISTRIBUTION AND ECOBIOLOGY OF *NEOLISSOCHILUS* SP. IN MEGHALAYA, INDIA

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Neolissochilus belong to a group of fishes which are universally known as ‘Mahseers’. In the state of Meghalaya the fast-flowing fresh waters and the ideal agro-climatic condition of the state is suitable for its survival and also for its propagation. In this study we have surveyed different rivers of the state for presence of different species of the genus *Neolissochilus*. During the exploration, ten rivers viz. Umngi, Khri, Amlayee, Amshariang, Pamblang, Lakroh, Umran, Umralone, Umiam, Janiaw during 2015-2017. It has been found that only two species are available in those rivers that were explored. The species collected were carried out for biometric analysis and the eco-biology of the species is discussed. The observation confirmed the species collected as *Neolissochilus hexagonolepis* and *Neolissochilus hexastichus* and the population distribution based on catch per netting of the fishes are discussed. The initial survey suggests that the population of *Neolissochilus hexagonolepis* found in all ten rivers explored but the population of *Neolissochilus hexastichus* is restricted only in certain pockets of East Khasi hills District of the Meghalaya. However, more detail survey in other river also needs to be carried out for presence of the species in elsewhere of the state. It has been also observed that there is an urgent need to study and conserve its natural habitat and also to rear the hatchery produced larvae of Mahseer under captive rearing conditions to increase the population of this fish in the natural water bodies of Meghalaya, which is an important component of biodiversity.

Keywords: mahseer, *Neolissochilus hexagonolepis*, *Neolissochilus hexastichus*, biometric, eco-biology.

**(RAM-21) FISH DIVERSITY AND PHYSICO-CHEMICAL PROPERTIES OF BAIGUL
RESERVOIR IN THE TARAI REGION OF UTTARAKHAND**

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The Tarai region of Uttarakhand has several reservoirs constructed for irrigation and hydroelectric power generation purpose. These include Nanaksagar, Baigul, Tumaria, Haripura, Baur Dhaura and Sharda sagar. Baigul reservoir was constructed in the year 1968 across the river Baigul, a tributary of the Ganga originating from foothills of Kumaun Himalayas. A perusal of the physico-chemical regime reveals that water of Baigul reservoir is moderately productive with suitable pH, alkalinity and dissolved oxygen profiles and has moderate concentration of nitrate-nitrogen and of phosphate-phosphorous. A total of 36 species of fish belonging to 13 families were identified in the reservoir. The fish species such as *Labeo calbasu*, *Labeo rohita*, *Labeo goni*, *Catla catla*, *Puntius spp.*, *Cirrhinus mrigala*, *Mystus tengara*, *M. seenghala*, *Gadusia chapra*, *Notopterus notopterus*, *Wallago attu* and *Mastacembelus armatus* etc. were quantitatively the main components of the fishery of the reservoir. Medium sized carps comprised a major share contributing 48.94% to the total fish catch. *L. goni* which contributed 40.83% to the annual catch constitutes the most dominant fishery in the Baigul reservoir. The paper discusses the suitability of physico-chemical regime in Baigul reservoir for fish production.

Keywords: Baigul reservoir, fish diversity, fish production, physico-chemical properties.

**(RAM-22) PRESENT STATUS OF FISH DIVERSITY AND POPULATION ABUNDANCE OF
SELECTED FISH SPECIES IN BHAGIRATHI RIVER AT UTTARAKHAND**

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Bhagirathi River is one of the largest tributary of river Ganga in India and sustains a rich fish biodiversity as cold water fishery resources. The river is characterized by heterogeneity in habitat substratum features harboring diverse fish fauna. At present, Bhagirathi River is facing alarming threat of being habitat fragmented by the construction of hydroelectric projects. The present study aimed to study the current status of fish species and population abundance of selected fish species in Bhagirathi River at Uttarakhand. During the present study, a total of 19 fish species belonging to 4 families were reported. *Schizothorax* fish species (Cyprinidae family) and *Tor* fish species (Cyprinidae family) were the dominant species (>50 % of total fish catch) in the riverine segment of the river Bhagirathi, while *Cyprinus carpio* (common carp) is the dominant species in the impoundment segment of river Bhagirathi (reservoir area). Few other species of *Barilius*, *Garra*, and *Glyptothorax* etc. also have been recorded during the study. The comparison of present result with earlier reports delighted that endemic fish fauna has to be diminished with the progression of time in the Bhagirathi river system, which may because of debasement and fracture of riverine natural habitat caused by various natural and anthropogenic activities. The environmental change in the natural flow pattern of river, hydrological characteristics including indiscriminate fishing practices and other natural calamities are the main factors for decline the fishery resources in Bhagirathi River. The present research data will be contributed significantly to assess the status of fishery resources and their fish biomass in relation to design the fish conservation policies in upland aquatic ecosystem.

(RAM-23) ECOLOGICAL IMPACTS OF DAMS ON THE FISH DIVERSITY OF BHAGIRATHI RIVER IN CENTRAL HIMALAYA (INDIA)

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Large numbers of dams have been built in hill states of India for harnessing the hydro energy besides water supply for drinking, household purposes and irrigation. Bhagirathi River in Garhwal region of northern India is also dammed at four locations (Maneri Bhali Phase I, Phase II, Tehri Hydroelectric Dam and Koteshwar Dam) for hydro power generation resulting in the fragmentation of riverine habitat. Substantial part of river is forced through tunnels where river has lost her identity leading to discontinuity in its original course while, considerable segment of river has also been converted into deep impoundments. These Dams have affected seasonal cycles of floods, natural flow regime, and has caused increase sedimentation in impounded section of river affecting habitat quality, life-history stages and population dynamics of the biota. These effects are augmented in lower stretch due to construction of dams in cascades. Consequently, the composition and structure of fish assemblages in the river has been affected. Most affected species are the indigenous rheophilic species viz. *Schizothorax*, *Glyptothorax*, *Pseudecheneis*, *Garra*, *Labeo*, *Crossocheilus*, *Noemacheilus*, *Barilius*, *Psilorhynchus*, *Clupisoma*, *Mastacembelus*, and migratory *Tor*, spp., which require distinct habitats to fulfil their life cycle stages. Populations of fast flowing riverine species have been collapsed or even disappeared from fragmented sections of the river system.

Keywords: Central Himalayas, dams, fish diversity, habitat alteration, habitat ecology, river fragmentation.

**(RAM-24) PRESENT STATUS OF FISHERY IN THE RIVER BHAGIRATHI IMPACTED BY
HYDROPOWER PROJECTS**

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Bhagirathi River is a parent tributary of the Ganga river system in Himalaya. Four Hydropower projects are commissioned on the river (Maneri Stage-I, Stage-II, Tehri and Koteshwer). The river from Maneri is diverted up to Uttarkashi at Tiloth power station and from Uttarkashi up to Dharasu power station. In the present study, an attempt has been made to study the current abundance and fishery status in the regulated stretches of river. Fishing was done at Jamak 2 km upstream to Maneri dam and in two diverted stretches at Uttarkashi and Dharasu with the help of local fishermen. Three gears were used for fishing; cast and gill net (with mesh size 1.5cm²) and fish traps (mesh size 2 cm²). Fishing at Dharasu was done once in a month at regular monthly interval during 2016-2017, where as experimental fishing was done at Maneri and Uttarkashi for 3 to 5 hours once a month for four and three months respectively. Only four cyprinid fish species contributed to fishery, It ranges from 0.6kg (January) to 1.3kg (March) at Jamak, 1.2kg (December) to 2.1kg (March) at Uttarkashi and 3kg (January) to 11kg (March) at Dharasu. Among the ichthyofaunal elements share of *Schizothorax plagiostomus* was largest followed by *Schizothorax richardsonii* and *Schizothorax progastus*, at all stations, where as Tor species contributed (7.7%) only once at Dharasu in October. Thus, the study shows poor state of fishery in the regulated stretch of the River Bhagirathi. Lack of other faunal elements is also a notable adverse change.

Keywords: Bhagirathi, hydropower projects, abundance, total fish catch.

(TXI-01) SOME STUDIES ON THE BIOMETRICS OF RAINBOW TROUT *ONCORHYNCHUS MYKISS* WALBAUM (SALMONIFORMES: SALMONIDAE) FROM KASHMIR

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The present study involves analysis of morphometric characters and length-weight relationship of *Oncorhynchus mykiss* collected on monthly basis from three state owned trout fish farms. Eleven morphometric characters studied showed high level of interdependence ($R^2 = 0.502$ to 0.876) among which standard length and pre-anal length were found to have highly significant relationship with total length ($R^2 = 0.876$ and 0.807 respectively), reflecting thereby that the morphometric characters of fish were highly correlated. The length-weight relationship was established as $W=1.957L^{3.028}$. The correlation coefficient (R^2) for length-weight relationship was found to be 0.608 , indicating a positive relationship between the two parameters.

Keywords: rainbow trout, morphometry, *Oncorhynchus mykiss*, length- weight, Kashmir

(TXI-02) ABSOLUTE AND RELATIVE FECUNDITY OF RAINBOW TROUT *ONCORHYNCHUS MYKISS* WALBAUM FROM KASHMIR

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The study is based on the estimation of absolute fecundity and relative fecundity of *Oncorhynchus mykiss* collected from three state-owned trout farms namely Mammur Trout Farm, Dachigam Trout Farm and Achabal Trout Farm. The highest value of absolute fecundity was estimated at 2600 eggs for a fish of total length 269mm (239.50g) with a gonad length of 135mm (45.5g) and the lowest value obtained was 1204 eggs for a fish of total length 273mm (252.00g) and gonad length of 90mm (14.5g). The relative fecundity ranged between 3.502 to 10.855 per gram of body weight. The scatter gram between fecundity against fish weight, fish length, gonad weight and gonad length depicted positive relationship ($R^2 = 0.599, 0.704, 0.662, 0.559$ respectively).

Keywords: *Oncorhynchus mykiss*, fecundity, scatter gram

**(TXI-03) EMBRYONIC DEVELOPMENT OF SNOW TROUT, *SCHIZOTHORAX NIGER*
(HECKEL, 1838)**

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Coldwater fishes form an important component of freshwater fisheries in India. The valley of Kashmir is bestowed with bountiful fresh water resources in the form of lakes, rivers, streams and low lying areas. Most of the commercially important fishes of Kashmir valley belongs to genus *Schizothorax* which inhabit highland waters in all three regions of Jammu, Kashmir and Ladakh. *Schizothorax niger* (snow trout) is an endemic fish of Kashmir. This study was conducted to describe the various embryonic developmental stages of *S. niger*. The embryonic development starts with the penetration of sperm in the egg. The diameter of fertilized eggs ranged from 2.6-3.2mm. Embryos were reared from fertilized egg to hatchling. Careful observation on morphological difference of embryonic development under light microscope was observed and revealed nine periods and 30 stages. These stages were based on diagnostic features viz. number and size of blastomeres, form of the blastoderm, extent of epiboly, number and form of somites, optic development, development of the notochord, heart development, movement of the body and development of the tail. The nine periods were fertilized egg, cleavage, morula, blastula, gastrula, neurula, segmentation, pharyngula, and hatchling. The total duration of embryonic development for *S. niger* from fertilized egg to hatchling was 7 days 9 hours at 10–12 °C.

Keywords: embryonic development, snow trout, fertilized egg, hatchling

(TXI-04) STUDY ON GONADAL DEVELOPMENT IN RELATION TO SOME HAEMATO-BIOCHEMICAL PARAMETERS OF *SCHIZOTHORAX NIGER* HECKEL IN DAL LAKE, KASHMIR

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The present study was conducted to investigate changes in haemato-biochemical parameters and GSI of *Schizothorax niger* Heckel during pre-spawning, spawning and post-spawning period in Dal Lake, Kashmir from November, 2014 to July, 2015. Fishes ranging in length from 75-374mm and in weight from 56-557g were taken during the study. The mean values of Total protein, Total albumin and GSI were recorded as 8.36 g/dl, 5.26 g/dl and 2.02 of the fish during pre-spawning period. During spawning period the mean value of Total protein, Total albumin, GSI, Absolute fecundity and Relative fecundity were recorded as 3.71 g/dl, 2.72 g/dl, 20.37, 21981 and 109 respectively. During post-spawning period the mean value of Total protein, Total albumin and GSI were recorded as 8.73 g/dl, 4.53 g/dl and 1.43 respectively. Total Protein, Total Albumin were found low in fish during spawning period as compared to pre-spawning ($P < 0.01$) and post-spawning ($p < 0.05$) periods respectively. Maximum Gonadosomatic Index in *Schizothorax niger* Heckel were recorded in March, i.e. during spawning period (mean value of 20.37 in females). The GSI then started decreasing gradually and was recorded minimum in July (mean value of 1.43 in females). Thus the peak breeding season of the fish during the present study was found in March. Absolute Fecundity and Relative Fecundity of *S. niger* were recorded with mean values of 21981.60 and 109.82 respectively. A positive correlation was recorded between Total Protein and GSI ($p < 0.05$) during pre-spawning period and also between Total Albumin and Absolute Fecundity ($p < 0.01$) during spawning period. A positive correlation was observed between GSI and Relative Fecundity at $p < 0.05$ level of significance during spawning period.

Keywords: *Schizothorax niger*, Dal lake, haematological parameters, GSI, Kashmir valley

(TXI-05) **REPRODUCTIVE BIOLOGY OF ENDEMIC SNOW TROUT, *SCHIZOTHORAX LABIATUS* McCLELLAND IN CHANGING ENVIRONS OF RIVER JHELUM, KASHMIR**

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A study on reproductive biology of *Schizothorax labiatus* McClelland – a commercially important snow trout in Kashmir Himalaya was carried during 2015 using 310 specimens (221 males and 89 females) for a period of twelve (12) months. The fish was found to be an annual breeder and histological studies showed follicular atresia both during pre-spawning and post-spawning period. Maximum GSI values recorded during April for both males (6.19) and females (11.12) indicated that the fish fully matures during this month and spawns during May with absolute and relative fecundity as 10323 and 42 respectively. Sex ratio was found as 1:0.41 indicating a significant dominance of males over females and length at first maturity (L_m) was estimated to be 196 mm and the corresponding age at this length was 2⁺ years for the fish. The study is an attempt to bring forward various aspects of reproductive biology of *S. labiatus* McClelland and a step towards conservation of fish diversity of the river system.

Keywords: GSI, Jhelum, maturity, *Schizothorax labiatus*.

**(TXI-06) GONADAL MATURATION AND HISTOLOGICAL OBSERVATIONS OF
SCHIZOTHORAX CURVIFRONS IN RIVER JHELUM KASHMIR**

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The objective of the present study is to describe the phases of gonadal development and determine the spawning season of *Schizothorax curvifrons* in River Jhelum Kashmir. A total of 298 fish specimens were studied to analyse the gonadosomatic index and maturity stages of *S. curvifrons*. Five maturity stages namely, Immature phase, Preparatory phase, Maturing phase, Ripe/spawning phase and Spent phase were observed in the gonads. Based on GSI values and gonadal conditions, April to June appears to be the spawning season for *S. curvifrons*.

Keywords: gonads, GSI, maturity stages, spawning season, river Jhelum, Kashmir.

**(TXI-07) STUDIES ON SOME REPRODUCTIVE ASPECTS OF *SCHIZOTHORAX CURVIFRONS*
HECKEL FROM KASHMIR**

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Schizothorax curvifrons, an indigenous cyprinid fish of Kashmir, forms an important coldwater fishery resource of the valley. The present investigation deals with the assessment of the average sex ratio, condition factor and length at first maturity of *Schizothorax curvifrons* collected from river Jhelum, Kashmir. Sex ratio (Male: Female) varied from 1:0.20 in May to 1:0.59 in November. The average sex ratio for the entire period of study was 1:0.40 (Male: Female) indicating a significant dominance of males. The estimated condition factor (K) varied from 0.62 to 0.86 in case of females and 0.64 to 0.87 in case of males. The length at first maturity (L_{50}) for females of *S. curvifrons* was estimated at 252 mm.

Keywords: Sex ratio, condition factor, length at first maturity, *Schizothorax curvifrons*, Jhelum.

(TXI-08) BIOMETRIC STUDIES OF SNOW TROUT *SCHIZOTHORAX CURVIFRONS* IN RIVER JHELUM, KASHMIR

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The present study was aimed to describe the morphometrics and length-weight relationship of *Schizothorax curvifrons* inhabiting River Jhelum Kashmir. The various morphometric characters showed high co-efficient of correlation (r) values, indicating that the characters were highly correlated to each other. The length-weight relationship was established logarithmically as $\text{Log } W = -3.9323 + 2.5863 \text{ Log } L$ ($r^2=0.746$) for males, $\text{Log } W = -4.1708 + 2.6852$ ($r^2=0.745$) $\text{Log } L$ for females and $\text{Log } W = -3.9975 + 2.6138 \text{ Log } L$ ($r^2=0.746$) for pooled data. The b value (2.6138) was found to be significantly different from 3 indicating negative allometric growth.

Keywords: *Schizothorax curvifrons*, length-weight relationship, morphometrics, Jhelum

**(TXI-09) SNOUT AND OROMANDIBULAR MORPHOLOGY OF THE LABEONINE GENUS
GARRA HAMILTON**

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The cyprinid genus *Garra* is a diverse speciose group among the subfamily Labeonine. Unshared with all other cyprinid fish groups, Labeonine exhibits high degree of morphological modification in its snout and oromandibular structure, which is the basis for recognition of most of the genera included. *Garra* shows high modification in snout and oromandibular structure which is the most potential diagnostic character in identifying the species. The genus exhibits two groups having different snout morphology: 1. *Garra* with smooth snout and 2. *Garra* with a snout with proboscis. The first group may be subdivided again into two: those with a rostral flap or those with a rostral lobe on the snout. *Garra* with proboscis on the snout is characteristic in having different structures: transverse groove, depressed rostral surface, lateral surface and tubercles. The shapes of the proboscis and tubercles differ from species to species. The shape of the proboscis may be quadrate, triangular, bilobed or trilobed, truncate or anteriorly rounded. Tubercles may be unicuspid, bicuspoid, tricuspoid, tetracuspoid and multicuspoid. The oromandibular structure consists of rostral cap, lower lip, anteromedian fold, anterolateral lobe, central callous pad, lateroposterior flap. The adhesive disc of central callous pad is placed anteriorly, medially or posteriorly in different species. The present study deals with different structure and morphology of snout and oromandibular found in *Garra*.

Keywords: *Garra*, smooth snout, proboscis snout, diversity

(TXI-10) BREEDING BIOLOGY AND GROWTH OF *SCHIZOTHORAX NIGER* IN DAL LAKE, KASHMIR

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Aspects of age, growth and reproduction of the important food fish of Kashmir *Schizothorax niger* (Heckel, 1838) in Dal Lake of Kashmir were investigated with a view to obtain basic information that could be used in the management of the fishery in the Lake. A total of 238 specimens, comprising 116 females and 122 males, were collected for the study. The size of individuals ranged from 62mm to 367mm in total length and 10 g to 491 g in body weight. The maximum observed age was found to be 8 years. The fishes of 1st age group were of the Length group 62-102 mm with an increase of 40 mm in each subsequent year. The fishes of age 8 year (8+) were found to be of Length group 342-382 mm. The estimated growth parameters of von Bertalanffy Growth Formula (VBGF), L_{∞} (cm), K, and t_0 value were found to be 465.99 mm, 0.07, and -0.1822 respectively. Growth was significantly different ($p < 0.05$) between males and females as revealed by length (L)-weight (W) relationship and both showed negative allometric growth of the cube law. The mean length of 1st sexual maturity in males was found to be 178.14 mm and in females was found to be 167.32 mm with corresponding age being 3 years (2⁺).

Keywords: Dal lake, *Schizothorax niger*, VBGF, Length-Weight relationship, allometric growth

(TXI-11) PHENOTYPIC AND GENETIC VARIATIONS IN FRESHWATER MURREL, *CHANNA PUNCTATUS* (BLOCH)

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Morphometric and genetic variations were studied using truss network analysis and random amplified polymorphic DNA-polymerase chain reaction (RAPD-PCR) respectively in *Channa punctatus*. The specimens of *C. punctatus* was collected from River Gomti (26° 56' N 80° 43' E) in the Lucknow region, Pond situated in the Malihabad region (26° 55' N 80° 43' E) and from a pond situated in Kolkata (22° 34' N 88° 22' E). A total of 23 truss measurements were found to be highly significant ($p < 0.001$) in one way ANOVA. Principal component analysis (PCA) accounted for a total variance of 91.95% in which the first principal component (PC 1) extracted in PCA accounted 83.25% of total variance while second (PC 2) and third (PC 3) accounted 5.33% and 3.37% respectively. In discriminant function analysis (DFA), 100% of original grouped cases were correctly classified in their respective samples and two discriminant functions DF 1 and DF 2 explained 99.6% and 0.4% variations between groups for morphometric truss measurements. Scatter graph at 95% confidence interval in PCA and combined groups plots in DFA depicted three isolated populations. The 5 random primers out of 20 showing good reproducible bands amplified a total of 50 loci, out of which 44 (88%) and 6 (12%) were polymorphic and monomorphic respectively. Highest genetic polymorphism was found to be in the fish from Lucknow region, whereas it was 52% and 38% in the Malihabad and Kolkata populations respectively. Maximum genetic diversity (0.2031) was observed in Lucknow population. The UPGMA dendrogram based on the Nei's (1978) genetic distance indicated the segregations of three populations of *C. punctatus*. Maximum genetic identity was found between the Kolkata and Malihabad populations and maximum genetic distance was between the Lucknow and Malihabad populations of *C. punctatus*. Truss analysis and RAPD revealed significant morphometric heterogeneity and genetic variation respectively, and indicated the presence of three distinct phenotypic stocks.

(TXI-12) PHYLOGENETIC ANALYSIS OF *NOTOPTERUS NOTOPTERUS* (PALLAS) AND *CHITALA CHITALA* (HAMILTON-BUCHANAN) FROM HARIKE WETLAND USING MITOCHONDRIAL 12S RRNA GENE

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Identification and classification of animal species is a key pre-requisite for many biological studies. Species identification strictly on the basis of morphological characters alone is quite unreliable on account of the confusing and overlapping characters. Application of techniques based on molecular markers especially mitochondrial markers is the current trend in resolving phylogenetic and taxonomic issues. The status of the *N. notopterus* (Pallas) and *Chitala chitala* (Hamilton-Buchanan) belonging to family Notopteridae has been controversial on account very few morphological characters which have been used to differentiate these two fish species. In the present study, an attempt has been made to study the phylogenetic relationship of these two fish species from Harike wetland (A Ramsar site in Punjab) using mitochondrial 12S rRNA gene. The fish muscle samples were collected from Harike wetland in the month of November 2016. DNA was isolated using standard procedures and isolated DNA was checked for its quality and quantity by spectrophotometric analysis and Agarose Gel Electrophoresis respectively. They were then amplified using Forward primer (5'-CAA ACT GGG ATT AGA TAC CCC ACT AT-3) and Reverse primer (5'- GAG GGT GAC GGG CGG TGT GT-3). The samples were then sequenced from Chromas Biotech, Bangalore, and analysed using MEGA6 software. In phylogenetic analyses using 12S rRNA, the outgroup species were well separated from the other species. One of the two obtained clusters showed *species* of Genus *Chitala* while the other cluster showed *N. notopterus*. The two phylogenetic trees constructed on the basis of 12S rRNA showed the same topology. The present study thus reinforces the belief that these two fish species i.e. *Notopterus notopterus* and *Chitala chitala* have been rightfully separated by Jayaram (2010) to be belonging to different genera and not just to one genus *Notopterus* as earlier described the Talwar and Jhingran (1991).

Keywords: Notopteridae, molecular markers, 12S rRNA, phylogenetic relationship.

**(TXI-13) GENETIC DIVERSITY ANALYSIS OF *LABEO ROHITA* (HAMILTON, 1822)
COLLECTED FROM TWO ZONES OF RIVER GANGA USING MICROSATELLITE DNA
MARKERS**

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The present study was conducted to investigate the level of polymorphism and genetic diversity in natural population of *Labeo rohita* collected from selected zones of River Ganga using microsatellite DNA markers. 5 primers out of 10 produced amplicons and were selected for primary screening and further genetic analysis of the population. On the basis of the values of Average Nei's Genetic Diversity, observed and expected heterozygosity, fixation index, Shannon's information index obtained through microsatellite marker technique, the present study is indicative of the fact that the stock of *L. rohita* of Haridwar region of River Ganga is more genetically diverse and genetically differentiated as compared to the stock of Kanpur region as these sites are distantly located and having negligible chance of exchange of gene pool with each other which is responsible for weak sub-structuring of stocks. Genetic variation observed between the two riverine sites may also be caused due to high level of anthropogenic activities in Kanpur region thereby causing blockage of fish movement as well destruction of breeding grounds thus hampering the proper mating within the population and also reducing effective population size.

Keywords: *Labeo rohita*, river Ganga, microsatellite markers, genetic diversity.

**(TXI-14) GENETIC VARIABILITY AND SPATIAL POPULATION STRUCTURING IN
FRESHWATER FISHES**

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The morphometric, meristic, truss and molecular genetic studies suggested higher genetic diversity in freshwater fishes than marine and estuarine fishes because of presence of physical barriers. The genetic variability and spatial population structuring were reported by many workers in the sub populations of fish species confined to various geographically isolated places characterized by different environmental conditions in the country. These subgroups of fish are having different growth potentials and fecundity. The study of isolated breeding populations of fish for intraspecific divergence is consider to be important for the preservation and conservation of fish genetic resources in order of reaping their full benefit.

Genetic diversity is an intergral component of biodiversity and it is anticipated that the far reaching development in aquaculture for rising yields per hectare and per unit of time lie basically in stock improvement programme through genetic researches. The development of molecular genetic techniques have made possible to understand the genetic constituents of fish, and revolutionized our ability to understand genetic divergence at sub species level in fresh water fishes The Stock Identification Methods Working Group has been promoting standard protocols since 1992 that include both traditional and new molecular technologies for stock analysis studies.

Altogether 20 thousand fish species have been so far recorded from all over the world and, out of these, 22 hundred fish species are known to occur in different aquatic habitats of India. National Bureau of Fish Genetic Resources, Lucknow recently enlisted 79 species of threatened fishes of India under different categories of threatened status. Therefore, a detailed study of fish genetic resources of the country along with cataloguing of genotypes is considered to be very important.

(TXI-15) HAEMATOLOGICAL CHANGES IN *CYPRINUS CARPIO* IN RELATION TO SEX AND REPRODUCTIVE STATUS

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Aquaculture is being advocated as the possible solution to meet the ever increasing demand for easily digestible protein, it is necessary that the fish cultivated is disease free, healthy and thus more nutritious its meat should be devoid of harmful heavy metals and other pollutants which all make include into it via blood supply. In other words, the hematology of fish blood needs to be periodically monitored in aquacultural operations in order to ensure a quality fish supply to market or consumer. Fish blood is a fluid tissue comprising plasma, erythrocytes, leukocytes, thrombocytes and is contained within the cardiovascular system. It comprises 1.3 to 7% of the total body weight of fishes and is one of the most active components that contribute to fish metabolic processes by ensuring gas exchange within body and between the fish and the environment. Any dysfunction of blood can have serious effects on the physiological activities of fish. The primary role of blood in fish is oxygenation and nutrition of tissues, maintenance of acid-base balance and elimination of metabolic waste products from tissues. Thus the application of haematological techniques has been proved valuable for fishery biologists in assessing the health of fish.

Keywords: hematology, *Cyprinus carpio*, reproduction.

**(TXI-16) SEASONAL REPRODUCTIVE CYCLE IN *MACROBRACHIUM DAYANUM*
(HENDERSON) FOUND IN RIVER GOMATI, LUCKNOW (INDIA)**

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Reproductive activity in *M. dayanum* found in river Gomati (26°55'; 80°59'E), Lucknow (India) exhibited cyclic pattern but continuous breeding activity with two distinct spawning seasons- March-May being the major and June-August the minor peaks. Development and maturation of gonads is related to changes in hepatopancreas. The reproductive stages in male *M. dayanum* have been characterized into four stages- inactive (stage I), active (stage II), mature (stage III) and spent (stage IV). The male *M. dayanum* produces germ cells throughout the year but attains major peak during June-July and minor peak during February-March and four stages of spermatogenesis like spermatogonia, spermatocyte, spermatids and sperms have been characterized on the basis of size, nucleus and staining reactions. Two or more than two stages are visible at the same time in the seminiferous tubules. Based on the gonadal development, ovarian maturity has been delineated into five stages-immature (stage I), early maturing stage (stage II), late maturing (stage III), mature (stage IV) and spent (stage V). On the basis of size, nucleus and cytoplasmic inclusions, five stages of oocytes such as proliferative, meiotic, previtellogenic, vitellogenic (mature) and resorption or atretic oocyte phase. Mature ova were predominant in February-March and July-September. The hepatopancreas also depicted changes in relation to gonadal development which were more pronounced in females. An inverse relationship was noticed between hepatopancreatic cell size and gonadal maturity suggesting that the reserve food materials are getting mobilized to the gonads. The minimum value of mean fecundity (38.2±4.5) of female *M. dayanum* was recorded with mean body length (4.790±0.086 cm) and body weight (1.010±0.047 gm) in September and maximum value of mean fecundity (142.9±4.8) with mean body length (6.490±0.069) and weight (2.896±0.097 gm). The weight and length represented the linear relationship with the fecundity, relation between the weight and fecundity, found to be more significant.

Keywords: reproductive activity, testis, ovary, hepatopancreas, *Macrobrachium dayanum*

**(TXI-17) SUB-SPECIATION TENDENCIES, GENETIC DIVERSITY AND DIVERGENCE OF THE
SCHIZOTHORAX PROGASTUS (MCCLELLAND 1839) IN PARENT TRIBUTARIES
OF GANGA RIVER IN INDIAN HIMALAYA**

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In the Ganga river *Schizothorax progastus* is widely spread all along the course of the parent tributaries Bhagirathi and Alaknanda, each about 200 Km in length from respective source. Frequent exchanges can occur close to the confluence in lower stretch of these tributaries but seem less possible 100 to 140 Km upstream of the confluence, especially since the construction of Maneri dam (1984) on the Bhagirathi and Srinagar Dam (2014) on the Alaknanda. The present investigation determines sub-speciation tendency and compares molecular characteristics of *S. progastus*, in the Bhagirathi and Alaknanda. The sample size consisted of 34 specimens from the Bhagirathi and 37 specimens from the Alaknanda for morphometric analysis, while 3 samples from each river for molecular characterization. In both rivers most of the body parameters in relation to Total Length (TL) and Head Length (HL) were genetically controlled indicates lack of sub-speciation tendency. Mitochondrial DNA cytochrome oxidase I (COI) gene analysis revealed no significant genetic divergence between the samples of *S. progastus* from Bhagirathi and Alaknanda. The study shows no intra-specific sequence divergence in *S. progastus* within the Ganga river. This study also confirms the significance of COI gene in such studies and support the conclusions based on morphometric data.

Keywords: *S. progastus*, Ganga river, sub-speciation, COI, molecular characterization.

(TXI-18) MORPHOLOGICAL VARIATIONS AMONG INDIAN TROUT, *SCHIZOTHORAX RICHARDSONII* POPULATIONS OF RIVER KOSI, UTTARAKHAND, INDIA

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The Indian trout, *Schizothorax richardsonii* (Gray) is a commercially important coldwater fish widely distributed in some part of North and North-East Indian upland, but the stock structure of the species is not well known. Stock identification is an interdisciplinary field that involves the recognition of self sustaining components within natural populations. Morphometric data - several body measurement methods were extensively used to identify stock have been criticized because of inherent biases and weaknesses. Recently, a new system of morphometric measurement called truss network has been increasingly used for stock identification. The present investigations were carried out to identify the variations of natural populations of snow trout species of River Kosi of Uttarakhand from its originating point (Berchukot, 2340 m als) to the entering place in foothill (Ramnagar, 410 m asl) through sampling in different five selected stations in different elevations. Truss distances between 12 landmarks consist of 66 truss measurement of 274 fish specimens were calculated for stock analysis from five sampling sites. Multivariate analysis, Factor analysis, principal component analysis and discrimination analysis were performed to investigate distinction and patterns of morphological variations between the populations of five sampling stations. All the characters contributing almost equally to the factor PC I. The measurement associated with the head portion of the body were loaded highly on factor PC II whereas measurements of the caudal portion were of the body were loaded highly on PC III. The factor analysis of size corrected truss variables showed that the first three factors accounted for 99.142 percent of the total variance with Eigen values 114.838, 1.433 and 0.566 respectively, while the factors 4 to 7 contributes less than 0.5 percent variation to the total variance and rest of the factors individually contribute less than 0.1 percent with no significance. The bivariate plots as well as Elliptical plots of the factor 1 against factor 2 and factor 1 against factor 3 revealed the fully mixing of population.

Keywords: Indian trout, morphological variations, truss network, principal component

(TXI-19) SEMEN QUALITY DETERMINANT APPROACH FOR MAHSEER FISH SPS. (TOR PUTITORA) FROM CENTRAL HIMALAYA

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Semen has a unique composition containing spermatozoa and substances supporting the spermatozoa. The evaluation of seminal quality is essential in aquaculture for planning efficient artificial fertilization protocols in restoration programs involving supportive breeding together with other innovative conservation strategies as gamete cryopreservation. The evaluated semen quality parameters of Golden Mahseer, *Tor putitora* were: colour, volume, sperm density, spermatocrit value, sperm motility percentage and motility duration. Semen samples from ripe male brooders were collected during the period from April to July 2017 from the River Bhilangana and its impoundment (Tehri reservoir). The observations related to semen characteristics are based on 70 fish samples of *T. putitora* ranging from 220mm to 620mm in total fish length and weight ranging between 200g to 900 g. The colour of semen is milky white to creamy white. Semen volume varies from 0.2ml to 4.5ml in different individual brooders. The sperm density ranges from 1.28-2.23x10⁹ sperm/ml. The sperm motility duration ranges from 38-56 seconds and the spermatocrit value range from 51.40% to 71.92%. The present study is aimed to evaluate the semen quality of *Tor putitora* for estimating the reproductive potential of male brooders and find out the timing of optimal fertilization for seed production in the hatcheries.

**(AQN-01) STUDY ON ACID FERMENTED SQUID WASTE SILAGE AS A PARTIAL
ALTERNATIVE FOR FISH MEAL IN THE DIET OF GANGETIC KOI (*ANABAS
COBOJIUS*)**

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A feeding trial was conducted for 60 days in indoor circular cement cisterns to evaluate the utilization of acid fermented squid waste as feed ingredient in the diet of *Anabas cobojus* fingerlings. Three different test diets were prepared by replacing fish meal with either formic acid fermented squid waste @10 % (T₁), sulphuric acid fermented squid waste @10% (T₂), combination of formic acid fermented squid waste (5%) and sulphuric acid fermented squid waste (5%) (T₃), combination of formic acid fermented squid waste (10%) and sulphuric acid fermented squid waste (10%) (T₄). The basal diet without acid fermented squid waste served as the control (C). The crude protein level of the diets was maintained at around 30%. Each diet was tested in triplicate, being fed to fishes in a set of three tanks each. The study was conducted in cement cisterns of capacity 300 litre stocking was done with fingerlings of *Anabas cobojus* @ 10 no. / cistern. Completely randomized design was adopted for the study. Feeding was done @ 5% of body weight twice daily. The water quality parameters in the cisterns were monitored by sampling in 12 days span. Fish growth was also assessed by periodic sampling, the quantity of feed given being readjusted based on the increase in weight. On termination of the study all surviving fishes were collected and their length and weight recorded. Feed ingredients and formulated feeds were analyzed for proximate composition employing standard methods. The present experiment indicate best growth of *Anabas cobojus* in terms of average weight gain (12.54g), SGR (1.79), FCR (1.58) in diet T₁ containing 10% formic acid fermented squid waste than the other groups. Survival rate was good in all the treatments with mean survival value ranging from 83.33% to 100%.The results suggest the possibility of utilizing formic acid fermented squid waste at 10% level in the diets of *Anabas cobojus*.

Keywords: squid waste, acid fermentation, silage, fish meal, *Anabas cobojus*.

**(AQN-02) FIRST RECORD OF HATCHING AND REARING OF RAINBOW TROUT
(ONCORHYNCHUS MYKISS) EYED OVA IN A CLOSED RE-CIRCULATORY GLASS
TANK**

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This paper describes a practical application of an experimental device for Rainbow trout eggs and fry rearing in a closed water circulation system. One of the major problems some of the trout hatcheries often facing are the regular supply of clean and non contaminated water in sufficient quantity. Sometimes extended period of very low water temperature in hatcheries may prolong incubation period of eggs and inhibiting optimum growth of fry in a given time frame. To overcome such problems a simple incubation cum rearing device was designed in which requirement of water was minimized and by maintaining higher water temperature, embryonic development and fry growth were accelerated. The complete incubator and rearing device consists of a glass tank, PVC pipe under gravel filter which was covered with 3-4 inch thick gravel bed and powered by a power head water pump, a thermostat heater and indigenously designed hatching tray. The size of glass tank incubator was 90x45x60 cm that holds 150- 160 litre of water. A specially designed hatching tray having dimension of 60x30x20 cm were placed on the gravel bed. About 1500 eyed ova of Rainbow trout were placed over hatching tray in incubation chamber. Water temperature of incubation chamber was maintained at 18±2oC by immersion thermostat heater. Eyed ova were successfully incubated up to alevin stage with minimum mortality of (8-10%). In another experiment 250 numbers of alevins were reared for 60 days in same glass container up to fry stage up to 40-50 mm size with 80% survival rate. When results of total water quantity requirement were compared with traditional flow through incubating hatching tray systems, it was estimated that about 2,30,000 litres of water were required for incubating and rearing of per 1000 fry in 60 days period. Where as in closed re-circulatory device only 1000 litres of water required for incubating and rearing of per 1000 fry. Furthermore as the device was a closed system where rising of water temperature was possible so that incubation period of eyed ova was considerably reduced and accelerated growth of fry was achieved at very low cost. The device is portable, low cost, farmers friendly, simple in operation and has very less water requirement. This device has also been successfully used for chocolate mahseer (*Neolissochilus hexagonolepis*), *Barilius bendelisis* and *Labeo dyocheilus* eggs incubation and fry rearing.

Keywords: Rainbow trout, re-circulatory system, hatching trays, incubation

(AQN-03) FISH FARMING IN HIGH ALTITUDE POND - A SUCCESS STORY

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The success story of Mr. Vishal Manhas of a temperate village Nalthi (1700 m above msl), Bhaderwah of district Doda, J&K, is prepared and presented here so that more farmers from the similar locality can be aware and attracted towards fish farming as an economic venture. Mr. Manhas is an educated progressive farmer with six hectares of land, and was following the local cropping patterns. He came into contact with the state govt. fisheries dept. and started culturing trout in about 0.25 acre area of earthen pond with full financial support from the dept. during late 2004-05. Later on during 2008-09, because of non-availability of any financial support for trout seed and feed, he converted the trout pond into carp pond. Initially, he started rearing of Chinese carp in this pond and stocked about 1500 fingerlings of Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*) without any supplementary feeding. The fish production during this period was non-satisfactory. Further, he got knowledge and training from KVK-Doda (during 2015-16) about supplementary feeding by locally available feed ingredients even in earthen type ponds and started feeding maize flour dough @ of about 5% of fish body weight (approximated), twice (in equal installments) daily. Now the carps showed double growth rate and achieved 750 gm to one kg in a year. He earns about rupees one lakh in a year from the same small pond without much investment on fish feed. Further, it is also reported that as the pond is earthen with running water facility, the carps (both grass and common) are naturally breeding with sufficient survival rate, and hence in the subsequent years he never stocked the pond with fresh seed. Now, he is very excited and with our interventions, planning to extend his fish farm area and very interested to convert some more nearby unutilized land towards fisheries. He is also going to start focused carp seed production unit so that he can earn more income from fisheries venture.

Keywords: fish farming, success story, supplementary feeding, carp

**(AQN-04) SILKWORM PUPAE (*BOMBYX MORI* L.) AN ALTERNATIVE TO FISHMEAL IN
TROUT CULTURE TO DEVELOP COST EFFECTIVE FEED**

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Geographically the State of Jammu & Kashmir has warm, cold and cold arid zones. As far as Kashmir Division is concerned the climate is temperate type. The scope for development of coldwater aquaculture is enormous. About 20 Streams existing in various districts of the Kashmir Division are suitable for cold water fisheries development. Nearly 65% of the State falls in the cold zone and is therefore suitable for cold water fisheries development especially in the higher reaches which can be utilized for trout production in private sector and can grow as economic activity along with the employment generation in such backward areas. The basic impediment in this respect is the development of cost effective trout feed. The opportunity exists to create better fish feed formulations at lower costs while reducing the amount of fish meal incorporated into a formulation. In Jammu and Kashmir, silkworm rearing and production of cocoon is the year round activity. The state has about 27,000 farming families produce around 829 MT of cocoons worth Rs.5.50 crore. Majority of cocoon production comes from the spring crop - an autumn crop. Waste and by-products from sericulture are of good value. Silkworm larvae, pupae being rich sources of protein particularly in lysine and methionine can be used to replace costly fish meal in trout feed in order to bring down the cost of production.

(AQN-05) A STUDY ON THE EFFECT OF BEETROOT WASTE EXTRACT (BRWE) AS A NATURAL SOURCE OF CAROTENOID ON THE SKIN PIGMENTATION OF *PUNTIUS CONCHONIUS*

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The present study was conducted to evaluate the effect of beetroot waste extract (*Beta vulgaris*) on total carotenoid of rosy barb (*Puntius conchoni*). Sixty fishes of average body weight (5.5 ± 0.10 g) were randomly selected and distributed into four treatments in triplicate (10 fishes per tank). Four isonitrogenous ($32.37 \pm 0.48\%$ crude protein) diets were prepared with T1-0.5%, T2-1.0% and T3-1.5% of beetroot waste extract along with a control diet without supplementation of beetroot waste extract. Body carotenoid was significantly enhanced ($p < 0.01$) by the dietary supplements, increasing linearly with increase in beetroot waste extract concentration. Carotenoid concentration was recorded at T3- 10.88 ± 0.08 mg/g wet wt. tissue, T2- 9.81 ± 0.2208 mg/g wet wt. tissue and T1- 7.38 ± 0.15108 mg/g wet wt. tissue as against control C- 4.62 ± 0.0808 mg/g wet wt. tissue. Present results indicate that economical and naturally available carotenoid source such as beetroot waste extract can be incorporated into the diet of rosy barb (*Puntius conchoni*) to enhance pigmentation in order to improve the ornamental value of the fish which otherwise, have little commercial value.

Keywords: beetroot waste extract, *Puntius conchoni*, rosy barb, carotenoids

**(AQN-06) INCUBATION OF EGGS AND LARVAL REARING OF *LABEO DYOCHAILUS* AN
IMPORTANT COLD WATER MINOR CARP UNDER CLOSED RE-CIRCULATORY
SYSTEM**

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This paper presents and describes a practical application of an experimental device for egg incubation and larvae rearing of *Labeo dyocheilus* in a closed water re-circulatory system. The device was a simple glass tank of 90x45x60cm size that holds 120-150 litres of water. The glass tank was equipped with indigenously made PVC pipe under-gravel filter. Pipe filter was covered with 8-10 cm thick layer of 3-5 mm gravels. The filter was operated by a power head water pump. Sand gravel act as a substrate for biological filter that eliminates the toxic ammonia generated from decomposition of protein egg shells and metabolic activities of fry. A thermostat immersion heater was placed in incubation chamber to maintain desirable uniform water temperature. Power-head water pump was continuously operated for churning eggs and water filtration in incubator tank. For experiment purpose tank was loaded with 40,000 fertilized eggs of *Labeo dyocheilus* and incubated for 96 hours. Water temperature of 18-20°C was maintained. After 96 hours of incubation period 90% hatching rate was recorded. Furthermore total 1000 spawns were reared in same incubation tank up-to fry stage for 21 days at a temperature of 18-20°C. Initially the spawn were fed on poultry yolk suspension for 10 days and subsequently fed on crushed fish feed. During rearing period daily one fifth volume of tank water was siphoned by gravel vacuuming to eliminate detritus matter. Water quality parameters like ammonia, dissolved oxygen and nitrite were continuously monitored during experimental period and found at their optimum level. Results were compared with simultaneously running circular carp hatchery loaded with same batch of *Labeo dyocheilus* eggs where incubation period was prolonged up to 120 hours and 70-80 % hatching rate was achieved. In rearing nursery tanks after 21 days period spawn to fry survival rate was 60-70%. There was a significant difference in growth rate and uniformity in fry size. Furthermore in the present device, for production of 1000 spawn of *Labeo dyocheilus* it needed maximum 10 litres of water where as about 3000 litres of water consumed in circular carp hatchery model. Further the device can be refined for a small scale hatchery model as it need negligible quantity of water thus it has applications in both cold water as well as for carp hatcheries.

Keywords: *Labeo dyocheilus*, re-circulatory system, egg incubation, larval rearing, hatchery model.

**(AQN-07) AQUACULTURE AND ITS SUSTAINABLE MANAGEMENT TO OVERCOME THE
FOOD CRISIS IN INDIA**

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Aquaculture also known as aqua-farming, is the farming of fish, crustaceans, molluscs, aquatic plants, algae, and other aquatic organisms. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions and can be contrasted with commercial fishing, which is the harvesting of wild fish. As the global population exceeds in recent years, aquaculture is destined to play a more important role in providing animal protein in terms of aquaculture potential and high feed conversion rates. Aquatic products are well-known for their high contents of high-quality protein and other nutrients that are good for humans. As such, the consumption of aquatic products keeps on increasing and their importance as dietary protein source is now receiving more attention. Aquaculture will surely play an important role in the overall increase in aquatic production. But there are certain limiting factors of aquaculture development. To overcome, those limiting factors attempts should be made to develop technical and non technical strategies for sustainable aquaculture development which includes careful introduction of exotic species, development of formulated feeds, importance of aquaculture engineering, strengthening of studies on fish diseases and related vaccines, fish waste management programme for a more environment friendly aquaculture, the concept on food safety and quality over quantity. It is really hoped that the efficient development of aquaculture will also bring a wealth of welfare in terms of providing sufficient food and promoting improved human nutrition, especially at this time when food crisis is felt as one of the major problem in India.

Keywords: aquaculture, food crisis, welfare

**(AQN-08) IMMUNOMODULATORY RESPONSES AND EXPRESSION OF IMMUNE GENES
(IFN- γ and TNF- α) IN *LABEO ROHITA* FED WITH *HOULTTUYNIA CORDATA* LEAF**

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A 60-day feeding trial was conducted to assess the effect of dietary *Houttuynia cordata* leaf on immunological responses and expression of immune related genes (IFN- γ and TNF- α) in *Labeo rohita* (rohu) fingerlings. Two hundred and seventy rohu fingerlings with an average weight of 3.37 ± 0.23 g were randomly distributed in six experimental groups in triplicates. Six isonitrogenous (35 CP %) and isocaloric (around 400 kcal/100g DE) experimental diets were prepared with supplementing graded levels of meal or ethanolic extract of *Houttuynia cordata* leaf, comprising control (without leaf extract and meal), LE-0.25 (0.25% leaf extract), LE-0.5 (0.5% leaf extract), LE-1.0 (1% leaf extract), LM-1.0 (1% leaf meal) and LM-2.0 (2% leaf meal). At the end of feeding trial LDH, MDH, SOD, catalase, blood glucose, respiratory burst activity, lysozyme, blood parameter and immune related gene expression were studied. Hepatic LDH, MDH, SOD and catalase activities were significantly lower in treatment groups compared to the control, whereas, blood glucose level showed a decreasing trend with the increasing level of dietary *H. cordata* leaf extract or meal. Respiratory burst activity and lysozyme activity were significantly ($P < 0.05$) higher in LE-1.0 and LM-1.0 groups compared to the control group. Haemoglobin, total leukocyte count (TLC), total erythrocyte count (TEC) and haematocrit value were significantly higher in leaf extract 1% fed group. However, evaluation of immune related gene expression demonstrated that the expression of interferon-gamma (IFN- γ) and tumor necrosis factor-alpha (TNF- α) of both kidney and liver were significantly up regulated with the increasing level of dietary leaf extract or meal and highest fold change expression was observed in the LE-1.0. The results of the present study suggested that the dietary inclusion of *H. cordata* leaf in the form of ethanolic extract at 1% level ensure better immunity in *L. rohita*.

(AQN-09) EFFECT OF DIETARY UTILIZATION OF GARLIC, ALLIUM SATIVUM ON GROWTH IN FINGERLINGS OF AMUR CARP, *CYPRINUS CARPIO* VAR. *HAEMATOPTERUS*

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The present study was carried out to evaluate the growth promoting, antimicrobial, immunomodulatory potential of garlic powder in fingerlings of Amur carp, *Cyprinus carpio haematopterus*. From the result of qualitative analysis of phytochemicals it was recorded that saponin, alkaloids, tannin, steroids, flavonoids, lipids, ketones, phlobutanin, glycosides and reducing sugar were present in garlic powder extracted in both water and ethanol. The dried garlic powder was incorporated at three concentrations (0.5%, 1.0% and 1.5%) in feed for conducting the experiment. The experimental diet was fed to fish over the period of 245 days followed by challenge with *Aeromonas hydrophila*. In the current study, higher growth parameters like SGR (0.180%), FCR (1.54), GCE (0.647), WG (195.18g), NWG (32.40g) and PER (1.160) were achieved in T₄ as compared to control and other treatments. The water quality parameters like pH, dissolved oxygen, temperature, free carbon dioxide and total alkalinity were within the tolerance range of the experimental fish, Amur carp. It is inferred from the results of the study that dried garlic powder can be safely incorporated up to 1.5 % in carp feeds for enhanced immunity against aeromonad pathogens.

Keywords: Garlic powder, feed ingredients and Amur carp

(AQN-10) HIGH DIETARY CARBOHYDRATE LEVELS IN *LABEO ROHITA*: EFFECTS ON GROWTH PERFORMANCE, NON-SPECIFIC IMMUNITY AND ANTIOXIDANT CAPACITIES

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Forty five days feeding trial was conducted to understand the effect of feeding graded level of gelatinized starch (GS) on growth, immunity and stress parameters of *Labeo rohita*. Fish were fed with four semi-purified diets containing 30% crude protein with graded level of gelatinized starch 30% (T₁), 35% (T₂), 40% (T₃) and 45% (T₄). The results indicated higher weight gain % (WG), specific growth rate (SGR) and protein efficiency ratio (PER) in 45 % GS fed group (T₄) with significantly (p< 0.05) lowest feed conversion ratio (FCR). The blood NBT and serum complement 3 (C3), serum protein, albumin and globulin were increased with the increase in carbohydrate level in the diet. The SOD, catalase, alanine transaminase (ALT) and aspartate transaminase (AST) in liver increased significantly (p>0.05) with the increasing level of GS in the diet. Furthermore, highest percentage of survival was found in T₄ group after challenging with *Aeromonas hydrophila* followed by T₃ group. The results obtained in the present study suggested that *Labeo rohita* fingerlings may utilize the high digestible carbohydrate upto 45% that will help to improve the growth without having any adverse effect on their immune system.

(AQN-11) GROWTH PERFORMANCE OF *LITOPENAEUS VANNAMEI* (BOONE, 1931) FED WITH GRADED LEVELS OF POTASSIUM AND MAGNESIUM THROUGH FEED IN INLAND SALINE WATER

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Potassium and magnesium deficient inland ground saline waters (IGSW) are suitably manipulating with commercial fertilizers (Muriate of potash and Magnesium chloride) for culture of *Litopenaeus vannamei*. The present study was made to explore the use desired mineral supplements through feed rather than in water. A 60 days experiment was conducted to investigate the effect of different dietary levels of K⁺ Mg²⁺ on *L. vannamei* juveniles in two types of waters namely raw IGSW and 100% K⁺ Mg²⁺ fortified IGSW (FW) at par with sea water at constant salinity of 10 ppt at ICAR- Central Institute of Fisheries Education, Rohtak Centre, Haryana. Three diets were formulated using commercial shrimp feed with varied K⁺ and Mg²⁺ levels (K⁺ = 5 g/kg, Mg²⁺ = 150 mg/kg, K⁺ = 10 g/kg, Mg²⁺ = 300 mg/kg, K⁺ = 15g/kg, Mg²⁺ = 450 mg/kg) and the same commercial feed as control diet. The mean weight gain, SGR, FER, PER, PWG and survival were recorded, and the highest growth obtained in shrimps fed with K⁺ = 10 g/kg, Mg²⁺ = 300 mg/kg fortified feed in FW. There were no significant difference in osmoregulatory capacity among different treatment groups. Though fortification IGSW with K⁺ Mg²⁺ is common practice, fortification of feed with these two ions played key role in enhancing the growth of shrimp which in turn enhance the overall production.

(AQN-12) PHYSIO-METABOLIC RESPONSES OF *LABEO ROHITA* FED WITH DIFFERENT INCLUSION LEVELS OF DEOILED RICE BRAN

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One feeding trial of 60 days was conducted with different inclusion levels of deoiled rice bran (DORB) to observe the physio-metabolic changes and oxidative stress in *Labeo rohita* fingerlings. Six isonitrogenous (30%), isolipidic (6%) and isoenergetic semi purified diets were prepared with the following inclusion levels of DORB viz. 0(control), T20 (20%), T30 (30%), T40 (40%), T50 (50%) and T60 (60%). Three hundred and fifteen fingerlings with an average weight of 8 ± 0.5 g were randomly distributed in seven treatments in triplicates following a completely randomised design. At the end of experiment results showed that the net weight gain and metabolic growth rate were significantly higher in 30, 40, 50 and 60% DORB inclusion level. Protease and amylase activity was higher in 20, 30 & 40% DORB fed groups whereas, catalase activity was significantly lower in the same group. The T50 and T60 groups showed significantly higher hepatic LDH, GST and catalase activity while RBC and WBC levels were significantly lower in these groups. Serum glucose were higher in T40, T50 and T60 groups while serum total protein, albumin, NBT and haemoglobin levels were not significantly differed among the treatments. From the study it can be concluded that though the weight gain was not significantly varied among the groups, on higher inclusion (50 & 60%) of DORB caused to *L. rohita*.

Keywords: deoiled rice bran, digestive enzyme, oxidative stress, metabolic enzyme, *Labeo rohita*

**(AQN-13) COMPARATIVE STUDY ON MAJOR COMPONENTS OF FARMED AND WILD
OSTEOBRAMA BELANGERI OF MANIPUR IN TWO DIFFERENT SEASONS**

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The present study was to determine the major components of wild and farm fish viz. *Osteobrama belangeri* of two different seasons of Manipur. Significant higher moisture (76.39 %) content was found in wild *O. belangeri* of summer season however, lowest moisture content (74.43 %) was found in wild farmed fish. Higher lipid (9.25 %) and protein (22.32 %) content were observed in farmed *O. belangeri* of winter season. Ash content (4.96 %) was found highest farmed *O. belangeri* of summer. The variation in the protein content among the wild and the farmed fishes might be due to differences in their food habit. The results indicated that both wild and farmed *O. belangeri* shows significantly higher amount of protein and lipid which play an important role in maintenance of various body processes. Thus consumption and conservation of these fishes should be encouraged.

Keywords: wild and farmed fishes, maintenance, food habits and conservation.

(AQN-14) IMPACT OF ARTIFICIAL ENHANCEMENT OF TEMPERATURE ON EMBRYONIC DEVELOPMENT, HATCHING OF COMMON CARP (*CYPRINUS CARPIO*, LINN) IN ASSAM

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Effect of environmental temperature on breeding process of cultivable fish species has been well documented. Common carp (*Cyprinus carpio*, Linn) is recognized as one of the most widely established cultivable fish species throughout the globe due to its adaptability to different agro-climatic situations. The natural breeding season for this species is commenced during December- February in Assam. However during this season, the atmospheric temperature in the state (10°C-18°C) is not suitable for embryonic development, hatching and seed raising of common carp. As such attempts have been made to study the impact of artificially enhanced temperature on the embryonic development, hatching and subsequent growth and development of this species. The experiment was conducted at Fisheries Research Centre, Assam Agricultural University, Jorhat, Assam during 2016-17. Fertilized eggs of *Cyprinus carpio* were kept for hatching in a concrete pond, where a water temperature of 24°C-28°C was maintained artificially by erecting an UV stabilized LDPE film cover over the pond and by recycling the pond water through a heating system. A control set was maintained in an earthen pond under normal water temperature (15°C-17°C). It has been observed that under the artificially enhanced temperature, the embryonic development was faster and hatching took place after an incubation period of 37±0.7 hour whereas in control, the incubation period was 125±10 hour. The rate of hatching was 35-40% higher under the experimental condition of enhanced temperature. This indicates technical viability of the system for seed production of common carp in the state.

Keywords: environmental temperature, *Cyprinus carpio*, incubation period, UV stabilized LDPE film, technical viability.

(AQN-15) MORPHOLOGICAL SIGNS AND SYMPTOMS OF PROTEIN, FAT AND VITAMINS A, B, C & E DEFICIENCY IN *CLARIAS BATRACHUS*

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Fishes are one of the most important heterogeneous groups of vertebrate and are rich source of nutritive and medicinal food for human beings, which provides essential amino acids, unsaturated fatty acids and vitamins that are essential for the health of human beings. Therefore, nutritional fish pathology, being concerned with the study of those health disorders/ailments which results from nutrient deficiencies or dietary imbalances, accounts for immediate attention in aquaculture practices. Lipids, proteins and vitamins comprise the beneficial nutrients required for growth, structural and metabolic functions of fish. Moreover, many of these nutrients are not synthesized by the organism and required in the diet, called as “essential” or “indispensible” such as unsaturated fatty acids, essential amino acids and vitamins. Hence, deficiency of any one of these indispensable nutrients can limit their synthesis, causing reduced body weight and other specific symptoms. The present work aims for the study of specific morphological symptoms resulting from deficiency of particular nutrient in *Clarias batrachus* and making the fish recover by providing deficient nutrient in the diet. Six batches of 5 specimens of the fish were fed with all the nutrients as per the contents of commercial fish feed except a particular nutrient for which the fish was made deficient viz. protein, fat, vitamins A, B, C & E. A parallel control batch of 5 specimens of fish were kept under identical laboratory conditions and were fed with commercial fish feed and egg. Reduced body weight and skin lesions were remarkably observed in protein and fat-deficient fish. Vitamin “A” deficiency resulted in prominent exophthalmia while eroded barbules and loss of appetite were observed in vitamin “B” deficient fish. The vitamin “C” deficiency causes scoliosis (broken back disease), whereas skin haemorrhage were seen in vitamin “E” deficiency. The fish recovered to an appreciable extent when fed with the deficient nutrients.

Keywords: nutritional fish pathology, nutrient deficiency

(AQN-16) EFFECT OF RESTRICTED FEEDING ON GROWTH PERFORMANCES OF PANGASIANODON HYPOPHthalmus (SAUVAGE, 1878) AND ECONOMIC VIABILITY OF THE CULTURE

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The present experiment was carried out for a period of 90 days (January to March 2017) to evaluate the effect of food restriction on growth performance of *Pangasianodon hypophthalmus*. The experiment was divided into three treatments i.e. T₁ (2nd day starved), T₂ (3rd day starved) & T₃ (4th day starved) with control C (daily feeding) in triplicates. Fish *Pangasianodon hypophthalmus* were stocked @ 10/cistern. Specific Growth Rate (weight) of fish in Control (C) was 0.883% per day, insignificantly (P > 0.05) higher than T₃ (0.868 % per day), T₁ (0.614 % per day) & T₂ (0.767%/day) respectively. Feed Conversion Ratio (FCR) and feed conversion efficiency (FCE) values were also varied insignificantly (P>0.05). Highest value of FCR (3.950521) was recorded in Control (C) and lowest value (2.974114) was observed in T₃. Highest value of FCE (33.62346) recorded in T₃ and lowest FCE value (25.31312) was recorded in Control. Experiment T₃ provided high profit due to three days consecutive feeding with one day starvation. For a period of 90 days of culture, feed of 21 days was saved having similar growth rate of control (C). The physico-chemical parameters of water such as temperature, pH, dissolved oxygen, free CO₂, total alkalinity, ammonia-nitrogen (NH₃-N) and phosphate-phosphorous (PO₄-P) were in the range of normal fish culture except total hardness which was above the ideal range. Feeding strategy (3 day feeding and 1 day starvation) in T₃ gave maximum economic benefit than normal and other feeding strategy.

Keywords: *Pangasianodon hypophthalmus*, specific growth rate, feed conversion ratio, feed conversion efficiency.

**(AQN-17) REPRODUCTIVE CYCLICITY AND SEED PRODUCTION OF *CLARIAS BATRACHUS*
(MAGUR) UNDER TARAI CONDITIONS OF UTTARAKHAND**

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The present study was conducted to assess the gonadal development and maturity of *Clarias batrachus* under prevailing differential temperature regimen in indoor and outdoor tanks under tarai conditions of Uttaranchal. An effort has also been made to standardize and assess the success of induced breeding and growth performance of larvae of this fish produced at different times in the breeding season. The experiment was conducted during February to October, 2003. During February to May one group of both sexes of *C. batrachus* was kept in indoor tank and other in outdoor tank. Both groups were kept under similar environmental (except temperature) and feeding regimen. The ranged 12 – 25°C in indoor tanks and 11 – 32°C in outdoor tanks recorded during February to April. In May indoor group of fish was also transferred to another outdoor tank. The water temperature ranged between 23.0 – 30.8°C, without much variation in averages, during May to August in outdoor tanks. Significant differences in GSI, lipid concentration in liver, total lipid content (mg/ovary) and lipid concentration (mg/gm) in ovary, water percentage in ovary and muscle, protein and gross energy levels of muscle and histological observations of ovary and liver in the females of both the groups in May, July and August indicated that gonadal development and maturity in indoor group females was delayed due to prevailing low temperature in indoor tanks upto May and which got accelerated after transfer to outdoor tanks having comparatively high temperature. In males though changes in biological indices and biochemical parameters were not of sufficient magnitude for delineating differential responses but histological observations of testis did reveal similar response of delayed maturation in indoor group. This suggests that above strategy has the potential of obtaining appropriate level of maturity in broodstock of *C. batrachus* for longer period during breeding season. The observations on breeding trials suggested that appropriate ovaprim dose level is 2.0 ml/kg body weight and latency period in 24 hrs in this fish under tarai conditions of Uttaranchal and better breeding performance can be achieved by induced breeding at appropriate time of the breeding season depending upon the level of maturity of broodstock of *C. batrachus*. Latency period and hormonal dose requirement and success level depended mainly on the level of gonadal maturity of its broodstock. It was also observed that though survival rates were not significantly different in all three groups but overall performances that of June were better. The growth performance of larvae produced earlier (*i.e.* June) was better than the performance of larvae produced in July mainly due to falling environmental temperature.

**(AQN-18) RESPONSES OF WATER HARDNESS ON GONADAL DEVELOPMENT OF OSCAR,
ASTRONOTUS OCELLATUS (CUVIER, 1829)**

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Oscar (*Astronotus ocellatus* Cuvier, 1829), a high value ornamental cichlid, is a native of South America. Just as all other fishes, its maturation is influenced by several environmental factors, of which water hardness is an important abiotic parameter. A 90 days experiment was conducted to assess the responses of water hardness (30 ppm, 90 ppm, 130 ppm and 180 ppm respectively), compared with 60 ppm, (control), on its gonadal development. After 90 days of experimentation, highest maturation was achieved at a hardness of 90 ppm, even though growth was highest at both 30 and 90 ppm respectively. Gonadal histology and steroid profiles also indicated and confirmed the same result, even though gonads were underdeveloped and not discernable at 30 and 180 ppm hardness respectively. Detailed analysis of gonadal steroids revealed a marked elevation of serum steroid levels, estradiol (860.56 pg/ml) testosterone (177.03pg/ml) and progesterone (431.27pg/ml) after 75 days at 90 ppm hardness, followed by further elevation in their titres after 90 days, when the concentration of estradiol (831.95 pg/ml) testosterone (192.76 pg/ml) and progesterone (245.19 pg/ml) indicated further progression of maturation at a hardness of 90 ppm, as compared to other treatments. Histological examination revealed that oocytes in late cortical alveolar stages/yolk vesicle or vitellogenic stages (primary and secondary yolk stages) were more numerous after 75 days at 90ppm, followed by dominance of late secondary yolk and tertiary yolk stages or ripe oocytes at 90 days at the same hardness level. Testicular histology also indicated better maturation at 90 ppm in the testes. The present study therefore, provides an insight into the fact, that among the four treatments, Oscar adapts to and matures better in water of hardness 90 ppm but is also able to mature in water of hardness 130ppm, even though maturation is slower than the former. This study can form an important advisory for ornamental fish farmers, wherein, they can breed this fish in areas where water of ambient hardness is unavailable up to the hardness levels suggested.

(AQN-19) IMPROVED METHOD OF PADDY CUM FISH FARMING FOR ASSESSMENT OF THE YIELD AND B:C RATIO AT HIGHER ALTITUDE REGION IN APATANI PLATEAU, ZIRO, ARUNACHAL PRADESH

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The experiment has been carried out in the farmer's field at seven different locations of Apatani plateau Ziro, Lower Subansiri District, Arunachal Pradesh, integrating the local variety of paddy with common carp. Paddy plants were transplanted from nursery plots and fingerlings of common carp (*Cyprinus carpio*) were stocked at the rate of 5000 per ha after a fortnight of transplanting paddy plants. Trenches of about 50 cm depth were constructed in the paddy fields in such a way that they divide the paddy field vertically or horizontally for suitable management of water. These trenches provide rearing place and shelter to fishes and also serve as shed for fishes especially during sunny days. The paddy fields generally have one inlet and two outlets. One of these outlets was used for the over flow of excess water and another was meant for draining of the water during harvest of fishes and paddy. The average fish and paddy production were 6.82 Qt/ha and 42.68 Qt/ha respectively with an average fish length of 16.4 cm and weight of 185 gm whereas in the control, the average fish and paddy production were 4.63 Qt/ha and 30.54 Qt/ha respectively. The B:C ratio of the experiment was 2.15:1 while in the control it was 1.63:1.

Keywords: integrated fish farming, paddy, common carp, Ziro, Arunachal Pradesh

(AQN-20) IMPACT OF LASTING CLIMATIC VARIATIONS ON EARLY MATURATION OF RAINBOW TROUT

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Shifting and intermingling of climatic pattern over the period of time has altered geographical as well as limno-biological parameters. In recent past, increase of several uncommon phenomena particularly in coldwater fish farms has been reported. With an objective of documenting relation between rainbow trout breeding behavior with rearing climatic variations, present observations were made for a period of 5 year from 2012-2016 at Champawat ICAR-DCFR Field Centre in Uttarakhand state. Year wise stripping/maturation time, fecundity, total breeding days, incubation period, total eyed ova and larval survival including physicochemical parameters of brood fish raceways and hatchery were recorded. The yearly rearing water temperature range indicated no gradual increase or decrease in a particular fixed pattern and random fluctuations were observed overlapping the seasonal thermal boundaries which is evident in values of measured water quality parameters. The trend also showed higher raceways temperature above 21.0 °C in summer and rainy season while extreme low temperature below 5°C lasted only for a shorter duration in winter. Wide variations in breeding/ stripping days from 22 to 52 days has been recorded at Champawat farm showing the spread of breeding period with commencement of early brooder maturity. Similarly males also showed mature testis with GSI of 3.49-5.92, about one and half month before female maturity. The five year data reveals that early maturation of total 58 days till 2015-16 has been recorded compared to 2012, signifying pre-shifting of breeding/ stripping of rainbow trout from January last week to December, 1st week. Extended warmer conditions in rainbow trout raceways along with other rearing factors might be inducing such variations. The observations assume significance as trout seed stocking period and growth of farmed trout might get affected by such distinct pattern. Further, physiological and biochemical indices in this line would elucidate the above findings.

(AQN-21) A STUDY ON GROWTH PERFORMANCE AND SURVIVABILITY OF *OMPOK PABDA* (HAMILTON, 1822) FINGERLINGS IN EARTHEN POND FED WITH DIFFERENT FEED INGREDIENTS

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An experiment of one and half month was conducted to perceive the growth performance and survivability of *Ompok pabda* (Hamilton, 1822) fingerlings in earthen pond fed with different feed ingredients. These are four distinct types of feed ingredients with different percent of protein content in rice bran (RB) 14, mustard oil cake (MOC) 30, Floating feed (FF) 32% and fish meal (FM) 45% respectively. These all feed stuffs are formulated as EF-I (RB+MOC), EF-II (RB+FF) and EF-III (RB+FM) Three experimental ponds uniform sizes of rectangular earthen ponds (20 × 10 × 1.5) meters with triplicate replication was conducted. *Ompok pabda* experiment was started with few old days' fingerling having an average weight and length of (1.609 gm) and (6.85cm) respectively. 70 fishes are initially stocked. The highest gain in Weight P3C (9.20gm), P1C (6.70gm) & P2C (5.40gm), Length P1C (9.8cm), (P3C 8.8cm) & (P2 8.6cm), Average Daily Weight Gain P3C(0.175), P1C (0.692) & P2C (0.062), Specific Growth Rate P3C (2.102), P1C (1.731) & P21 (1.114), and Survivability of fishes P1C (97%), P3B (82%) & P3A (97%) And lowest Food Conversion Rate after experiment was P3B (0.488), P1C (0.692) & P2C (1.378) respectively. Beside this, the water quality parameters showed most of the fluctuations in phosphate level in water as compare to Ph, Ammonia, Temperature, Dissolve oxygen and others. The result implies that fish has better growth performance and survivability with EF-III firstly and secondly in EF-I as compare to EF-II respectively.

Keywords: *Ompok pabda*, experimental feed (EF), P1, P2 and P3=Pond numbers with section codes like A, B and C, survivability.

(AQN-22) A STUDY ON ACCEPTABILITY OF DIFFERENT FEED INGREDIENTS IN EARTHEN POND VIA *TOR TOR* (HAMILTON, 1822) FINGERLINGS

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An experiment of 45 days was conducted to perceive the acceptability of different feed ingredients *via Tor tor* (Hamilton, 1822) fingerlings in earthen pond. The protein content of the ingredients rice bran, MOC, floating feed and fish meal is recorded as 14%, 30%, 32%, and 45% respectively. These all feed stuffs are formulated as EFI (RB+MOC), EFII (RB+FF) and EFIII (RB+FM). Three experimental ponds uniform sizes of rectangular earthen ponds (20 × 10 × 1.5) meters with triplicate replication was conducted. *Tor tor* fingerlings were collected from Narmada River at Dongarwara ghat in the Hoshangabad. *Tor tor* experiment was started with few old days' fingerling having an average length P1 (EF1) 7.01, (EF2) 6.23, (EF3), P2 (EF1) 6.64, (EF2) 7.00, (EF3) 6.62 and P3 (EF1) 6.50, (EF2) 6.96, (EF3) 6.85cm respectively and average weight P1 (EF1) 3.93, (EF2) 3.55, (EF3) 4.06, P2 (EF1) 3.53, (EF2) 3.88, (EF3) 3.72 and P3 (EF1) 3.24, (EF2) 4.00, (EF3) 4.09gm of respectively. 70 fishes were initially stocked. During the experiment acceptability of feed was recorded lowest during initial 03 days. Average acceptability was recorded starting 3 day with EF1 (10-12.5%), EF2 (14-15%) and EF3 (17-20%). Acceptability increased during the last 15 days it was highest with maximum acceptability of EF3 (96-97 %). The acceptability of fish meal was found to be highest as compare to others.

Keywords: *Tor tor*, experimental feed (EF), P (Pond) numbers with section codes with A, B and C, survivability.

**(AQN-23) BIOFLOC TECHNOLOGY: A WAY FORWARD TOWARDS SUSTAINABLE
COLDWATER AQUACULTURE**

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Stagnant stage of marine capture fish production has demanded the shift towards the aquaculture production. The aquaculture industry is growing fast at a rate of 9% per year since the 1970s (FAO). However, this sector generates pollutants and needs the sustainable approach due to environmental concern. The critical element which deteriorates the water quality in aquaculture practice is the fish feed. The biofloc technology (BFT), in which nutrients are continuously recycled and reused without water exchange is the possible intervention. This technology intensively grows the heterotrophic bacteria by maintaining the C/N ratio, where in the microbes consume organic carbon and immobilize inorganic nitrogen. The amount of nitrogen removed from the system depends on the balanced addition of carbon. The addition of different types of organic carbon results in the production of microbial protein that can be used as fish food. The critical control factors that define the nutritional value and morphological characteristics of bioflocs includes, mixing intensity, dissolved oxygen concentration, organic carbon source, organic loading rate and temperature. The microbes behave differently on varied range of temperatures. With more deflocculation of flocs in cold water (4 °C) and bulking of sludge at higher water temperature (30-35 °C), the intermediate water temperature (20- 25 °C) flocs are stable. The maintenance of the water temperature in BFT systems imposes considerable additional operating costs, especially in outdoor ponds. Thus, in coldwater fisheries the opportunity lies in conducting the operation in indoor ponds. If not contributing to growth BFT may have other positive effects. The BFT reduces the disease causing microbes as it uses the available carbohydrates which makes it hard for opportunistic pathogens to survive. BFT is a step towards sustainable aquaculture production with benefits of reducing water use, effluent discharges, artificial feed supply and improved biosecurity.

Keywords: biofloc technology (BFT), nutrient recycling, heterotrophic bacteria, C/N ratio, sustainability.

(AQN-24) CHALLENGES IN CULTURE OF PANGUS (*PANGASIANODON HYPOPHthalmus*) IN CAGES OVERCOMING WINTER

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Pangus (*Pangasianodon hypophthalmus*), a native of Mekong river in Vietnam, now well established in South-East Asia which was introduced in India via Bangladesh in 1989 through Thailand. Culture of Pangus is profitable because of their high stocking density, year-round production barring severe winter months, quick growth, and high productivity. The fish provides ample protein supplement to rural poor mass in this sector of the world because of low market price coupled with significant demand. Accordingly, a large number of rural people living below the poverty line find employment in production as well as marketing systems for this species. India is no exception to that. The fish is a very good candidate species in cage farming installed in Indian reservoirs also and showed immense scope of horizontal expansion of its farming. ICAR-CIFRI has been instrumental in disseminating the technology of cage farming of Pangus across India since 2010 and engaged in providing technological support to 20 States with 7000 numbers of freshwater cages installed in reservoirs and some deeper wetlands. New areas are coming under Pangus culture in sub-tropical part, where technological packages are being modified accordingly, as the species though very hardy in nature, can't withstand cold being susceptible to multipronged attack by fungus, bacteria and viral diseases with the onset of winter. To overcome this untoward situation, the modifications in cage culture practices of table fish of the species involves i) stocking of advanced fries of 4-5 g size of previous year through overcoming winter ii) stocking should positively be made in between 15 March to 15 April, if ambient water temperature should be above 20°C iii) cage hapa depth should not be more than 2.0m initially with 1.5 m remains under water iv) stocking the fries with immune-stimulant and density should not be more than 125 nos./m³ v) mesh size of cage hapa shall be in the range 6-8 mm in first three months followed by vi) replacing smaller sized netlon hapa with larger (mesh 24mm & depth 4.0 m) multifilament knotless polypropylene hapa vii) stocking density for 150-200 g sized advanced fingerlings should not be >60 nos./m³ viii) feeding with higher protein/fat extruded feed 32-34CP/4-5Fat @8% BW, 1.0 - 1.2 mm grain size initially followed by low protein content with lesser feeding rate (6-3%BW) at larger grain size (3-4 mm) during grow out period ix) regular prophylaxis measure with due bath treatment (salt, KMnO₄, Blesson, CuSO₄·5H₂O, methylene blue, Malachite green, TH₄) including feed additives (OTC), besides maintaining cleanliness inside cage hapa through BMP and x) phase-wise harvesting should be made from end of October onwards positively. ICAR-CIFRI's endeavour in such study including development of package of practices would be of immense help in making the cage culture technology for this species acceptable and suitable in sub-tropical regions also.

Keywords: cage culture, reservoir, pangus, sub-tropical, protein-supplement.

(AQN-25) DIETARY TURN OVER AND CARCASS MAKE-UP OF *LABEO ROHITA* (HAMILTON) FINGERLINGS SUPPLEMENTED WITH PROVENDER FORTIFICATION OF ORGANIC CHROMIUM, CHROMIUM PICONILATE

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Feeding metabolism and carcass composition of *Labeo rohita* fingerlings were investigated with dietary supplementation of graded levels of organic chromium. Growth, feed efficiency, enzymatic activity and carcass output of the experimental animals were evaluated subsequent to a 60-days feeding trial. Four isonitrogenous (crude protein 35%) and isocaloric (415 k cal 100 g⁻¹) experimental feeds were prepared with the inclusion of different levels of dietary chromium picolinate viz., control (0.0 mg kg⁻¹), T1 (0.4 mg kg⁻¹), T2 (0.8 mg kg⁻¹) and T3 (1.2 mg kg⁻¹). One hundred and eighty advanced fingerlings of *L. rohita* (13.59 ± 0.02 g) were distributed in four distinct experimental groups with triplicates following a completely randomized design (CRD). Twelve rectangular plastic tubs of uniform size (300 l capacity) were used for the purpose where each tub contained fifteen fishes. Feeding was done to satiation twice a day and continuous aeration was provided along with 25% replacement of water at every 24 h interval. Weight gain WG (%), specific growth rate (SGR), feed efficiency ratio (FER), protein efficiency ratio (PER), protein retention (PR %) and apparent net protein utilization (ANPU %) were significantly improved (p<0.05) when chromium was supplemented at 0.8 mg kg⁻¹ feed. The liver glycogen was significantly increased (p<0.05) in T1 and T2 groups, however significant declining with higher chromium doses. Cr-Pic supplementation (0.8 mg kg⁻¹) also helps in raising protein: DNA ratio in muscle tissue, while DNA: RNA and DNA: tissue were significantly decreased indicating higher growth status. Similarly, significant increase in amylase, protease and lipase activities with lesser activity of glucose-6-phosphatase, when Cr-Pic supplemented at 0.8 mg kg⁻¹ diet (P < 0.05). Conclusively, higher growth index and carcass services were noticed by feeding the fingerlings with Cr-Pic (0.8 mg kg⁻¹) enriched diet in laboratory condition.

Keywords: digestive enzyme activity, carcass make-up, Chromium piconilate, *Labeo rohita*

**(AQN-26) CONTRIBUTION OF PROBIOTICS IN GROWTH AND IMMUNITY ENHANCEMENT
IN CARP *LABEO ROHITA***

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Sustainable aquaculture depends on perfect balance between growth and health conditions of fish. Several drugs, synthetic chemicals and vaccination programmes have been in practice to prevent and control the diseases, but partial success has been achieved. An alternative approach has been the application of various compounds to boost or stimulate the immune system of fishes and shrimps. One among such alternatives is probiotic. Probiotics generally includes bacteria, cyanobacteria, micro algae, fungi, etc. The present study was carried out to evaluate the effects of dietary supplementation of commercial probiotic Biosyn in the fingerlings of Indian major carp (*Labeo rohita*) on growth performances, haematological and biochemical parameters. The fishes with similar body weight (7.239 ± 0.232 g) were distributed randomly into four treatment groups T_0 , T_1 , T_2 and T_3 . Experimental diets were prepared by mixing rice bran, deoiled mustard oil cake, soybean cake and vitamin mineral mixture. The Biosyn was incorporated in to diet D_1 @0.2%, D_2 @0.4%, D_3 @0.6%. In control diet D_0 , Biosyn was not incorporated in feed. The fishes of group T_0 were fed with diet D_0 , T_1 with D_1 , T_2 with D_2 and T_3 with D_3 @5% body weight per day for 90 days. Fingerlings fed with diet D_3 achieved better specific growth rate (0.648%), feed conversion ratio (3.255) and gross conversion efficiency (0.299) as compared to other treatments. T_3 group of fishes showed higher value of TLC ($35.114 \times 10^3/\mu\text{l}$), TEC ($3.35 \times 10^6/\mu\text{l}$), Hb concentration (10.2 g%), total serum proteins (9.1g/dl), albumin(1.695 g/dl) and globulin (7.405 g/dl) as compared to control and other treatments. The obtained results indicated that T_3 was the best treatment which realized significant ($P < 0.05$) increase in all growth performance parameters, haematological and biochemical parameters. There was no adverse effect on water quality parameters among all the experimental treatments. It can be concluded from the obtained results that the inclusion of the commercial probiotic Biosyn @ 0.6% in diet of *Labeo rohita* is useful to get the best fish performance with friendly effects on the environment.

(AQN-27) EFFECT OF NUTRACEUTICAL ON FINGERLINGS OF INDIAN MAJOR CARP *LABEO ROHITA*

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Nutraceuticals using plants and animal extracts can be considered as a novel trend for control of fish diseases and hoping to achieve the same results as in the use of antibiotics and to overcome the problem of antibiotic resistance. The alternative herbal bio-medicinal products in the aquacultural operations, that have the characteristics of growth promoting ability and tonic to improve the immune system, act as appetite stimulators. The present study was carried to evaluate growth promoting and immune stimulatory potential of commercial nutraceutical Stimulin on the fingerlings of Indian major carps (*Labeo rohita*). Fifteen fingerlings with average weight of 7.203 ± 2.00 g were stocked into each of four treatment groups T1, T2, T3 and T4. Isonitrogenous experimental diets were prepared by mixing rice bran, deoiled mustard oil cake, deoiled soybean cake and vitamin mineral mixture. The nutraceutical Stimulin was incorporated into diet D2 @0.5%, D3@ 0.75%, D4 @1.00%. In control diet D1 Stimulin was not incorporated. T1 group fishes were fed with D1 diet, T2 with D2, T3 with D3 and T4 with D4@ 5% body weight per day for 90 days. The water quality parameters were regularly monitored. Fingerlings fed with diet D4 achieved significantly ($P < 0.05$) better specific growth rate (0.623%), feed conversion ratio (3.119) and gross conversion efficiency (0.294) as compared to other treatments. T4 group of fishes showed significantly ($P < 0.05$) higher value of total leukocyte count ($33.646 \times 10^3/\mu\text{l}$), total erythrocyte count ($3.26 \times 10^6/\mu\text{l}$), haemoglobin concentration (9.9 g %), total serum proteins (8.80 g/dl), albumin (1.445 g/dl) and globulin (7.358 g/dl) as compared to control and other treatments. The obtained results indicated that T4 was the best treatment which realized significant ($P < 0.05$) increase in growth performance, haematological and biochemical parameters. The results indicated that Stimulin has very good growth promoting and immune stimulatory potential in raising *Labeo rohita*. It can be incorporated in fish feed @1.0% without any deleterious effect on water quality and health of fish.

(AQN-28) SUCCESSFUL ARTIFICIAL BREEDING OF *LABEO GONIUS* IN CAPTIVITY UNDER COLD WATER CONDITION

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Labeo gonius (Hamilton, 1822) is a medium carp of cyprinidae family, commonly known as 'Kuria labeo' or Gonius, is one of the popular food fish and is widely distributed in Assam, West Bengal, Orissa, Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Punjab in the major freshwater rivers, reservoirs, jheels and tanks. The fish is ordinarily white and more elongated with a relatively small head found in hill region of Uttarakhand with a good consumer preference. Since the fish is herbivorous bottom feeder, it can be cultured as a bottom feeding substitute in mid altitudinal region under polyculture with exotic carps. Though, the artificial breeding of this species can be achieved at higher thermal regime i.e. at 24-30°C and also successful breeding in captivity under cold water condition at lower thermal regime of 18-20°C was obtained. Optimum dose of Synthetic hormone, Ovotide was found 0.7 ml/kg body weight for female and 0.3 ml/kg body weight for male with 92% fertilization rate. Three years old female of size 0.382 to 0.567 kg and male of 0.458-0.474 kg were found suitable for better breeding performance. 18-22°C water temperature was observed optimum for the egg incubation (48hrs) with higher hatching rate (82%) and better recovery of hatchlings. The average size of the egg was 3.3±0.6 mm, length of hatchling as 5-6mm was recorded. The spawning fecundity was observed as 203478 eggs/kg body weight. Thus, Successful captive breeding of this species enable us to produce seed for wild stock augmentation and species diversification in coldwater aquaculture.

Keywords: *Labeo gonius*, cold water condition, ovotide, breeding performance

(AQN-29) ZERO WATER EXCHANGE SYSTEM FOR SUCCESSFUL HATCHING AND LARVAL REARING OF MINOR CARP, *LABEO DYOCHAILUS*

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Labeo dyocheilus is an indigenous medium sized minor carp, bottom feeder fish, inhabiting upland streams and rivers at an elevation of 400-800m. DCFR, Bhimtal has developed breeding and seed production protocol of this species and used for field experimentation as climate resilient species for mid- altitudinal region (1000-1600m) of Himalaya. Generally, 10000 L water is required for the hatchery operation of 1 lakh fertilised eggs of carp in circulatory carp hatchery. Hence, huge quantity of water is required for breeding and seed production operation. A device was developed with glass aquaria having dimension of 90x45x60cm and water holding capacity of 120-150 litres equipped with bottom sand and gravel bed. Gravel bed was matured with nitrifying bacteria and continuous circulation of water was maintained by a power-head pump. 40000 fertilized eggs of *L. dyocheilus* were placed in the device and incubated for 72 hours. Water quality was monitored and recorded within permissible limit having >7mg/L dissolved oxygen and < 0.05 mg/L ammonia. 18-22°C water temperature was maintained during egg incubation. 80-92% hatching and 83-96% survival was achieved in comparison to 78-82% hatching rate and 60-78% survival in circular hatchery. It was calculated that 300 spawn can be produced by using 1 liter of water (330 L for 1 lakh spawn) with zero water exchange hatching device. The same device was used for rearing of spawn upto fry stage for 21 days and achieved uniform growth of the fry with 84-90% survival. Further, the system may be designed as small hatchery for seed production in coldwater conditions having low water requirement and better recovery of fry.

Keywords: Zero water exchange, minor carp, nitrifying bacteria, uniform growth.

(AQN-30) INCLUSION OF FRESH AZOLLA IN THE DIET OF CARP IN MID ALTITUDINAL REGION OF UTTARAKHAND

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An attempt has been made to include fresh azolla in the farm made feed of the exotic carp and minor carp. The experiment was conducted at 6 farms sites in Almora district of Uttarakhand state. Six polytanks having the size of 80-100m² were selected for the field experimentation with stocking density of 3-4 no. of stunt fish of size 40±8.6g. Three exotic carp i.e. Silver carp (30%), Grass carp (30%), Hungarian common carp (20%) and minor carp (20%) were selected for the experimentation. Farm made feed having protein level of 24% was formulated by using rice polish, mustard oil cake and paste of fresh azolla (30%) and tested in feeding trial of 6 months. Test diet was compared with supplementary feeding of rice polish and MOC. Better growth and survival was recorded with azolla based formulated diet with net weight gain of 184 ± 0.42 g and survival of 72% in 6 months. It was also observed that in the field trial 30% azolla is optimum in the diet of carp. Excess inclusion of azolla in the diet adversely affects the growth and survival. Farm made wet feed resulted to reduce the feeding cost upto 25%. *Azolla pinnata* and *Azolla microphylla* was grown in coldwater condition and analysed for proximate composition as moisture- 90-95%, crude protein- 22-24%, crude fat-6.0-6.2%, crude fibre-13-18%. Thus, Coldwater condition (5-22°C) is suitable for growth of *Azolla microphylla* with production of 5 times of its biomass in 7 days.

Keywords: polytank, fresh azolla, stunt fish, farm made feed.

(AQN-31) INTEGRATED RAINBOW TROUT AND CARDAMOM CULTIVATION: BETTER PRODUCTION AND MORE INCOME TO THE FARMERS IN SIKKIM

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Rainbow trout farming is an adoptable and profitable fish farming practice as livelihood option for the rural population dwelling in the higher altitudinal areas in hills. A flow-through system is required for trout farming with continuous flowing cool, clean and highly oxygenated water. A cement concrete raceway (RCC) is constructed with an area of 30-45m² (15m length, 2m or 3m width) and 1m depth towards inlet and 1.5m depth near the outlet. The annual rate of return in trout farming is nearly 57% of the total annual investment having net profit of Rs. 1,37,000/ 30m³ in 12 months. Integration of rainbow trout farming with cardamom cultivation is a practice for multiple use of water and better production of trout and cardamom in the higher altitudinal areas in hills. Trout raceway (RCC) is constructed with an area of 30m² and nutrient rich drain out water is used for irrigation of cardamom crop of 0.4 ha area. There is 30% increasing yield of cardamom in this integration. The net profit to the farmers in this integrated trout and cardamom cultivation is Rs. 2,14,000/ 0.4ha. Field study was conducted in West district of Sikkim state and disseminated to the farmers.

Keywords: integrated, rainbow trout, cardamom, raceway.

(AQN-32) POND AQUACULTURE WITH STUNT FISH: A WAY FOR DOUBLING THE FARMERS' INCOME

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The Fisheries in India is a sunrise sector in rural economy of the country. It has witnessed a spectacular 14 fold increase in fish production from 0.75 MT (1950-51) to 10.79 MT (2015-16) during the last six and half decades. At the current rate of around 6% overall growth of the sector and 8% in the aquaculture sector, it is expected that the country may achieve a production of 15 MT by the end of 2020 and 17.86 MT in 2022-23. Freshwater aquaculture with a share of 34 percent in inland fisheries in mid-1980s has increased to about 80 percent in recent years. Currently the average annual yield of pond fish culture is around 3.0 tons/ha. The production per unit water area is very low than the average productivity in many states, which needs a technical intervention to achieve the target of doubling the farmers' income. Field study was conducted in district Dewas adopting 10 farmers of the Dewas, Bagli and Sonkatch block. A common practice of composite fish farming with stocking of fingerlings (average wt. 4-5g) of IMC and exotic carp @ 5000 FLs per ha. was given to 5 farmers. A package of practice for 6 months with stocking of stunt fish (average wt. 60-80g), stocking density of 5000 fish/ha was given to another group of 5 farmers. The average production of group first was 3.1 tons/ha/yr, while another group has taken 2.8 tons in each crop of 6 months and 5.8 tons in two crops in a year. The input cost for the second group was 12% more over the input cost of the group first due to cost of stunt fish, transportation and intensive feeding. The ration of grass carp and Rohu was 10% more for the group II with the advantage of green foliage feeding and better market price of Rohu. The average net profit to the farmers of group I was Rs. 142000/ha/yr, while it is Rs. 228000/ha/yr in double crops with stunt fish. Availability of the stunt fish or seed bank is the prerequisite of this farm practice.

Keywords: stunt fish, IMC, exotic carp, grass carp, green foliage feeding.

(AQN-33) STRATEGIC INTERVENTIONS IN COLDWATER FISHERIES TO AUGMENT PRODUCTION FOR FIGHTING MALNUTRITION AND MICRONUTRIENT DEFICIENCIES

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Optimal nutrition for human health and development is well recognized and its ultimate goal is to achieve food and nutritional security. Fish in this context is a major contributor as it is an important source of quality animal proteins, omega (ω)-3 polyunsaturated fatty acids (PUFAs) especially the ω -3 PUFAs eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) and micronutrients (minerals and vitamins). Globally, the coldwater fishes like salmon, tuna, sardines and mackerel are high value food fishes and are integral part of human diet due to their high ω -3 PUFA content. In India, in the upland Himalayan region, species like golden mahseer (*Tor putitora*), chocolate mahseer (*Neolissochilus hexagonolepis*), rainbow trout (*Oncorhynchus mykiss*), snow trout (*Schizothorax richardsonii*) and common carp (*Cyprinus carpio*) are the commercially important food fishes. Nutritional composition analysis have showed that these coldwater fishes are rich in proteins (16-18%) (comparable or superior to the Indian Major Carps (IMCs) (15-16%)); essential amino acids lysine, tyrosine and tryptophan; PUFAs (18-32%), ω -3 PUFAs (8-21%) and microminerals selenium and calcium. Owing to their nutritional richness these fishes could play a significant role in fighting protein calorie malnutrition and micronutrient deficiencies. However, their contribution to the total fish production is much below their potential, currently. Optimal growth and production of any species depend upon the interaction among gene, environment and nutrition. Since the cold water fishes have excellent growth and production potential as seen in the western hemisphere, perhaps nutritional intervention through diet manipulation could be an important way to enhance their productivity. Moreover, introduction of high value cold water species like salmon could be attempted meaningfully against the introduction of exotic fishes already done (whether intentionally and/or accidentally) which are proving to be nuisance in Indian aquaculture and are replacing native fauna and disturbing the biodiversity.

Keywords: coldwater fishes, malnutrition, micronutrient deficiencies, strategic interventions.

**(AQN-34) IMPACT OF FRP MAGUR HATCHERY IN INDUCE BREEDING OF MAGUR (*CLARIAS
BATRACHUS*) IN THE NALBARI DISTRICT OF ASSAM**

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The success of culture of any species is largely depends on the availability of quality seed material. The developments of various hatcheries for induce breeding technique of fish species is boosting in fast growth of aquaculture. One of the hatcheries is FRP Magur hatchery which is specially designed by ICAR-CIFA, Bhubaneswar for magur breeding. A total of 8 magur hatcheries were provided to progressive and interested magur breeder of the Nalbari district of Assam by KVK Nalbari in collaboration with ICAR-CIFA on the basis of magur breeding experience of the farmers in the year 2014. After the three years of successive breeding seasons data related to breeding and seed rearing were collected and analyzed for impact study of these FRP magur hatcheries. It was found that by the use of this hatchery farmers could able to breed 8-10 kg of fish at a time which was 1-2 kg at a time without the FRP tank hatchery. This is possible because the FRP hatchery is equipped with water circulation system. It was also found that the survival rate of the one week old hatchling is 40% better in the FRP hatchery than the earlier practiced system of hatchling rearing in plastic buckets. The calculated BCR for the FRP hatchery is 3.4 compare to 2.8 in the earlier system. However, total turnover from breeding operation from each hatcheries were increased from Rs. 28,000 to Rs. 1.30 lakh at fry selling stage of the hatchery. Thus the FRP magur hatchery give direct advantages to the magur breeders of the district in terms of increased productivity, income as well as providing operational suitability in magur breeding and seed rearing.

Keywords: FRP magur hatchery, survival rate, productivity.

(AQN-35) EFFECT OF AMLA (*EMBLICA OFFICINALIS*) ON THE HEMATOLOGY AND SERUM BIOCHEMICAL PARAMETERS OF ROHU FINGERLINGS IN TARAI CONDITIONS OF UTTARAKHAND

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Embllica officinalis, is also known as amla, has been used in Ayurveda, the ancient system of Indian medicine. Amla has been used for curing many disorders such as common cold, scurvy, cancer and heart diseases in humans. It is supposed that the major factor responsible for all these curing activities is Vitamin C (Ascorbic acid), which is contained in large proportion in the pulp of amla. The present study was conducted to study the effect of different concentrations of amla as a feed additive on the hematology and serum biochemical parameters of Rohu (*Labeo rohita*) fingerlings. Four experimental diets, T0, T1, T2 and T3, were prepared with dried amla powder as a feed additive mixed @ 0% (Control), 1%, 5% and 10% of feed, respectively. The results showed that the haematological and serum biochemical parameters were better in all the fishes fed with T3 (10% dried amla per kg feed) in respect to haemoglobin, total erythrocyte, total leukocyte, total protein, albumin, globulin, creatinine, calcium and phosphate. All the results obtained were also statistically checked and found to be significant.

Keywords: vitamin C, *Embllica officinalis*, carps, hematology, serum biochemical parameters.

**(AQN-36) ORGANIC AQUACULTURE IN COLD WATER REGIONS: NEW APPROACH
TOWARDS THE SUSTAINABLE FISH FARMING**

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“Organic farming is a system of farm design and management that creates an ecosystem which can achieve sustainable productivity without the use of artificial external inputs such as chemical fertilizers and pesticides.” Organic aquaculture is a holistic system designed to optimize the productivity and fitness of the aquatic ecosystem including seaweeds, culture organisms, benthic organisms and people. This approach prohibits the use of any kind of chemicals such as herbicides, fertilizers, pharmaceuticals etc. It is an eco-friendly method of farming and processing foods. Globally, organic aquaculture is limited to trout, shrimp and salmon contributing 36%, 18% and 14% respectively. In China, 72 operations have received organic certification under the national Chinese regulation and hold the first rank in organic aquaculture production of 15,300 tonnes followed by United Kingdom (9,900 tonnes) and Ireland (7,500 tonnes). In Europe, the lead product in organic aquaculture is Atlantic salmon. INDOCERT (Indian Organic Certification Agency) is a nationally and internationally operating, certification body established in India for the organic products certification. Hilly areas are having a high potential for the organic fish farming as these areas are less polluted and more suitable for the organic production. The north eastern hill region of India has been identified as the potential zone of organic fish production because of two main reasons- thin population density and negligible use of inorganic inputs. In this region grass carp is widely cultured because of wide temperature tolerance. Organically grown Azolla is used as feed for producing organic fish. Organic fish has got good market value varying between US\$ 1.28 to US\$ 1.70 per kg. By solving the threats and weaknesses of this field, organic aquaculture can create a new revolution towards sustainability in India and rest of the world.

Keywords: organic aquaculture, eco-friendly, sustainability, hilly regions.

(AQN-37) A REVIEW OF FRESH WATER INTEGRATED MULTI-TROPIC AQUACULTURE (FIMTA): CATCH UP ON DREAM OF BLUE REVOLUTION IN INDIA

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The aquaculture production has grown steadily owing to the dramatic expansion in this sector worldwide. During the past three decades, production has increased from 6.2 million tonnes in 1983 to 73.8 million tonnes in 2013 (FAO, 2016). Intensive finfish farming in cages can release significant quantities of nutrients to the farm site from left over feed, faeces and excretory products. These metabolic wastes mostly include ammonia, may contribute to increased nutrients and localized eutrophication in the farm. One of the major challenges for the sustainable development of aquaculture industry is to minimize environmental degradation concurrently with its expansion. Then Freshwater Integrated Multi-Trophic Aquaculture (FIMTA) system can also be used to increase aquaculture production which is better known as Aquaponics. IMTA is the practice which combines, in the appropriate proportions, the cultivation of fed aquaculture species (e.g. finfish) with organic extractive aquaculture species (e.g. shellfish/herbivorous fish) and inorganic extractive aquaculture species (e.g. Aquatic plants) to create balanced system for environmental sustainability (biomitigation), economic stability (product diversification and risk reduction) and social acceptability (better management practices). The multi-trophic sub-systems are integrated into IMTA that refers to the more intensive cultivation of the different species in the proximity of each other, linked by nutrient and energy transfer through the water. FIMTA can be used in cold water region and recently word out Developing Integrated Multi-Trophic Aquaculture systems for commercial salmon hatcheries. FIMTA applies the same principles as those used in marine IMTA (MIMTA) but takes place in a freshwater setting. It is not only important for branding purposes, but can also increase the sustainability of the industry by reducing water usage and waste production, increase product diversification, and improve the societal acceptance of the industry. FIMTA can be used to enhance farmer income.

Keywords: FIMTA, MIMTA, environmental degradation, economic stability.

(AQN-38) MICROALGAE: THE SUPER ECOFOOD FOR FUTURE

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All over the world commercial production of microalgae for human nutrition is already a reality, but for most people, the thought of algae conjures up images of a smelly pond or a neglected fish tank. Choose of the right food to eat in an early stage of life associated with a healthy lifestyle can have important benefits in future life. A healthy diet based on microalgae novel food products can have important benefits for all age groups, showing a highly favourable panorama for the development of foods with high nutritional contents and functional properties. This changes the people's mind because of the rapid increase of the world population, and the concern of a possible insufficient protein supply.

Microalgae such as the Chlorella, Spirulina and Nostoc are considered an alternative source of high value nutrients, with 50 to 60 percent protein, unlike other plant protein sources. Oils from microalgae rich in some PUFAs seem particularly suitable for children, pregnant women, vegetarians and patients with fish allergies. Since algae also represent an important source of vitamins, minerals, antioxidants and natural colorants, the incorporation of the whole biomass in food and feed could be used to provide the color, increment nutritional value, and improve texture or resistance to oxidation.

Numerous combinations of microalgae or mixtures with other health foods can be found in the market in the form of tablets, powders, capsules, pastilles and liquids, as nutritional supplements and also be incorporated into food products (e.g. pastas, biscuits, bread, snack foods, candies, yoghurts, soft drinks). Successful authorization of these microalgal based foods and food ingredients broaden perspectives for a wider inclusion of these valuable microorganisms in the human diet and therefore, there is still a very large untapped opportunity in this food area.

(AQN-39) EFFECT OF SOAKING ON ANTI- NUTRITIONAL FACTORS AND IN- VITRO DIGESTIBILITY OF SWEET POTATO LEAF MEAL (SPLM) USED AS A CARP FEED INGREDIENT

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Soaking is the process of becoming softened and saturated as a consequence of being immersed in water. Soaking helps to remove the water soluble anti-nutritional factor and to improve the nutritional value of leaf. In the present study effort were made to investigate the effect of soaking on nutritional, anti-nutritional factor and *in-vitro* protein digestibility of sweet potato leaf meal (SPLM). SPLM can be a suitable feed ingredients for fish feed as it is rich in nutritional compounds *viz.* crude protein (23.92%), crude lipid (5.5%), NFE (52.04%), ash (10.17%). The crude fibre content of SPLM is low (8.3%). However, it contains several anti-nutritional factors (ANFs) which limit the utilisation of nutrients in animals. After soaking for 24h at room temperature the significant reduction of anti-nutritional factor were achieved with reduction of tannin from 23.03 to 4.84 mg/100g, phytate from 15.02 to 11.06 mg/100g, oxalate from 1.36 to 0.29%, alkaloid from 1.36 to 1mg/g similarly the cyanide content reduced from 38.8 to 23mg/100g, but reduction of trypsin inhibitor was non-significant ($p>0.05$). The protein digestibility of SPLM was increased from 34.88 to 64.72%. However, the leaching of nutrient were observed with the increase in soaking time. Thus, result obtained in the present study revealed that the soaking is suitable and effective method to reduce the ANFs in SPLM and to increase *in-vitro* protein digestibility making it as a potential ingredients for fish feed.

Keywords: soaking, in-vitro protein digestibility, anti-nutritional factors, sweet potato leaf meal

(AQN-40) FIRST RECORD OF NATURAL SPAWNING, BREEDING AND SEED REARING OF CRITICALLY ENDANGER FISH SPECIES DARK MAHSEER NAZIRITOR CHELYNOIDES (MCCLELLAND, 1839) IN CONTROLLED AQUARIUM CONDITION

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The dark mahseer *Naziritor chelynoides* is a cold water fish, native to streams of Garhwal Himalaya. It is listed as vulnerable and critically endangered category in IUCN. The species has very good potential as ornamental fish and candidate species for cold water aquaculture. This report presents the first record of species *Naziritor chelynoides* natural spawning in aquarium condition, spawning behaviour and breeding habits. This species can be naturally bred in a confined aquarium environment without using any stimulating synthetic hormone or pituitary extract. Natural spawning in the aquarium was first observed on 16.11.2016 and second spawning was observed on 10.7.2017. Fertilized eggs were collected and hatching period, larval development, rearing of seed and water quality parameters were studied. Species breeding season and spawning behaviour were also studied. Understanding these aspects will largely benefit captive breeding programme which will be useful for mass production of seeds. This can also be used to assist in development of aquarium trade, restoration of natural population and commercial exploitation using aquaculture practices and employment generation.

Keywords: *Naziritor chelynoides*, endangered fish, natural spawning, captive breeding

**(AQN-41) FIRST RECORD OF MULTIPLE NATURAL SPAWNING OF CHOCOLATE MAHSEER
(NEOLISSOCHILUS HEXAGONOLEPIS MCCLELLAND, 1839) IN AQUARIUM
CONDITION**

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The chocolate mahseer (*Neolissochilus hexagonolepis* McClelland, 1839) is highly esteemed food and game fish of North Eastern region particularly high lands of Meghalaya. This fish is considered as a threatened species and hence it needs special attention to conserve it from extinction. This report presents the first record of *Neolissochilus hexagonolepis* species that both the sexes of *Neolissochilus hexagonolepis* can attain sexual maturity in confined aquarium condition and spawned multiple times without use of any pituitary extract or synthetic hormones. Brood stock of this fish in ratio of 2 female and 4 males with average weight of 800 and 650 grams respectively were maintained in wall aquaria of 130x120x95 cm in size with water holding capacity of about 950 litres at DCFR Bhimtal. Natural spawning of fish was observed in the month of November 2016 in the aquarium. Fertilized eggs were collected and hatching period, larval development, rearing of seed and water quality parameters were studied. During November 2016 to August 2017, within a period of 11 months same brood stock naturally spawned six times in same aquarium. Spawning behaviour and breeding habits of this fish were also observed. This study is attempts to help in standardize a protocol for natural breeding of *Neolissochilus hexagonolepis*. This fish is a batch spawner, with good brood stock management practices in controlled condition, mass scale seed production of *Neolissochilus hexagonolepis* is possible round the year which in turn will help in conservation of the fish in natural habitat as well as increased fish production from culture system.

Keywords: *Neolissochilus hexagonolepis*, chocolate mahseer, aquarium, multiple spawning, spawning behaviour

(AQN-42) THE ANTIOXIDANT STATUS IN *LABEO ROHITA* FINGERLINGS SUBJECTED TO RESTRICTED FEEDING AND RE-ALIMENTATION

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The effect of feeding nutraceutical during exposure to stress (crowding and feed restriction) and compensatory growth in *Labeo rohita* fingerlings (8.0g ± 0.5) was studied for four months with two levels of stocking density (10 & 20 nos.), feeding rate (1% and 3 % of body weight) and three levels of nutraceuticals (0, 0.1 and 0.5%). Hence, the experimental groups were, THR0, THR1, THR5, TNS0, TNS1 and TNS5 during the stress phase. The compensatory growth was studied by redistributing the THR0 group into three levels of nutraceutical fed groups (0, 0.1 and 0.5%) with satiation feeding (TN0, TN1 and TN5) in re-alimentation phase. During the stress phase, the SOD-1 and GPx-1 gene expression, SOD and GPx enzyme activities were significantly higher (p<0.05) in THR0 group in all the four months. Catalase gene expression and enzyme activity showed variation in second month onwards in all the groups and a significantly higher value was observed in THR0 group during the experimental period. Glutathione level was significantly higher in THR0 group in first two months of stress exposure after which showed a decreasing trend while total antioxidant status was significantly lower in this group in all the four months. Fish exposed to three month stress, but fed with 0.1% nutraceuticals showed a significantly lower gene expression and activity of enzymatic antioxidants during compensatory growth, whereas the groups fed without nutraceutical showed opposite trend. Hence, it is concluded that the feeding of 0.1% vitamin-mineral based nutraceutical can reduce the stress effect during restricted feeding and re-alimentation phase.

(AQN-43) EFFECT OF STARVATION AND REALIMENTATION ON GROWTH OF FINGERLINGS OF *ANABAS TESTUDINEUS* (BLOCH, 1792)

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An attempt was made to find out effect of periodical starvation and subsequent refeeding to satiation in fingerlings of *Anabas tetudineus*. The study was designed with four treatments D₁, D₂, D₃, D₄ and control and continued for 105 days. Fish of the treatments such as D₁, D₂, D₃, D₄ were starved for one day, two days, three days and four days towards end of each week and they were @ 5% body weight during rest of days of the week like the control. The left out feed was removed by siphoning after two hours of feeding and it was dried for estimation of feed intake periodically. The water quality parameter like temperature, D.O., pH, Hardness were monitored along with change in average length and average weight at weekly intervals. There was significant difference (P<0.05) in average weight and length of fish in different treatments during termination of the experiment which was attributed to differential feeding, hyperphagy and seasonal environmental condition in the aquaria. There was no significant difference (P<0.05) in the weight of the fish D₁, D₂ compared to control which indicated growth compensation in fish. However it was significantly low in the treatments D₃, and D₄. The bioindices like condition factor, Hepatosomatic index, Gastrosomatic index as well as proximate composition of muscle was estimated during termination of the experiment. A significant difference (P<0.05) was found HIS of treatment D₁, D₂, D₃, and D₄ compared to control which might be due to mobilization of lipid for energy during fasting. It is also corporate from significantly lower lipid level in muscle of the fish in D₃ (t = 6.158, P<0.05) and D₄ (t =6.094, P<0.05). It was inferred from the present study that growth of fish was compensated in treatments D₁, and D₄ with comparatively low feed consumption compared to control indicating skipping one and two days of feeding in a week can save cost due to feeding and it does not hamper the growth in fish.

(AQN-44) EFFECT OF DIFFERENT PROTEIN AND FAT LEVELS ON AMINO ACID AND FATTY ACID VARIATION IN MORPHOTYPES OF NURSED *MACROBRACHIUM ROSENBERGII* POST LARVAE (DE MAN, 1879)

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An experiment of 60 days was conducted to assess the effect of variation in dietary protein and fat in diets on growth of nursed *Macrobrachium rosenbergii* Post larvae (PL) which were stocked in 300 L tanks at stocking density 2 PL/10 L (N=50). They were fed with two formulated feeds with different dietary protein and fat levels; first treatment (T1) with 35% protein and 5% fat, and second treatment (T2) with 40% protein and 5.5% fat. After 60 days, among the 2 treatments 3 morphotypes were recorded according to growth, i.e. M1 \leq 4.0cm, M2=4.1-4.5cm and M3 $>$ 4.5cm among which M1 were considered stunted or laggards and M3 were considered jumpers. Overall survival percentage in treatment T2 (79.33 \pm 3.06) was observed to be higher than that of treatment T1 (76.67 \pm 3.06). Weight gain, specific growth rate, feed conversion ratio and protein efficiency ratio in treatment T2 were also observed to be favorable among two treatments. The amino acid and fatty acid profile of the whole body tissues of jumpers (M3) and laggards (M1) from treatments was found to have only major differences among Methionine, Valine and Tyrosine for amino acids and among all Monounsaturated Fatty Acids (MUFAs), linoleic acid and eicosapentaenoic acid (EPA) for Polyunsaturated Fatty Acids (PUFAs).

(AQN-45) SUSTAINABLE COMPOSITE FISH FARMING TECHNOLOGY FOR RURAL DEVELOPMENT IN HILLS OF UTTARAKHAND

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Fisheries sector plays an important role in food and nutritional security of the people. The Himalayan region is comprised of vast aquatic resources. The available resources provide immense potential for the sustainable exploitation on of fishery resources as well as development of aquaculture for the livelihood of under privileged rural population in the hills. No single accepted technology can be adopted in hills, due to different climatic regimes of the region. Four types of ponds/ tanks are constructed in hills- earthen ponds (made of earth only), tanks (made of RCC/ brick masonry work), ponds with stone-pitched dykes and earthen bottom, and polytanks (lined with polythene).

Composite fish farming is polyculture of carps where fast growing compatible species having complementary feeding habits are stocked in such ratios and numbers so that all trophic and spatial niches available in the ponds are maximally utilized. Technology of composite fish farming is different for lower hills (below 1000 m ASL) and mid hills (1000-1700 m ASL). In high hills composite culture of carps is not feasible. In lower hills composite culture of six species of fish is more suitable but in the situation of non availability of a particular species, three or four species culture may also be practiced. The fish seed of the size of 2-4 inch should be stocked at the rate of 1.5 – 2.5 fingerling/m³.

In mid hills region, fingerlings of three species (silver carp, grass carp and common carp) are stocked in the ratio of 30:40:30 respectively. The management practices and fish health management aspects have been detailed out in the paper. By adopting above farming practices a fish production of 0.4-1.0 kg/ m² may be obtained in different farming structures in hills. The results of case studies on composite fish farming in District Champawat in mid hill region of Uttarakhand are included in the paper.

**(AQN-46) OPTIMIZATION OF STOCKING DENSITY FOR SUCCESSFUL REARING OF
CHAGUNIUS CHAGUNIO LARVAE**

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Chagunius chagunio, commonly known as “Chaguni” belongs to family Cyprinidae is one of the economically important indigenous fish of Himalayan region. After the development of breeding protocol, larval rearing is one of most critical steps during culture practice of any species which requires greater attention and monitoring. During this phase, various factors affect the growth and survival of larvae and stocking density is one of them deciding the overall performance of the species and economics of the culture. Therefore, the present study was undertaken to optimize the stocking density of *C. chagunio* larvae in cold water conditions. Spawn having average initial length of 8.2 ± 0.10 mm and weight 0.007 ± 0.01 g were stocked in four different stocking densities 1, 2, 3 and 4 nos.L-1 and assigned as treatments; D1, D2, D3 and D4 respectively. All the treatments were maintained in triplicates for a time period of 90 days from June to August, 2014 to assess suitable stocking density with respect to their growth and survival. At the end of the experiment, it was observed that growth performance of fish larvae was significantly affected by the stocking density and found maximum in lowest stocking density and minimum in higher stocking density. The results reflect that in treatment D4 (4 larvae l⁻¹), inspite of poor growth and survival, the total number of fry obtained were maximum in comparison to D3 (3 larvae l⁻¹), D2 (2 larvae l⁻¹) and D1 (1 larvae l⁻¹). From seed production point of view, higher seed survival is more important than growth at initial stages of life cycle, therefore, treatment D4 (4 larvae l⁻¹) having highest stocking density of fry is considered suitable to have maximum quantum of seed of indigenous carp *C. chagunio*.

Keywords: *Chagunius chagunio*, growth, larval rearing, stocking density, survival

(AQN-47) PROTEIN SOURCE USED IN STARTER FEED INFLUENCES EARLY LIFE GROWTH AND METABOLISM IN RAINBOW TROUT

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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, the present study 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. 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). Conversely, 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 (AMPK1 α) 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 indicates that protein source used in the starter feed substantially influences growth, feed utilisation, carcass amino acid content and hepatic metabolism of rainbow trout.

(AQN-48) OPTIMIZATION OF HAULING CONDITIONS FOR PROLONGED TRANSPORT OF RAINBOW TROUT FINGERLINGS IN PLASTIC BAGS

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Breeding and seed production of rainbow trout is limited to government operated hatcheries in India, which often necessitates the transport of stock size fish to geographically distant farm units. Therefore, the present field study was carried out to derive suitable conditions for prolonged transport of rainbow trout fingerlings in plastic bags. Critical factors such as starvation period (24 vs. 72 h), loading density (13.3, 26.7 and 40 g/L), addition of salt (0, 3 and 6 g/L) and mild sedation with clove oil (0, 10, 20 and 40 µl/L) were evaluated based on fish survival and changes in total ammonia nitrogen (TAN), un-ionized ammonia (NH₃-N), CO₂ and pH of the transport water. The experimental fish (mean weight 4 ± 2 g and mean total length 5.5 ± 1.5 cm) were packed in plastic bags containing 6 L of stream water and 12 L of pressurized oxygen atmosphere, and transported by road in a refrigerated truck, at a constant temperature of 13°C. The total distance covered and duration taken was 750 km and 40 h, respectively. On the basis of zero fish mortality and least adverse water quality after transport, we suggest that a starvation period of 72 h, loading density of 26.7 g/L and light sedation of fish with 40 µl/L clove oil prior to packing is suitable for transporting rainbow trout juveniles in plastic bags up to 40 h. To ascertain the benefit of adding salt to the transport medium, we need to further investigate the aspects of delayed mortality and long term fish welfare.

(AQN-49) FIRST RECORD OF NATURAL SPAWNING AND BREEDING OF *BARILIUS BENDELISIS* (HAMILTON) IN CONTROLLED AQUARIUM CONDITION

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The hill trout *Barilius bendelisis* (Hamilton, 1807) has recently drawn an attention as one of the potential candidate species for aquaculture in several parts of the Himalayan and North Eastern region. This species has a great potential as a demanding ornamental fish in aquarium trade. As an important cold water fish only few scattered reports on breeding and spawning behaviour of this species are available. This report presents as a first record of *Barilius bendelisis* species natural spawning in aquarium condition, its spawning behaviour and breeding habits. This species can be naturally bred in a confined aquarium environment without using any stimulating synthetic hormone or pituitary extract. Its embryonic development of eggs, incubation period, larval development, rearing of seed and required water quality parameters were also studied. Understanding these aspects will largely benefit captive breeding programme which are useful for mass production of seeds. This can also be used to assist in development of aquarium trade, restoration of natural population and commercial exploitation using aquaculture practices and employment generation.

Keywords: *Barilius bendelisis*, natural breeding, spawning behaviour, captive breeding

(AQN-50) PROSPECTUS OF BREEDING AND CULTURE OF COMMERCIALY IMPORTANT COLD WATER ORNAMENTAL FISH OF KUMAUN AND NORTHEAST REGION TOWARDS LIVELIHOOD SECURITY OF RURAL PEOPLE

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Ornamental fish production globally is a multibillion dollar industry and supports thousands of rural people in developing countries. World trade of ornamental fish is estimated to be about Rs. 2000 crores, but, India's share is only Rs. 15 crores, which is very insignificant. Kumaun and North East region has rich diversified habitat in form of streams, lakes, and reservoirs. These resources hold considerable population of coldwater endemic ornamental fishes. Many small varieties of food fishes which are not suited for aquaculture practices have very good potential as ornamental fish. Some of the important varieties of ornamental fishes are *Puntius chola*, *P. gelius*, *P. phutunio*, *P. terio*, *P. ticto*, *Danios* species, *Barilius barila*, *Barilius bendelisis*, *Danio devario*, *Brachidanio rerio*, *Rasbor spp.* Loaches, *Acanthocobitis botia*, *Botia histrionica*, *B.berdmorei* *Nemacheilus spp* *Gagata cenia*, *Hara hara*, *Chaca chaca* *Naziritor chelynoides*, *Glyptothorax pectinopterus*. *Garra gotyla*, *Garra lamta*, *Glyptosternum*, *Chanda nama* and *Chanda ranga* etc. These ornamental fishes have very good demand in domestic as well as in international market. Protocol development for judicious collection from natural resources, their captive breeding and culture management of these ornamental fish has a promising sector to provide livelihood options for marginal and landless farmers in hilly localities. There is a need to explore the possibilities of establishing collection centres and seed banks for indigenous ornamental fishes, their judicious exploitation, collection of fishes from natural resources, their acclimatization, their captive breeding and rearing them up to marketable size. Directorate of cold water fisheries research has taken initiative in this direction. Commercially important ornamental fishes like *Puntius ticto*, *Danios species*, *Naziritor chelynoides*, *Barilius bendelisis*, *Barilius barila*, *Garra gotyla*, *Nemacheilus* and *Botia* has been collected from natural resources and their successful breeding and rearing has been achieved in aquarium condition. Promotion of ornamental fish production in hill aquaculture has already been taken. Disseminating and popularizing ornamental fish culture technology is in under progress to emphasize the socio-economic upliftment of unemployed rural youths and women to augment income.

Keywords: ornamental, northeast India, Kumaon, coldwater, livelihood

(BWC-01) AQUATIC BIODIVERSITY: MANAGEMENT AND CONSERVATION

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Aquatic biodiversity includes variety of life and ecosystems of freshwater, brackish water and marine environment. The human societies had long been depending upon aquatic biodiversity for food, medicine and other uses including commercial and industrial nature. The economic value of aquatic biodiversity is immeasurable and immense. In recent times, the factors like over-exploitation, pollution, habitat alteration and destruction, introduction of alien species etc. are overwhelmingly causing impacts and threats to aquatic biodiversity. As the demand for marine and freshwater resources increases, so do the strains upon the ecosystems that sustain them. The loss of aquatic biodiversity undermines ecosystems and threatens global food security. Causes include: over-fishing; release of captive-raised juveniles into the wild; some kinds of aquaculture; proliferation of alien species; and climate change and pollution. Unfortunately, our unique marine and freshwater biodiversity is under threat from a wide range of environmental factors including increasing population and movements, a changing climate, coastal developments, and aquatic pests. Sustainable fisheries rest upon aquatic biodiversity, but conservation of that biodiversity has always been a “hard sell,” lagging behind the strides made for terrestrial plants and animals. Because the issue is still largely viewed as a technical one, and has made little impression on policy makers or the public, our number one challenge is to raise the profile of aquatic biodiversity across the board. We help by raising awareness through various initiatives and projects aimed at students, teachers, media and the general public, as well as through more technical tools, including consultations, workshops, books and research focusing on international policy and communication. Ecologically effective ecosystem management will require the development of a robust logic, rationale and framework for addressing the inherent limitations of scientific understanding. It must incorporate a strategy for avoiding irreversible or large-scale environmental mistakes that arise from social and political forces that tend to promote fragmented, uncritical, short-sighted, inflexible, and overly optimistic assessments of resource status, management capabilities, and the consequences of decisions and policies.

Keywords: aquatic biodiversity, management and conservation

**(BWC-02) IMPACT OF ANTHROPOGENIC ACTIVITIES ON HAEMATOLOGICAL PARAMETERS
OF *SCHIZOTHORAX NIGER* (HECKEL: 1838): A STUDY FROM SHALLOW
HIMALAYAN FRESHWATER LAKE IN KASHMIR**

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The present study was undertaken to assess the influence of anthropogenic activities on the haematological profile of *Schizothorax niger* from Anchar lake. Various physico-chemical parameters of lakes like pH, Dissolved oxygen, Free carbon-dioxide, Nitrate, Ammonia, Orthophosphate and Total Phosphorus and fish haematological parameters like Hemoglobin concentration, Total Erythrocyte Count, Total Leucocytes Count, Differential Leucocyte Count, Hematocrit, Erythrocyte Sedimentation Rate, Mean Corpuscular Volume, Mean Corpuscular Haemoglobin and Mean Corpuscular Haemoglobin Concentration were assessed during the study period. The result depicted increased level of nutrient concentration changed haematological profile of *Schizothorax niger*. Statistically, it was also revealed that increased anthropogenic activities have resulted in increased nutrient concentration which has in turn altered haematological profile of *Schizothorax niger*. These findings emphasize that haematological indices can also be used as an important tools to monitor the variation in the trophic status of lakes.

Keywords: physico-chemical parameters, anthropogenic activities, Anchar lake.

**(BWC-03) POLY-LINING OF POND FOR WATER CONSERVATION AND FISH FARMING-A
NEW INTERVENTION IN DISTRICT DODA**

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Even with lot of natural water resources and potential of fish production, the present status of fish production from district Doda of Jammu & Kashmir is very low. There is tremendous scope of boosting fish production and thereof farmers income several fold. This needs, farmer's awareness about the recent advancement in the fish farming technologies and new interventions. Most of the soil of the district is of sandy, silt or rocky type, and therefore the water holding capacity is very low. There are several water harvesting cemented tanks constructed by the state govt. departments, for several purposes excluding fisheries, while in most of these ponds there is problem of getting cracks one or two year of construction, because of the frequent earthquakes. In view of the above back ground, KVK-Doda brought a technology of constructing/converting seasonal pond into perennial pond by poly-lining, from Directorate of Coldwater Fisheries Research (DCFR), Bhimtal. KVK organized several awareness/trainings/demonstration programmes for this technology in different villages of the district, and launched this technology. The results are very encouraging, and a farmer namely Mr. Maskoor from village Malnai of district Doda, who adopted this technology first time in the district history and started fish (Chinese carp) farming reported that *“before poly-lining of my cemented tank I was unable to hold the water even for 15 days, but now after KVK intervention my pond is always full of water and I am using this water for several purposes like cattle and irrigating vegetables grown near by the pond”*. Several other farmers also now adopted this technology for fish farming (either in cemented tank or constructed new earthen pond) as well as water storage for irrigation and other purposes. The DCFR technology introduced in the district by KVK-Doda getting good response and result in water conservation as well as in boosting fish production, and in near future enhancing farmers income status. The technological intervention is in line with the Hon'ble Prime Minister statement “Per Drop More Crop”.

Keywords: poly-lining, water conservation, rainwater harvesting, technology, fisheries

(BWC-04) ASSESSMENT OF TROPHIC STATUS OF NIGEEN LAKE, KASHMIR

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The purpose of the study was to evaluate the trophic status of Nigeen lake, through the interaction of nutrient concentration based on Carlson's TSI. In order to determine the trophic status of Nigeen lake, surface water samples from six different sites of the lake were collected from December 2015 to May 2016. Seasonal variation among different parameters was observed during the study period. Highest temperature was recorded during spring season along with higher values of depth, conductivity, ortho phosphate, total phosphorous and chlorophyll-a during this season. However, dissolved oxygen, transparency and pH values were minimum during spring and maximum in winter season. The data analysis from Carlson's TSI indicates that the average TSI(SD) was in the range of 47.19 to 56.26, TSI(TP) ranged from 84.63 to 85.6 and TSI (Chl-a) was in the range of 58.24 to 61.37. The overall results of the study showed that the Carlson's TSI (Total) of Nigeen lake ranged from 65.7 to 67.6 indicating that the lake is in hyper-eutrophic condition. The myriad ways in which people use the lake along with the numerous pollutant-generating activities have stressed the lake ecosystem in diverse ways. The study suggests that managers and policy makers should take action to slow down or halt eutrophication by applying best management practices for conservation of Nigeen lake.

Keywords: Nigeen Lake, physico-chemical parameters, trophic status, Carlson's TSI, eutrophication

**(BWC-05) AN INSIGHT INTO PHYTOPLANKTON COMMUNITY OF NAINITAL LAKE,
UTTARAKHAND**

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Lake Nainital is situated at Nainital district (known as Lake District of India) in Uttarakhand. It is formed tectonically and is situated in the Kumaun Himalayas (between 29.24° N, 79.28° E and 29.4°N, 79.47°E) at an altitude of 1938 m above sea level. Qualitative and quantitative structure of the phytoplankton in lake was assessed for a period of eight months from September, 2016 to April, 2017 to evaluate the ecobiological status of the lake. On the basis of human interference three sites were selected. Site1 (S1) was near pump/compressor house at thandi sadak, which was installed to improve the dissolved oxygen content of the lake. Site 2 (S2) was near Naina Devi Temple, where drainage of temple is flushed into the water. Site 3 (S3) was near Boat stand, where there is a lot of human intervention by tourist activities. The floristic composition of Nainital lake consisted of total number of 41 different taxa belonging to 4 classes namely Bacillariophyceae (20), Chlorophyceae (16), Cyanophyceae (3) and Euglenophyceae (2). During the study period the density of phytoplankton varied from 2×10^4 to 4.26×10^4 cells L⁻¹, with a mean population of 3.13×10^4 cells L⁻¹. Maximum density of phytoplankton species was observed in the month of April while minimum density was found during September. Dominant phytoplankton species of lake Nainital were *Fragilaria* sp., *Tabellaria* sp., *Gomphonema* sp., *Navicula* sp., *Amphora* sp., *Synedra* sp. and *Caloneis* sp. Calculation of various diversity and evenness indices depicted that Site 1 possess maximal diversity, whereas Site 2 possess maximum density of phytoplankton. Site S3 was least diversified both in terms of density and diversity due to maximum human interference causing pollution load.

Keywords: phytoplankton, qualitative and quantitative structure, ecobiological status, diversity and evenness indices.

(BWC-06) RICHNESS, DENSITY AND DISTRIBUTION OF BENTHIC MACRO INVERTEBRATE ASSEMBLAGES IN HYDROPOWER AFFECTED ALAKNANDA RIVER, UTTARAKHAND

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The present study examined the richness, density and distribution of benthic assemblages in the Alaknanda River regulated for hydropower during 2016 - 2017. For this purpose, the stretch between the two Vishnuprayag and Srinagar HEP and below was examined. Four stations were selected, S1 (50 kms d/s Vishnuprayag HEP), S2 (15kms from S1), S3 (48 kms from S2) and S4 (15 kms d/s Srinagar HEP) depending on accessibility. Macro invertebrate samples were collected by lifting stones and sieving clay-silt substratum from 0.09 m² area. The samples were preserved in 5 % formalin and identified at family level using standard methodology. The count data was used to determine the density and distribution of benthic assemblages. At S1 and S3, Heptagenidae and Baetidae dominated in all the months except Chironomidae at S3 during February and March. There are variations in the dominants (Heptagenidae, Ephemerellidae and Baetidae) from month to month at S2. Hydropsychidae dominated the assemblages at all stations during May and June. No taxa recorded at S4 from September to June except February due to variation in the flows between generation and non-generation period. The density and taxon richness was highest in January and lowest in September at all the stations. Density ranged from 17-665 ind m⁻², 13-594 ind m⁻², 15-583 ind m⁻² and 0-17 ind m⁻² at S1, S2, S3 and S4 respectively. Taxon richness showed the increasing trend from S1 (10) to S3 (15) and decreasing trend at S4 whereas density showed the decreasing trend. The dominant in macro invertebrate assemblages were largely Heptagenidae and Baetidae at S1 to S3. The benthic assemblages are same throughout the examined stretch possibly due to the river regulation for hydropower. In a free flowing river assemblages are expected to vary longitudinally and hence altitudinally.

(BWC-07) ASSESMENT OF HEAVY METALS IN WATER, SEDIMENT, MACRO VEGETATION AND FISH OF LAKE NAINITAL

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Assessment of heavy metals concentration in water sediments, macro vegetation and fish of Lake Nainital was made from September 2016 to February 2017 with the help of Atomic Absorption Spectrophotometer(AAS) in the present investigation to evaluate pollution status of the lake. Three sites viz., S₁ (Aeration centre at thandisadak), S₂ (platform near the Naina Devi Temple in Malli Tal) and S₃ (boat stand in Talli Tal near bus stand) were selected based on pollution level and fortnightly sampling was done. The important physico-chemical parameters such as temperature, electrical conductivity, TDS, transparency, pH, DO, free CO₂, alkalinity and hardness of the lake were also analysed. The average concentration of heavy metals in water and soil of Lake Nainital during investigation period were observed as Zn (0.029 mgL⁻¹), Pb (0.346 mg L⁻¹), Cu (0.113 mg L⁻¹), Mn (0.361 mg L⁻¹), Cd (0.007 mg L⁻¹), As (0.001 mg L⁻¹) and Zn (0.871 mg L⁻¹), Pb (1.150 mg L⁻¹), Cu (0.156 mg L⁻¹), Mn (1.778 mg L⁻¹), Cd (0.132 mg L⁻¹), As (0.003 mg L⁻¹) respectively. The values of Heavy metal Pollution Index shows that the water of Lake Nainital is slightly affected with Mn and seriously affected with Pb. Values of Bio-concentration Factor reflected that gills of collected fish serve as hyper-accumulator for Zn, Mn and Cd whereas muscles were hyper-accumulator for Zn and Mn. Low hyper-accumulation was recorded in leaves or roots of macrophytes. The study concludes that the presence of elevated levels of Pb and Mn in lake water pose threat to human population as the lake water is used for domestic water supply. Also the increased level of Zn, Mn and Cd in fish is a matter of concern as it can result in imbalance of food web in the lake.

**(BWC-08) HYDROBIOLOGICAL CHARACTERISTICS OF THREE SNOW-FED STREAMS OF
KAMENG DRAINAGE OF ARUNACHAL PRADESH**

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A study was conducted to analyze the physicochemical parameters, nutrient variables and plankton diversity in three snow-fed tributaries *viz.*, river Dirang *chu*, river Sangti and river Tenga of Kameng drainage in West Kameng district of Arunachal Pradesh in the Eastern Himalayas during 2016 with an objective to understand the thriving environment of snow trouts. The major physicochemical parameters in the three rivers *viz.*, temperature, pH, dissolved oxygen were found in the range of $11.42 \pm 0.04 - 14.25 \pm 0.06^\circ\text{C}$; $7.32 \pm 0.02 - 7.9 \pm 0.03$; $8.06 \pm 0.05 - 8.31 \pm 0.05$ ppm respectively. Nutrient variables *i.e.* ammonium, nitrite, phosphate, alkalinity, hardness were observed in the range of 0.01 mg/l; $8.33 \pm 0.58 - 11.0 \pm 1.0$ $\mu\text{g/l}$; $0.11 \pm 0.005 - 0.38 \pm 0.03$ mg/l; $25.33 \pm 2.31 - 17.33 \pm 2.31$ mg/l; $26.66 \pm 1.15 - 15.33 \pm 1.15$ mg/l respectively. The abundance of plankton species comprised of *Stigeoclonium* (50%), *Pinnularia* (20%), *Navicula* (15%) at river Dirang *chu*, whereas *Stigeoclonium* (30%), *Fragilaria* (30%) and *Lyngbya* (10%) dominated at river Sangti, followed by *Pinnularia* (40%), *Acanthidium* (20%) and *Synedra* (10%) at river Tenga. Overall, it was observed that the rivers being snow fed remained clear and transparent (0.39 ± 0.02 NTU) during the study period. As the diverse plankton groups remained abundant and most of the essential water quality parameters were within the favorable range, a good health of the water body and conducive environment for the abundance of the snow trout could be concluded.

Keywords: Kameng drainage, physicochemical, nutrients, plankton, snow trout.

(BWC-09) SOME ASPECTS OF REPRODUCTIVE EFFECT MEASURES IN FISH – USE OF EFFLUENT OF SEWAGE TREATMENT PLANT

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Sewage effluent contains a complex mixture of chemicals. Now a day, use of antibiotics, painkiller, birth control pills, anti depressants also use of fragrances, sunscreen agent and preservatives increased in the population. The used/partial used and disposal of pharmaceuticals entering rivers and sewer systems. However sewage treatment plants which have been established to treat household, industrial and commercial waste water sadly are not designed to eliminate low concentration of synthetic pollutants such as pharmaceuticals. Fish is one of the main indicators of effect on aquatic ecology and eventually human health. Hormones in fish and humans are remarkably the same. The present study has therefore been carried out on *Puntius sophore* for 60 days to a dilution water control, positive control and graded effluent concentrations of 25 (E 1), 50 (E 2), 75 (E 3) and 100% (E 4) (n = 21 fish/treatment). Some aspects of reproductive parameters such as GSI and HSI values, vitellogenin (VTG) concentration in males, reproductive defects through histological studies have been performed. Result reveals incidence of ova-testis in gonad of experimented fish in E3 and E4. Exposure to the sewage effluents (E 1, E 2 and E 3) did not appear to affect ovary growth in females (as per GSI value) but effects on the gonad were observed in males exposed to effluents concentration 50%, 75% and 100%. Increased VTG in males exposed to all dilutions; the condition factor/HSI found significant different among groups. These findings suggest that the effluent contains estrogenic components/endocrine disruptors which are responsible for the reproductive impacts observed.

(BWC-10) A PRELIMINARY ASSESSMENT OF ENVIRONMENTAL HEALTH OF NORTHERN PLAIN REGION OF THE UMTREW RIVER IN MEGHALAYA AND ASSAM

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India is a blessed country in terms of water resources which is available in the form of numerous rivers, lakes etc. There are 14 major, 55 minor and numerous small rivers in the country. But, rapid growth in industrialization to support the country's growing population and economy has polluted our rivers like never before. This poses a serious health problem as millions of people continue to depend on this polluted water from the rivers. River Umtrew and its tributaries has a basin area of 1369.6 km² and most of its part falls under the northern hill ranges of Meghalaya plateau and rest is under the low lying areas of Brahmaputra plain in Assam. The Northern plain region of the Umtrew river after entering Assam is known as river Digaru. From the new Umtrew Hydroelectric Project site the river traverses a distance of around 30 kms before joining with the Kopili tributary of river Brahmaputra at Latitude of 26°22'89''N and Longitude of 91°60'66'' E. In this journey of 30 km the river is facing tremendous anthropogenic stress in the form of industrial pollution of Burnihat industrial estate effluents and domestic sewage of dense human habitation. The ultimate impact of these pollutants on the aquatic biodiversity of the Umtrew river becomes evident in the form of mass mortality of fishes reported from time to time. In the present study, a preliminary assessment of the environmental health of the Northern plain region of the Umtrew river was carried out in terms of physico-chemical and biological parameters of the river water in three different stations during September, 2016. The values different physico-chemical parameters of the river water were water temperature (26-26.5°C), pH (6.9-7.1), DO (2.6-4.4 ppm), CO₂ (6-8 ppm), Alkalinity (91-126 ppm), Total Hardness (80-95 ppm), Ammonia (0.2-0.7 ppm), Nitrate (9.4-28.4 ppm), BOD (220-270 ppm) and COD (340-376ppm). The phytoplankton and zooplankton density of the river water found to be very poor. The physico-chemical and biological parameters of the river water reflects deteriorating environmental health of the Northern plain region of the Umtrew river not conducive for aquatic life.

(BWC-11) MITIGATION OF TOXIC *MICROCYSTIS AERUGINOSA* BLOOM BY ALGICIDAL BACTERIA ISOLATED FROM COLDWATER OF NORTHERN INDIA

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Algicidal bacteria are a promising and environmental friendly way to control cyanobacterial blooms. Cyanobacteria, mainly *Microcystis aeruginosa* is a toxin producing algae known to cause the mass fish death. Therefore, the aim of this study was to isolate algicidal bacteria against *M. aeruginosa* from coldwater of Himalayan region of northern India. Twenty one bacterial strains were isolated and screened to test its ability to inhibit the growth of *M. aeruginosa* by well diffusion and liquid-culture methods, among which three bacterial strains exhibited algicidal activity against *M. aeruginosa* cells. Based on the biochemical test and 16S rRNA sequence (~1400 bp) analysis, the isolated strains were identified as *Pantoea eucrina* U8 (GenBank accession number KY426067), *Pseudomonas oryzae habitans* U10 (GenBank accession number KY426066) and *Fictibacillus phosphorivorans* U12 (GenBank accession number KY426064). All the three bacterium lysed *M. aeruginosa* by direct contact, but had different algicidal mechanism. Algicidal activity of strain U8 towards *M. aeruginosa* was initiated after 6 days of inoculation (1.66×10^6 cfu/ml) and cyanobacterial cell component were extensively aggregated. Algicidal activity of U10 towards *M. aeruginosa* was observed after 5 days of inoculation (6.6×10^7 cfu/ml), and cells were significantly swollen, which subsequently resulted in lysis of cells. Algicidal activity of U12 was at peak after 6 days of inoculation (1.78×10^8 cfu/ml), and algal cells were decomposed. The pathogenicity of the algicidal bacteria was also assessed and all the three strains were found to be non pathogenic. Our results indicated that these bacterial strains may possess a novel function for controlling harmful blooms and further studies will provide new insights into its role in water environment.

Keywords: harmful cyanobacteria, bloom, algicidal bacteria, *Microcystis*

(BWC-12) SEASONAL VARIATION OF WATER QUALITY AND PLANKTON DIVERSITY IN UPLAND LAKES OF KUMAON REGION

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The present study was carried out to evaluate the seasonal changes in physico-chemical parameters of water and plankton diversity in four Kumaon lakes viz. Bhimtal, Sattal, Naukuchiatal and Nainital. The water quality parameters were estimated by standard methods of APHA (1999) and Merck Spectroquant Multy, which revealed that the TDS, Conductivity, Free CO₂, Hardness, Alkalinity, Chloride and Calcium content were comparatively higher in Nainital lake, followed by Bhimtal, Naukuchiatal and Sattal lake. This explained higher trophic level of lake ecosystem in Nainital compared to others. Sewage water received from the catchment areas influenced significantly on the quality of water in Nainital lake. Similarly, analysis of plankton revealed greater dominance of Diatoms (Bacillariophyceae) such as *Fragilaria crotonensis* > *Navicula* > *Frustulia* > *Cosmarium* > *Cymbella* and Chlorophyceae such as *Ulothrix* > *Pediastrum simplex* > *Chaetophora* in these lakes. In Bhimtal, the density of *Aphanizomenon* was found to be 1440 to 1750 x 10³ ind/L indicating commencement of blue green algal bloom. Cyanophyceae, Chlorophyceae, Euglenophyceae and Silicoflagellates were the major groups of phytoplankton identified from these studied lakes. Daphniidae and Cyclopidae were the important zooplankton families found in all the lake which shows possibilities of higher fish production in the lakes of central Himalayas with some distinct variations. The entire ecosystem largely depends on the quality of the water and its biotic communities. Thus, conservation of these lakes for fish production and eco-tourism development should have the utmost significance through regular monitoring and adopting suitable management practices.

Key words: Kumaon lakes; water quality; plankton

**(BWC-13) ASSESSING THE GENOTOXIC RISK OF TRIVALENT CHROMIUM USED AS A
TANNING AGENT IN TANNERY INDUSTRY**

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Chromium is an essential trace element as it is required for normal metabolism of glucose, fat and also to potentiate insulin. Chromium stimulates synthesis of fatty acid and cholesterol, which are important for brain function and other body processes. However, it is poisonous in excess. The dominant form of chromium (VI) i.e. the chromate ion $(\text{CrO}_4)^{-2}$ in neutral aqueous solutions, can readily cross cellular membranes via non-specific anion carriers, while chromium (III) is poorly transported across membranes. Cr (VI) does not react with macromolecules while both Cr (III) and the reductional intermediate Cr(V) are capable of coordinate covalent interactions with macromolecules such as DNA, RNA, protein and lipids. In tanning industry Cr(III) is widely used in tanning and its effluents causes contamination in soil water and environment. It is estimated that Chromium concentration in serum of workers from tanning and retanning departments is higher than those who do not work in tannery. Workers in these industries are exposed to airborne fumes, mists and dust containing chromium and its compounds through inhalation or dermal contact. Cr(III) interacts with DNA to induce DNA strand breaks, DNA cross-links with cysteine, histidine, or glutathione, interstrand DNA cross-links, and oxidative DNA base modifications such as the formation of 8-hydroxydeoxyguanosine (8-OH-dG). The oxidative stress with respect to Cr (III) involves the reduction of Cr (III) to Cr (II) in the presence of biological. The newly formed Cr (II) reacts with hydrogen peroxide to produce hydroxyl radical which causes lipid peroxidation. In response to deleterious effects of free radical induced lipid peroxidation, cells activate antioxidant defense mechanisms in which superoxide dismutase (SOD) and reduced glutathione (GSH) act synergistically to detoxify the effects of lipid peroxidation. It is assess that workers of tanning industry found to be higher DNA damage and significant increase of oxidative stress.

Keywords: Cr (III), DNA damage, oxidative stress, SOD

**(BWC-14) A NEW SPECIES OF *ARCTODIAPTOMUS KIEFER*, 1932 (COPEPODA,
DIAPTOMIDAE) FROM CENTRAL HIMALAYA OF INDIA WITH COMMENTS**

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A new species of freshwater copepod of *Arctodiaptomus* is described from a high altitude lake of central Himalaya. The nearest species of the new species is *Arctodiaptomus parvispineus* which was reported by Kiefer in 1935 from a pond in Chushol, Ladakh, western Himalaya, India. As the species was not described completely, new re-description was made by Shu et al., 2013 with its report from Potatso National Park, of Yunnan, China. *Arctodiaptomus shaikhomensis* n. sp. was different from *A. parvispineus* and distinguishes mainly by the presence of strong comb shape spine on antepenultimate segment reaching well beyond distal margin of succeeding segments. Endopodite has no septum, apex rounded without hairs in female. The identified diaptomid tend to have restricted in Himalayan region and suggests apparently isolated from the purported main area of origin.

Keywords: copepod, new species, diaptomidae, *Arctodiaptomus shaikhomensis*

**(BWC-15) DIVERSITY OF ZOOPLANKTON (PROTOZOA) IN RELATION TO SPECIFIED
HYDROLOGICAL PARAMATERS IN KALIYASOT DAM BHOPAL**

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Zooplanktons are microscopic organisms, acts as integral components of aquatic food web and contribute significantly to productivity of freshwater ecosystems. Zooplankton diversity is one of the most important ecological parameters in water quality assessment. The distribution of zooplanktons depends on a complex of factors such as, change of climatic condition, physical and chemical parameters and vegetation cover. The present study deals with the study of protozoan density and diversity in "Kaliyasot reservior" of Bhopal. In the present investigation an attempt has been made to analyze the percentage variation among all zooplankton collected and identified for the period of December 2013-July 2014 from the four sites. During the course of present investigation, 14 species of free living protozoan were recorded which belonged to the three classes namely class Amoebae, Cilliate and Flagellate. Class Amoebae and Cilliate contribute 5 species each while 4 species represented of class Flagellate were recorded. It has been observed that the sites infested by some specific matters are reason for support to growth of protozoan population. Impact of different land use patterns shows that the sites having no any outer interference found to be free from more protozoan diversity as well as density.

Keywords: protozoa, Kaliyasot, diversity, zooplanktons.

**(BWC-16) IMPACT OF PHYSICO-CHEMICAL FACTORS ON BENTHIC MACRO-
INVERTEBRATES OF BILAWALI TALAB OF INDORE (M. P.)**

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Water is one of the most essential components for survival of life on the earth. One of the major problems of ill health is largely due to lack of safe drinking water. The physico-chemical and biological characteristics of water of Bilawali talab of Indore were studied during September 2013-August 2015. The correlation between 4 chemical parameters has been calculated. Benthic macro invertebrate species has been used as an indicator of the status of a water body. The results revealed that the Physico-chemical factors directly influence the diversity of the benthic macro-invertebrates.

Keywords: Bilawali Talab, Biodiversity, Physic-chemical parameters, Benthic macro-invertebrates.

**(BWC-17) CONSERVATION OF RIVERINE ECOSYSTEMS WITH SPECIAL REFERENCE TO
CENTRAL NARMADA RIVERSCAPE**

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Narmada, the lifeline of Madhya Pradesh, is a major west flowing river of central India originates from the Satpura ranges of Madhya Pradesh and joins the Bay of Cambay flowing through three states namely MP, Maharashtra and Gujarat. Out of 1350 km stretch, about 1210 km of its stretch falls in MP. In last few decades the river has witnessed many ecological changes due to increasing human interference. The present paper discuss in details about the changes took place in last few decades in the catchment area of the river and fragmentation of habitats due to formation of small, medium and large reservoirs. For the present study we selected the central stretch of the river starting from the confluence of Dudhi to Indira Sagar reservoir. We selected five sub-basins of major tributaries in this riverscape and prepared their thematic maps with the help of GIS. Remote Sensing data was also used to prepare land use maps and change in land use has also been detected. Physical habitat mapping was also done using the Rapid Bioassessment Protocol. Mesohabitats present in these tributaries were also mapped and documented during the study. The sub-basins of the tributaries namely Dudhi, Barna, Ganjal, Sip and Jamner were selected for the present study. During the study it was found that since most of the tributaries are in hilly slopes, they have a series of runs and riffles but very few pool habitats are available in these streams. Physical habitat assessment indicates that four sub-basins namely Ganjal, Barna, Sip and Jamner are in Optimal category whereas Dudhi sub-basin falls in marginal category indicating its deteriorating condition. Substrate categories indicate that sand is the dominant substrate type in Dudhi whereas Barna and Jamner are dominated by cobble substrate type. Ganjal has gravel and Sip has boulder substrate type in domination. Landuse and landcover change has also been detected in these sub-basins for the last few decades and it was found that in some sub-basins a major change in landuse has been recorded. Fragmentation of habitat and disruption in flow is another important factor in this riverscape as a medium reservoir has been constructed by damming the stream Barna which has created a discontinuation of the stream from the main river. This reservoir has also altered the ecological conditions of the streams of Barna sub-basin as most of the stream stretch is now inundated by the back waters of the reservoir and converted the shallow water habitats into deep water habitats. The reservoir also supports a rich biodiversity of fishes which are exploited for commercial fishery also. Dam across the Barna stream is also a barrier for fish migration which in long term will adversely

affect the fish diversity. Similar conditions have been in Jamner stream which joins the Indira Sagar reservoir from its tial end and the backwaters of the reservoir alter the ecology of the stream. The present paper deals with ecological problems associated with these sub-basins and suggest possible solutions to conserve and manage the ecosystem of these streams and the river Narmada.

Keywords: stream ecosystem, landuse-landcover, catchment, fragmentation of habitats.

(BWC-18) PSORALENE PHOTOTOXICITY ON HILL STREAM FISHES IN DOON VALLEY

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Increases in UV-B radiation at the earth's surface have been observed over the past few decades and are related to depletion of the ozone layer. UV-B penetrates into surface waters and is regarded as an environmental stressor. The depth of UV-B penetration is highly variable because factors such as turbidity dissolved organic matter, phytoplankton concentration and suspended particles change the water's optical properties. Extensive research has been performed on the impacts of UV-B radiation on a wide variety of marine organisms such as bacteria, microalgae, phytoplankton, zooplankton, coral and fish. Fish are especially vulnerable to UV-B radiation during the planktonic early life stages. A number of studies have reported deleterious effects of UV-B on DNA damage, increased mortality, malformation, lesion of skins, eyes, growth, and immune depression. However, the indirect and sub-lethal impacts of UV-B radiation on the behavior of fish, egg, larvae and juveniles are still poorly known. Psoralen is a natural product obtained from plants. It becomes phototoxic with UV radiation. Psoralen can also be activated by irradiation with long wavelength UV light. In this study, monitoring of solar UV-B was performed and effect of solar and elevated artificial UV-B was studied on fishes at high and low temperature with psoralen. Growth, mortality, behavioral studies were performed. Solar UV-B shows seasonal, latitudinal and annual variations with highest value from the month July to October in Doon Valley. *Barilius bendelisis* was more sensitive than *Nemacheilus rupicola* and showed higher mortality at high temperature. UV-B radiation and environmental changes lead to significant threat to aquatic ecosystem.

Keywords: aquatic biodiversity, UV radiation, psoralene, zooplankton, *Barilius*, *Nemacheilus*.

**(BWC-19) RELEVANCE OF RIPARIAN FORESTS IN THE DEVELOPMENT OF
COLDWATER FISHERIES**

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The riparian forest communities are the components of terrestrial ecosystems contributing greatly to the productivity and structure of coldwater aquatic ecosystems in many ways. Adjoining riparian vegetation bestows considerable inputs of particulate organic matter as leaf litter and wood to the water bodies in forested watersheds. The extent of forest activities in the territory and the allochthonous inputs from the riparian forests significantly affect the budgets of the streams or lakes thus assessing their impact on fish habitat and suggesting conservation minded management strategies have become a necessity. The presence of riparian forest helps in stabilizing banks, filtering surface water, providing shelter to fish by ensuring large woody debris input, maintaining water temperature, food supplies such as insects, larvae, fruits and leaves for fish, supplying organic substance for aquatic environment, addressing landscape-scale water quality issues such as hypoxia and preventing excessive sediment and nutrient input from disturbed areas. Harvesting forests can lead to changes in the amount of water entering streams as well as the timing of these flows. The potential negative impact on coldwater bodies caused by deforestation near the aquatic ecosystems brings changes to stream hydrology, water quality, in-stream habitat and higher levels of sediment in nearby water bodies. Although human interference like climate change, forest management measures such as logging and drainage have caused substantial changes to the water quality, primary production, composition of benthic animals, sediment loading of streams and to the spawning and nursery habitats of coldwater fishes in particular. Riparian restoration, particularly riparian tree planting, provides relatively uncomplicated and inexpensive opportunities for fisheries habitat restoration. Forests in the banks of hilly waters provide opportunities to integrate profitability and productivity with environmental stewardship resulting in healthy and sustainable coldwater systems that can be passed on to future generations.

Keywords: coldwater, forests, riparian, sediment.

**(BWC-20) CHRONOLOGICAL CHANGES IN DIVERSITY OF MACROZOOBENTHOS IN LAKE
NAINITAL, KUMAUN HIMALAYA**

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Lake Nainital lies at an altitude of 1937 m above sea level in the hills of Kumaun Himalaya. The lake is a natural fresh water body and has a great bearing on the socio- economic conditions of the region. Since a long time it has been fascinating the limnologists for its structural and functional studies. Many aspects of the lake ecology have been studied so far. The purpose of this paper is to analyse the long term changes in the macrozoobenthic biodiversity in last four decades. Macrozoobenthos in the lake were surveyed for the first time in 1977 (Gupta, 1981). At that time, a total of 30 species belonging to 9 taxonomic groups were reported. Later on, when the benthos were studied during 1998- 2001, only 18 species belonging to 6 taxonomic groups were found (Nagdali 2002). After a gap of about 6 to 7 years, the survey of these organisms showed 8 species belonging to 5 taxonomic groups (Gupta2008). These organisms were again investigated in the lake during 2010- 2012 when 8 species of 5 groups were reported by Joshi (2013). The current survey by the authors (2017) indicated the presence of 15 species belonging to 7 taxonomic groups in the lake. The reasons for the drastic changes in the species diversity of macrozoobenthos in relation to major events in the lake such as inshore debris/sediment removal, invasion of an exotic fish species, hypolimnetic aeration, biomanipulation, etc. and changes in the lake's catchment are discussed in the paper.

**(BWC-21) OBSERVATIONS ON ZOOPLANKTON COMMUNITY OF NANAK SAGAR
RESERVOIR, UTTARAKHAND**

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The zooplankton density and diversity along with important physico-chemical parameters were studied on fortnightly basis during the period of eight months from August, 2016 to March, 2017 in Nanak Sagar reservoir, Uttarakhand. Three sampling sites of the Nanak Sagar reservoir i.e. (A1, A2 & A3) were selected according to human intervention for regular sampling of zooplankton and water. The range of physico-chemical parameters i.e. water temperature, dissolved oxygen, free carbon-dioxide, transparency, pH, conductivity, total dissolved solids, total alkalinity, nitrate and phosphate during the study period were 16.9 to 34 °C, 3.2 to 9.6 mgL⁻¹, 0 to 6 mgL⁻¹, 67.9 to 194 cm, 7 to 8.7, 118 to 336 µS cm⁻¹, 91.7 to 156 mgL⁻¹, 60 to 140 mgL⁻¹, 0.22 to 0.64 mgL⁻¹ and 0.043 to 0.2 mgL⁻¹ respectively. The zooplankton mainly consists of Rotifera, Copepoda, Cladocera, Ostracoda and Diptera, Out of 24 genera, 10 were from rotifera, 6 from cladocera, 5 from copepoda, 2 from ostracoda and 1 belonged to diptera group. The average density of zooplankton was 6250 ind. L⁻¹, 4125 ind. L⁻¹ and 4000 ind. L⁻¹ at site A1, A2 and A3 respectively. Diversity of zooplankton showed their own maximum and minimum abundance during a particular season. Zooplankton diversity was high at site A2 as compared to site A1 & A3 throughout the study because of stable environment and less human intervention. The water quality parameters of Nanak Sagar reservoir reveal that the environmental conditions are good from fisheries point of view.

Keywords: zooplankton, diversity, physico-chemical, rotifera, Nanak Sagar, reservoir, density

(BWC-22) ASSESSMENT OF HEAVY METALS IN WATER, SEDIMENT, MACRO VEGETATION AND FISH OF LAKE NAINITAL

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Assessment of heavy metals concentration in water, sediment, macro vegetation and fish of Lake Nainital was made from September 2016 to February 2017 with the help of Atomic Absorption Spectrophotometer (AAS) in the present investigation to evaluate pollution status of the lake. Three sites viz., S₁ (Aeration centre at thandi sadak), S₂ (platform near the Naina Devi Temple in Mallital) and S₃ (boat stand in Tallital near bus stand) were selected based on pollution level and fortnightly sampling was done. The important physico-chemical parameters such as temperature, electrical conductivity, TDS, transparency, pH, DO, free CO₂, alkalinity and hardness of the lake were also analyzed. The average concentration of heavy metals in water and soil of Lake Nainital during investigation period were observed as Zn(0.029 mg L⁻¹), Pb(0.346 mg L⁻¹), Cu(0.113 mg L⁻¹), Mn(0.361 mg L⁻¹), Cd(0.007 mg L⁻¹), As(0.001 mg L⁻¹) and Zn(0.871 mg L⁻¹), Pb(1.150 mg L⁻¹), Cu(0.156 mg L⁻¹), Mn(1.778 mg L⁻¹), Cd(0.132 mg L⁻¹), As(0.003 mg L⁻¹) respectively. The values of heavy metal pollution index shows that the water of Lake Nainital is slightly affected with Mn and seriously affected with Pb. Values of Bio-concentration Factor reflected that gills of selected fish serve as hyper-accumulator for Zn, Mn and Cd whereas muscles were hyper-accumulator for Zn and Mn. No hyper-accumulation was recorded in leaves or roots of macrophyte. The study concludes that the presence of elevated levels of Pb and Mn in lake water poses threat to human population as the lake water is used for domestic water supply. Also the increased level of Zn, Mn and Cd in fish is a matter of concern as it can result in imbalance of food web in the lake.

Keywords: Nainital, metal pollution index, hyper-accumulator, imbalance

(BWC-23) GENETIC DIVERSITY OF *ESCHERICHIA COLI* AND *VIBRIO* ISOLATES FROM RIVER GANGA AT ALLAHABAD

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Vibrio are pathogenic to aquatic animals and can cause serious infections on farms amongst fish and prawns. The genus *Vibrio* of the family Vibrionaceae contains more than 50 species and its taxonomy is continuously being updated due to the addition of new species detected by molecular taxonomic techniques. On the other hand the Gram negative bacterium *Escherichia coli* is a normal commensal of lower gastrointestinal tract as well as an environmental pathogen. *E. coli* population comprising of both commensals and pathogenic strains are voided into environment through faecal route. These are often responsible for ascending infections in humans and animals. Since the aquatic environment is a reservoir for these microorganisms, detailed studies on the pathogenic potential of these pathogens would contribute to understanding the virulence properties of these bacteria. *E. coli*, and *Vibrios* are frequently encountered pathogens of human as well as aquatic and terrestrial animals. Since more and more these pathogens are being found from different samples, development of sensitive and specific methods for their genetic characterization and rapid identification assumes very important. Many of the microbial procedures for the detection of these bacterial pathogens are laborious and time consuming or don't allow quantitative assessment of these organisms. A number of modern molecular biology techniques are available for this purpose. Genomic fingerprinting methods are considered as most accurate methods for typing of microorganisms and epidemiological purposes, and provide a more stable basis for microbiological investigation than phenotypic. Several molecular techniques including finger-printing by randomly amplified DNA polymorphism (RAPD-PCR), Amplified Fragment Length Polymorphism (AFLP), Pulsed Field Gel Electrophoresis (PFGE), Restriction Fragment Length Polymorphism (RFLP), plasmid profiling and ribotyping have been used to study different strains of microbes. However, PCR based fingerprinting is suited for molecular genetic characterization (Mazurier et al., 1992).

In the present study, the bacteriological quality of water samples of river Ganga at Allahabad zone was studied and *Vibrios* and *E. coli* were isolated and identified. Apart from conventional detection methods, molecular tools of polymerase chain reaction (PCR) and RAPD-PCR and ERIC-PCR have been used for characterization of the isolates. The study included cultural isolation of *Vibrios* and *E. coli* from water samples followed by their identification by biochemical tests. Molecular tools like RAPD- PCR and ERIC-PCR was used for characterization of pathogens. The details of the results have been presented in the paper.

(BWC-24) ISOLATION AND IDENTIFICATION OF MICROBIAL PATHOGENS OF PUBLIC HEALTH SIGNIFICANCE IN AND WATER QUALITY OF RIVER GANGA AND MANDAKINI

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River Ganga is the most important river of the country and to millions of people it is sustainer of life through multitude of canal system and irrigation of the wasting load. Hundreds of the villages and even the big cities depend for their drinking water on this river. Municipal sewage constitutes 80 per cent by volume of the total waste dumped into the Ganga, and industries contribute about 15 percent. The majority of the Ganga pollution is organic waste, sewage, trash, food, and human and animal remains. Water samples collected in Varanasi revealed fecal-coliform counts of about 50,000 bacteria per 100 milliliters of water, 10,000% higher than the government standard for safe river bathing. The result of this pollution is an array of water-borne diseases including cholera, hepatitis, typhoid and amoebic dysentery. An estimated 80% of all health problems and one-third of deaths in India are attributable to water-borne diseases. Several workers have worked on different aspects of bacterial contamination and pollution of river Ganga at various locations. Bhargava (1982) in a survey of total length of the river Ganga found that quality index was far above the prescribed limit at Kanpur. He further found that the Ganga water was having unusually fast regenerating capacity by bringing down B.O.D. owing to the presence of large amount of well adopted micro-organisms. As per the CPCB study, while the level of coliform present in water should be below 50 for drinking purposes, less than 500 for bathing and below 5000 for agricultural use. Again determination of antibiogram is essential for selecting antibiotics precisely in treatment bacterial diseases. In the present study, the bacteriological and physicochemical parameters of river Ganga at Allahabad zone and river Mandakini at Chitrakoot zone was studied. Different bacteriological parameters like Total bacterial count (TPC), total vibrio count (TVC), Total Aeromonas Count (TAC) and Total *E. coli* (TEC) or Faecal coli (TFC) count were estimated. Antibiogram profile of selected bacterial isolates was also analyzed. Study was also carried out to assess the incidence of *Vibrio* isolates and *E. coli* in water samples of river Ganga at Allahabad and to determine the sensitivity to commonly used antibiotics. Antobiogram profile of selected isolates indicated good antibiotic sensitivity to tetracycline, cotrimoxazole, gentamicin and chloramphenicol. However, the isolates were quite resistant to nitrofurantoin. The detailed results of present investigation have been presented in the present paper.

(BWC-25) SPATIO-TEMPORAL VARIATIONS IN CHL 'A' CONCENTRATION AT DHARAMTAR CREEK

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Dharamtar creek formed by confluence of Amba River and Patalganga River in Raigad district on west coast of Maharashtra not only plays important role in fisheries of the state but has also been identified as important Coastal and Marine Biodiversity Area (ICMBA) of west coast by Wildlife Institute of India. Fishermen community of this area belong to Koliwada community, who practise traditional fishing in the creek. The adjacent areas of the creek have been identified for many developmental works including port construction, which is expected to alter the ecology of the creek. Five stations were selected along the stretch of the creek to study the spatio-temporal variation in Chlorophyll 'a' (chl 'a') (as a measure of primary productivity) during Sep 2015 - Apr 2016. First station (18°50'14.81"N, 72°57'04.29"E) which was present at outer side of creek was predominantly influenced by tide. Second station (18°50'54.05"N, 72°58'14.02"E) was located at inner side in front of village Kasubala. Third station (18°51'43.20"N, 72°58'44.99"E) was near industrial cargo storage. Fourth station (18°52'07.6"N, 72°59'22.54"E) was near mangrove in parallel to Khadewal village. Fifth station (18°52'33.96"N, 72°59'55.24"E) was in front of Khopta village, below the bridge. During the study period the average chl 'a' concentration at Stations 1, 2, 3, 4, 5 was found as 12.29, 8.48, 13.11, 13.10, 13.26 mg/ m³ respectively. The chlorophyll concentration seems to be similar at all the stations, except at station 2 where remarkably lesser concentration could be seen, relating to lesser productivity and species diversity. Chl 'a' concentration with 16.94, 10.65, 12.56, 11.00, 9.01, 6.65, 10.02 and 19.56 mg/ m³ during Sep 2015, Oct 2015, Nov 2015, Dec 2015, Jan 2016, Feb 2016, Mar 2016 and Apr 2016 respectively show decreasing trend after monsoon and in winter months, picking up in March and increasing in April to reach maximum. Changes in chlorophyll 'a' concentration are often related to changes in nutrient availability. Relatively high value of chl 'a' could be due to abundance of nanoplankton such as *Skeletonema* sp., *Thalassiosira* sp., and *Nitzschia* sp. which are found mostly in large assemblages and thus result in high chlorophyll concentration.

Keywords: spatio-temporal, chl 'a', productivity, Dharamtar creek

**(BWC-26) SEASONAL VARIATION IN PHYSICO-CHEMICAL AND PHYTOPLANKTON
DIVERSITY OF ALAKNANDA RIVER AT GARHWAL REGION**

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Alaknanda river originated from Satopanth and Bhagirathi kharak glacier at an elevation of 3880 m in Garhwal region of Uttarakhand. The seasonal variation of physico-chemical characteristics and phytoplankton diversity of Alaknanda river were studied for a period of one year. In the present study, various physico-chemical parameters i.e. temperature, velocity, total suspended solids, total dissolved solids, total alkalinity, total hardness, pH, EC, calcium, magnesium, sodium, potassium, ammonium, phosphate, sulphate, chloride, fluoride and nitrate were analyzed during Summer, Monsoon and Winter on selected 12 sites from the period of Sep. 2016-Aug. 2017. The present study revealed that the physico-chemical parameters of river water showed a great seasonal variation as DO increases in winter season. Total suspended solids and total dissolved solids were found to be highest in Monsoon season which had a strong impact on other physico-chemical characteristics of river. pH, EC, total hardness and total alkalinity were observed highest in rainy season. 31 genera of phytoplankton were recorded under family as Bacillariophyceae, Chlorophyceae, Myxophyceae, Euglenophyceae and Xanthophyceae, however, the overall phytoplankton diversity was found maximum in winter and pre-summer season. The present study revealed that the existing water quality and rich phytoplankton diversity of Alaknanda river would be contributed significantly to enhance the ecosystem productivity.

**(BWC-27) IMPACTS OF HYDROPOWER PLANTS ON RIVERINE RESOURCES OF
BHAGIRATHI RIVER AT GARHWAL REGION (UTTARAKHAND)**

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Garhwal region of Uttarakhand state is blessed with major water resources including large Riverine system with its tributaries. Bhagirathi River is originated from prime source at Gaumukh, an ice cave at the snout of the Gangotri glacier (elevation 4100 m). It traverses about 205 km before it reaches Devprayag. The Bhagirathi river bed has a steep gradient of almost 50 m/km in its upper reach up to Loharinag. Its average slope along its length up to Devprayag is 12.5 m/km. The Bhagirathi and its tributaries are native home to a variety of biological resources in terms of distinct flora and faunistic diversity i.e. Phytoplankton (Bacillariophyceae, Chlorophyceae, Myxophyceae and Xanthophyceae etc.), Zooplankton (Cladocera, Protozoa and Rotifera etc.), Benthos (Ephemeroptera, Hemiptera, Diptera and Coleoptera), and fish species (Cyprinidae, Balitoridae, Sisoridae and Salmonidae). The Govt. of Uttarakhand has utilized these Riverine water resources as great potential Hydro-Power regions of the nation. A total numbers of around 32 hydropower projects are running in different stages (In operation, at construction and under development), which are developed by different union and organizations contribute around 3977 M.W. hydro energy in the region. These hydropower developments on Bhagirathi river have created several constraints in terms of various environmental variables i.e. habitat fragmentation, river water quality, river flows, disruption of fish migration, impact on aquatic biota and diversity, fragmentation of river length, loss of forest area, critical wildlife habitats and destruction of habitat for rare species. The present data based on different sources has enlightened on ground based requirement of sustainable environmental development in Garhwal Himalayan region for carrying capacity of running water to maintain the aquatic biodiversity.

**(BWC-28) EVALUATION OF PHYSICO-CHEMICAL CHARACTERISTICS OF CERTAIN FISH
PONDS OF B.U., BHOPAL**

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The research was conducted to study water quality of four different ponds in Barkatullah University, Bhopal from August 2015-October 2015. Four pond water samples were analysed from different locations for sampling purpose. Various physico-chemical parameters like water temperature, pH, Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Hardness, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Residual Chlorine, Chloride, Alkalinity were analysed from different pond water samples.

The observed range of physico-chemical parameters like pH, total dissolved solids (TDS), temperature, and salinity and dissolved oxygen (DO) were 6.50 – 9.69, 165.5 – 254.8 ppm, 20.9 – 33.8°C, 5.1 – 6.9 ppt, 2.41 – 4.8 mg/l respectively. Correlation coefficient (r) was found significant at $p < 0.05$ level for the tested parameters. The result of the proposed study reveals that water of different pond samples was found good for fish culture and various other purposes like domestic and agriculture.

Keywords: Dissolved oxygen, pond, physico-chemical, pH, COD, temperature, fish.

(BWC-29) JASINGFAA AQUA TOURISM CENTRE: A FISH BASED CONSERVATION MODEL

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Fish based eco-tourism activities can be the prime source of attraction for tourists and fish lovers all over the world. This fishery sector therefore has been termed as the sunshine industry keeping in view its acceptability, employability, commercial profitability and overall growth of the fishes. The Northeast region of India bestowed with numerous water resources and fish diversity is not very uncommon for eco-tourism activities in the guise of such fish sports nevertheless an organized effort in secluded. Mention can, therefore, be made about the Jasingfaa Aqua Tourism Centre (JATC), a fish based eco-tourism centre in Nagaon district of Assam that has put forward a convincing step in this regard. Apart from various tourist amenities in this center with a multi-cuisine restaurant, open air arena, children parks, conference hall and cottages, Jasingfaa is also engrossed with fish based tourism by promoting angling for young students and numerous anglers. Angling competitions for grown-ups and angling tips for young ones are organized each year inviting visitors across the country. Jasingfaa encourages conservation of many endangered and threatened fish species which are mostly indigenous or endemic to the region. The centre has set up a brood bank for golden mahseer (*Tor putitora*), in association with ICAR-DCFR, Bhimtal, aiming at increasing the mahseer population for seed production and propagation and fish watching. Another such important fish is *Osteobrama belangeri*, an endemic fish of Manipur being cultivated in the center. In addition, Jasingfaa has conserved more than 40 varieties of endemic fishes of Assam in its water bodies in the form of ponds, tanks and natural wetlands with an objective for their natural propagation. It is therefore noteworthy to mention herewith that these efforts of conservation is bearing fruits by increasing the fish population in these water and also attracting large number of tourists for fish watch and generating employment and avenues in return on a rural front.

Keywords: eco-tourism, angling, aquaculture, endemic fish, employment and Jasingfaa.

(BWC-30) GOLDEN MAHSEER ANGLING: A TOOL FOR CONSERVATION AND LIVELIHOOD SUPPORT

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“It is healthy for people to go Fishing”, as number of international medical authorities reported it. Sports Fishing of Golden Mahseer is a form of Eco-tourism; it enhances environmental consciousness among people, promotes healthy way of living by associated oneself with nature, more importantly it provides solution for sustainable development of the area. The catch, photograph, weight and release back to water is the order of the day for anglers today. In India there has been a shift of rural population towards urban areas in search of livelihood; Sports fishing can be an answer to job creation; and it helps in data creation, creel census, research on fish in breeding and migration. The angling-tourism will provide a platform for area specific livelihood opportunities, this might help in counteracting urban migration and urbanization. There is a huge need for detail study on Mahseer migration, breeding in the nature, and breeding habitat. The awareness generated through the eco-tourism will impart sense of belongingness to nature, particularly rivers, streams, rural heritage and culture of the area. There is need for capacity development for conservation, curriculum development wildlife and fisheries people for training on sports fishing.

(BWC-31) DIVERSITY OF MAHSEER, PROPAGATION AND ITS CONSERVATION

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Mahseer, the king of freshwater scaly fish belong to the genus *Tor* and *Neolissochilus* is distributed in the entire northeast Himalayan region. The importance of mahseer as a world famous game and sport fish is well known. It also fetches high market price and having excellent nutrient composition in terms of quality protein and fatty acid profile. Keeping the importance of this fish in Himalayan and peninsular rivers, streams and lakes, mahseer has all the qualities to become the national fresh water fish of India. However, the population of this fish is declining in natural water bodies and it is considered as an endangered fish as per IUCN status due to various natural and anthropogenic factors. Therefore, standard protocol for breeding and hatchery management is necessary for its rehabilitation and conservation. Suitable policies at different levels need to be formulated and implemented for improving its status and to bring this fish in mainstream of aquaculture. The protocol for artificial breeding and hatchery management of golden and chocolate mahseer has been standardised. Hatchery produced seed has been transported to the different states of India and stocked into the lakes/reservoirs/ rivers/ streams for enhancing the population. The paper will describe the status of mahseer resources in India, its breeding and hatchery management practices, conservation issues and policies, so that we can perceive this fish in the mainstream of aquaculture in near future.

**(BWC-32) STRATEGIC MANAGEMENT AND CONSERVATION OF ENDANGERED MAHSEER,
TOR PUTITORA IN MID HIMALAYAN REGION, INDIA**

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The Golden mahseer (*Tor putitora*) is called Himalayan pride and an excellent game and food fish but has now become endangered due to excessive exploitation due to a combination of factor including loss of breeding area, rearing habitat, over exploitation and low recovery rates of fishes, result in poor record of sustainability of *Tor putitora*. It is needed to incorporate different management strategies relevant to local socio- economic agenda. The management recommendation deal with method to improve the regulation of fishing, ways to improve conservation ethics and encourage active public participation for drawing specific management strategies. The present article reviews the problem faced in sustainability of mahseer in natural waters and to draw a comprehensive set of strategic management to conserve and propagate the mahseer fishery resources together with establishing of fish parks, fish reserves and conservation efforts of natural resources that would facilitate faster action towards enhancing the stock.

We have attributed an agro-climatic zones wise multifarious programme concept to establish of self sustained mahseer conservation model Interlinking ecotourism” as a tool for in- situ and ex- situ conservation. Under this perspective, production of stocking material through artificial propagation of this species and ranching in their natural habitats is the only solution to save its germplasm from extinction.

Keywords: golden mahseer, management, conservation

(BWC-33) BENTHIC DIATOM ASSEMBLAGES AS BIOLOGICAL INDICATORS OF TROPHIC STATUS IN THE STREAMS IMPACTED BY VARIOUS LANDUSE IN UTTARAKHAND

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Landuse is a broad indicator of the magnitude of anthropogenic stress. The human activities modify the natural conditions (landform, vegetation and its cover) and generate large proportions of nutrients and toxic chemicals, all of which converge into the streams and rivers draining the respective watersheds. The concentration of nutrient and other unwanted material increases with the magnitude of urbanisation, industrialisation or other developmental activities. Diatoms are sensitive to smallest change in water chemistry as well as river bed. Since they dominate by virtue of numbers as well as species, a diatom-based assessment was conducted to determine the natural/semi natural reference and impacted sites across the length and width of Uttarakhand State. The State was extensively sampled across the length and width of the State for 17 streams/ivers at 50 locations ranging from snowline to foothills and Doon Valley. The major river drainages include Nandakini, Pindar, Mandakini, West Ramganga, Saryu, Alaknanda, Khanda Gad, Gomti, East Ramganga, Gaula, Nayar, Khoh, Kosi, Song, Asan and Yamuna. Characteristic diatom assemblages, taxa and ecological state depicting trophic, saprobic, organic pollution, degradation and anthropogenic eutrophication were determined using OMNIDIA software.

Diatom assemblages differ in similar as well as different landuse not only at different but also at same elevations. Thus, the assemblage or characteristic taxon was not similar even in same landuse (forest) and at same elevation in two spring fed streams. e. g. Akashkamini (Mandakini basin, 1824 m Sy. *ina-A. sub: Cer. a var. r- Cer. a-D m*) and Ramganga at Kalimati (West Ramganga basin, 1826 m G pF cap- A m var. m- Em-N aungFc-Fragilariacapucina and Dm-Diatomamesodon) because former lies in the proximity of snowline and receives snow melt also while the latter is located in mid hills and devoid of the features of Akashkamini. Similarly in the forest and human settlement landuse, slight similarity occurs in the Nandakini (glacier fed) at Ghat (1357 m; *Reimeria sinuata*) and Ramganga (spring fed) at Mehalchaury (agriculture land use also, 1370 m; *Navicula cincta*, *Reimeria sinuate*, *Encyonem aminutum*), though source are different, landuse while distance of both location is a constant factor as in the Akashkamini and Ramganga above. In same landuse intermingled with agriculture, the locations at lesser altitude have taxa that are more common; the glacier fed Mandakini (Tilwara.707m *Cymbella tumida*, *Denticula kuetzingii*, *Synedra ulna*, *Synedra ulna form a mediocontracta*), Pindar (Karnprayag 758

m; *Adlafiaminiscula*, *Achnantheidium minutissimum*) and Sarju (East Ramganga Bageshwar 863 m; *Cymbella excisa*, *C. laevis*, *S. ulna form a mediocontracta*, *E. minutum*, *Cocconeisplacentula*, *Achnantheidium biasolettianum*). Only, *Cymbellalaewis* was characteristic taxa for Forest-Agriculture-Village landuse in Pindar (876 m asl) and Nandakini (1027 m asl) river's. In Doon Valley (400-600 m asl) only *G. parvulum* was characteristic for same landuse in the Song and Yamuna while more than one taxon in the Asan.

Ecological state of diatom community in all the streams/rivers of each zone is largely alkaliphilous (pH 7), salinity - fresh brackish along with high concentration of organically bound N₂ and oxygen level. The saprobity is medium (β -mesosaprobous (the environment having 70-85% oxygen saturation and 2-4 mg l⁻¹ BOD), in rivers of all the zones (except high in the Song and low in the Asan). Trophic status is medium (mesotrophic) only in case of the Pindar, Nandakini and Mandakini while eutrophic at all other locations. However, at few stations in the rivers the trophic status changes seasonally from low to high. The organic pollution, ecosystem degradation and anthropogenic eutrophication are mainly non-existent in the rivers of UK. However, at few stations it changes from non-existent to low in Pindar, Nandakini and Mandakini, moderate in case of other rivers, but the organic pollution and degradation is higher in the Doon Valley. Organic pollution is evident in the Alaknanda due to town area. The trophic state is mostly mesotrophic in the Mandakini, few eutrophic (Nandakini, Pindar in winter lean season), and rarely hypereutrophic in the Mandakini basin in winter and summer. This correlates with low degradation and low anthropogenic eutrophication, attributed to predominance of forest landuse. Degradation is low throughout this zone. Organic pollution is non-existent throughout the basin, but points to anthropogenic eutrophication in the Mandakini and Nandakini. Most pristine reference sites occur in this zone, till natural flows are hindered by hydropower projects and consequential urbanisation.

**(BWC-34) STATUS OF AQUATIC BIODIVERSITY IN RELATION TO HABITAT ECOLOGY OF
RAM-GANGA RESERVOIR AT KALAGARH (UTTARAKHAND)**

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Aquatic biodiversity is one of the most essential trophic characteristics of the aquatic ecosystem for maintaining its biocoenosis. Ramganga reservoir (latitude 29°-31'-13" longitude 78°-45'-35") is covering an area 7831 hectares of water surface at Kalagarh in the foot hills of Shiwalik Himalayan range in between Garhwal and Kumaun region of Uttarakhand. The present study was undertaken from August 2015 to July 2016 to assess the present status of aquatic biodiversity as species richness in relation to habitat ecology of Ram-Ganga reservoir. Surface water samples were collected on seasonal basis during summer, winter and rainy season from four sampling zones of Ramganga reservoir. . The water samples were analyzed for different physico-chemical attributes and various biological parameters including phytoplankton and zooplankton. The physico-chemical parameters like water temperature ranged between 13.1°C to 29.8°C, pH ranged between 7.14 to 8.5, E. conductivity ranged between 112.3µ/S to 152.2µ/S, Sodium ranged between 1.07 mg/l to 1.36 mg/l and Potassium ranged between 1.18 mg/l to 1.36mg/l. In total, phytoplankton were recorded as 12 taxa belonging to three different families Chlorophyceae, Bacillariophyceae and Cyanophyceae, out of which highest diversity was found from Bacillariophyceae. Similarly 11 taxa of Zooplankton belonging to 4 different genera including Protozoa, Rotifera, Copepoda and Cladocera were recorded. The physico-chemical conditions were favorable for the growth and survival of these aquatic organisms. The data collected was subjected to statistical analysis and significant correlation was recorded between the physico-chemical parameters and biotic organisms. The qualitative and quantitative occurrence of plankton populations indicated a good water quality of Ramganga reservoir and showed an good ecological indicators of high ecological productivity.

Keywords: aquatic biodiversity, habitat ecology, Ram-Ganga reservoir

(BWC-35) EVALUATION OF PHYSICO- CHEMICAL CHARACTERISTICS OF CERTAIN FISH PONDS OF BARKATULLAH UNIVERSITY, BHOPAL

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The research was conducted to study water quality of four different ponds in Barkatullah University, Bhopal from August 2015- October 2015. Four pond water samples were analysed from different locations for sampling purpose. Various physico-chemical parameters like water temperature, pH, Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Hardness, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Residual Chlorine, Chloride, Alkalinity were analyzed from different pond water samples. The observed range of physico-chemical parameters like pH, total dissolved solids (TDS), temperature, and salinity and dissolved oxygen (DO) were 6.50 – 9.69, 165.5 – 254.8 ppm, 20.9 – 33.8°C, 5.1 – 6.9 ppt, 2.41 – 4.8 mg/l respectively. Correlation coefficient (r) was found significant at $p < 0.05$ level for the tested parameters. The result of the proposed study reveals that water of different pond samples was found good for fish culture and various other purposes like domestic and agriculture.

Keywords: dissolved oxygen, pond, physico-chemical, pH, COD, temperature, fish.

(FPB-01) HAEMATOLOGICAL, BIOCHEMICAL AND BEHAVIOURAL RESPONSE OF INDIAN MAJOR CARP, *CIRRHINUS MRIGALA* (HAMILTON, 1822) IN RESPONSE TO CYPERMETHRIN (25% EC)

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The effect of exposure to sub-lethal concentrations of cypermethrin, a synthetic pyrethroid pesticide, on haematological and behavioural response of the Indian major carp, *Cirrhinus mrigala* was studied. The sub-lethal exposure studies were done for 45 days at 0.0914 $\mu\text{g L}^{-1}$ (1/50th), 0.0457 $\mu\text{g L}^{-1}$ (1/10th) and 0.914 $\mu\text{g L}^{-1}$ (1/05th) of 96 h LC50 of cypermethrin. The 96 h LC50 was found to be 4.57 $\mu\text{g L}^{-1}$. Haematological and serum parameters indicated the toxicity effect of cypermethrin in mrigala with an increased AST and ALT activities. Total protein, albumin and globulin values significantly decreased in all the treatment groups over control. Blood glucose was significantly high in all the treatment groups compared to control, showing a hyperglycemic condition which is common under stress. TEC and Hb values also showed significantly low level in treatment groups whereas TLC showed a reverse trend. Carp in test media exhibited loss of schooling behaviour, swimming near the water surface, hyper activity, erratic movements, seizures, loss of buoyancy, darting movements and hitting against the walls of test tanks. A film of mucus was also observed all over the body and also on the gills. The data suggest that sub-lethal exposure of cypermethrin alters the biochemical, haematological and enzymatic parameters of organs and exert stress on the fish.

Keywords: Cypermethrin, sub-lethal, pesticide, haematological, behavioural response, AST, ALT, TEC, TLC, Hb, *Cirrhinus mrigala*

(FPB-02) INVESTIGATION OF ACUTE TOXICITY OF CYPERMETHRIN (25% EC) ON INDIAN MAJOR CARP, *CIRRHINUS MRIGALA* (HAMILTON, 1822)

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Environmental protection has attracted the attention of the wide cross-section of people all over the world which has now become a global issue amongst scientists and researchers working in this area. Pesticides are toxic to aquatic organisms which are important components of food chain such as fishes. Fishes are important sources of protein in nation's diet. So a thorough understanding of pollutant effect on fishes would be rewarding for fish conservation and fishery development. Cypermethrin, a synthetic pyrethroid pesticide and potential toxic pollutant contaminating aquatic ecosystems, was investigated in the present study for acute toxicity. Indian major carp (*Cirrhinus mrigala*) were selected for the bioassay experiments. Experimental fish were exposed to different concentrations of cypermethrin ranging from 1.4 to 32.8µg/l for 96 hrs in test containers. The static renewal test method of acute toxicity test was used. Water temperature was regulated at 26±2° C. In addition, behavioural changes at each cypermethrin concentration were observed for the individual fish. Data obtained from the cypermethrin acute toxicity tests were evaluated using the probit analysis statistical method. The 96h LC50 value for *Cirrhinus mrigala* was estimated as 4.57µg/l. The variation in the LC 50 values is due to its dependence upon various factors viz., sensitivity to the toxicant, its concentration and duration of exposure.

Keywords: *Cirrhinus mrigala*, LC50, bioassay, cypermethrin, toxicity.

(FPB-03) VARIATION IN SOME REPRODUCTIVE BIOCHEMICAL PARAMETERS OF THE SEMINAL PLASMA IN CULTURED AND WILD STOCKS OF COMMON CARP, *CYPRINUS CARPIO* VAR. *COMMUNIS* IN KASHMIR

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Keeping the inbreeding depression in view, the present study was conducted to compare the biochemical parameters of seminal plasma between the cultured and wild stocks of Common carp (*Cyprinus carpio* var. *communis*) during the year 2015-16. A total of 60 fish samples were taken for the present study. In wild conditions, the seminal plasma contained 70.64 ± 10.75 mg/dl glucose, 1.99 ± 1.15 g/dl total protein, 12.99 ± 5.6 mg/dl triglyceride, 5.98 ± 0.629 mg/dl cholesterol and 25.22 ± 4.047 mg/dl urea, whereas in farmed conditions, the seminal plasma contained 85.06 ± 9.29 mg/dl glucose, 0.917 ± 0.62 g/dl total protein, 12.3 ± 5.22 mg/dl triglyceride, 5.53 ± 1.161 mg/dl cholesterol and 28.4 ± 5.75 mg/dl urea. The result revealed that total protein concentration were significantly higher in wild males than cultured counterparts (<0.01). Triglyceride and cholesterol were also found higher in wild environs than farmed conditions but difference of these parameters was found to be non significant (>0.05). On the contrary concentration of glucose and urea were found higher in cultured males than wild ones ($p < 0.01$). These differences can be attributed to the physiological acclimatization of the fish to their living conditions and feeding regime (nutritional deficiencies) which influence the energy metabolism. The present study gives us an idea of the effect of environment on milt quality of cultured & wild males of Common carp.

Keywords: *Cyprinus carpio* var. *communis*, seminal plasma, milt quality, cultured and wild, biochemical parameters

(FPB-04) EURYCOMANONE: A NATURAL COMPOUND FOR ENHANCING THE REPRODUCTIVE OUTPUT IN FISH

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Eurycoma longifolia Jack, also known as Tongkat Ali (TA) is a tropical plant belonging to the family of Simaroubaceae is widely distributed in South East Asian countries. The extracts of TA have been proven to have cytotoxicity, anti-proliferative and aphrodisiac properties. The compound eurycomanone present in the plant is having the property of testicular differentiation and development. The compound was first time tested in *Clarias magur* with the main aim of increasing the reproductive output in the particular species. The docking studies of eurycomanone with some steroidogenesis pathway enzymes was undertaken to know the binding efficiency between the receptor and ligand. The compound was tested in the *in vivo* conditions to know the main outcome in the form of mRNA expression of steroid pathway genes. The toxicity of the compound was done to decide the safe and efficient doses for fish. The toxicity was measured by LC50, genotoxicity, mRNA expression of apoptotic genes and histological analysis. The best dose of eurycomanone was decided and was injected in to the fish either alone or with chitosan. The significant increase ($P < 0.05$) in the transcript levels of steroid pathway genes was observed in the treatment groups with respect to control. This is the first report of the usage of the particular compound on any aquaculture species for reproductive enhancement.

Keywords: eurycomanone, LC50, genotoxicity, chitosan

**(FPB-05) BIOSYNTHESIS OF PUFA IN FISH AND ITS ANTI-CANCEROUS ACTIVITY IN
HUMANS BEINGS: A REVIEW**

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Polyunsaturated fatty acids derived from fish muscles including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are widely consumed as supplements within the community as they cannot be synthesised by the human body because of lack of $\Delta 12$ and $\Delta 15$ desaturase enzyme but they can be effectively synthesized by aquatic organisms including fish. Phytoplanktons and zooplanktons synthesize short chain precursors (linolenic, 18:3n-3 and linoleic acid, 18:2n-6) which are consumed by fish and converted into long chain fatty acids (EPA, 20:5n-3 and DHA, 22:6n-3) within the body of fish. Coldwater fishes are known to contain higher amounts of PUFAs to render tolerance to low water temperatures. n-3 PUFAs have been shown to have potential beneficial effects for chronic diseases including cancer. Considerable evidence from in-vitro cell culture experiments in the literature provide that n-3 PUFAs (EPA and DHA) both increase apoptosis and other death pathways. Anti-tumor effects are mainly initiated by the ability of DHA and EPA to alter lipid environment of the cell. n-3 PUFAs partially replaces n-6 PUFAs in the cell membrane and suppresses the production of arachidonic acid (n-6 PUFA) derived prostanoids (including prostaglandins (PGs), thromboxanes (TXs) and leukotrienes (LTs)), which are pro-inflammatory while n-3 derived prostanoids are anti-inflammatory where inflammation has been positively linked to cancer.

Key words: eicosapentaenoic acid, docosahexaenoic acid, arachidonic acid, cancer, apoptosis

(FPB-06) STUDY OF SOME HAEMOTOLOGICAL PARAMETERS IN *SCHIZOTHORAX NIGER* (HECKEL:1838) IN RELATION TO WATER QUALITY FROM A SHALLOW HIMALAYAN LAKE ANCHAR IN KASHMIR

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The present study was undertaken to assess the influence of lake water quality on the haematological profile of *Schizothorax niger*. Various physico-chemical parameters of the lake were measured and blood samples of fish were taken to measure haematological indices including Hemoglobin concentration (Hb), Total Erythrocyte Count (TEC), Total Leucocytes Count (TLC), Differential Leucocyte Count (DLC), Hematocrit (Hct), Erythrocyte Sedimentation Rate (ESR), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC). These parameters were studied on monthly basis from different sites of the lake. The present results statistically depicted increased levels of pollutants in Anchar lake are responsible for altering the haematological profile of fish. Our findings highlight that haematological indices can be used as an important tool to monitor the variation in the trophic status of lakes. The study recommends that immediate preventive measures need to be taken by the Govt. to protect Anchar lake from further degradation.

Key words: Anchar lake, haematology, *Schizothorax niger*

(FPB-07) HISTOLOGICAL IMPLICATIONS IN ANABAS TESTUDINEUS (BLOCH, 1792) UPON EXPOSURE TO CYPERMETHRIN (25% EC)

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The present study was carried out to investigate the effects of cypermethrin (cyanophenoxybenzylpyrethroid, categorized as restricted use pesticide (RUP) by US EPA because of its high toxicity to fish) on gill histopathology in *Anabas testudineus*. The 24 hr LC₅₀ value of cypermethrin in *A. testudineus* was found to be 17.1 µg/L. Three sublethal concentrations *i.e.* 4.275, 1.71 and 0.171 µg/L corresponding to 25, 10, and 1% of 24 hrs LC₅₀ were used for 45 days chronic studies. At each test concentration 24 pre-acclimatized healthy fishes (7.00±1.0 cm) were used for gill pathology bioassay. Histopathological changes in gills, like clubbing of cells, hyperplasia, fusion of secondary lamellae followed by intense blood congestion and degeneration of primary and secondary gill lamellae confirm the toxic effects of cypermethrin in the test fish. In conclusion, the present study showed that histopathological biomarkers of toxicity in fish organs are a useful indicator of pesticide toxicity. The organ and tissue damage in the experimental fish due to the direct toxicity of the cypermethrin on the gills showed that the degree of distortion of the tissues was proportional to the concentration of the pesticide.

Keywords: water pollution, cypermethrin, histopathology, LC₅₀, *Anabas testudineus*

**(FPB-08) EVALUATION OF SEASONAL GONADAL STATUS AND RENAL THYROID FOLLICLE
IN SEXUALLY MATURED GOLDEN MAHSEER (*TOR PUTITORA*)**

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Adult golden mahseer (*Tor putitora*) both male and female, but separately, were taken up for studying the seasonal dynamicity of gastro-somatic (GaSI) and gonadosomatic (GSI) indices, gonadal status, and renal thyroid follicles. At least five numbers of mature male and female fishes were sampled in summer, monsoon, pre-winter and winter, they were then subjected to measurement (length, weight), dissection (GaSI, GSI). Gonads and kidney were then processed for histological observation. The values of GaSI in females were found in the range from 3.51 to 5.69 with lowest in pre winter and highest in winter season; and in males, the values of the same were found in the range of 3.43 (summer) to 8.08 (winter). The trends of GSI values in both male and female were found to be similar, rise in values from summer to monsoon and then fall in pre-winter, followed by one more rise in winter. In female gonads, the compositions of oocytes, especially cortical alveolar and vitellogenic (both pre and post) were found to be associated with GSI values; more vitellogenic oocytes with higher GSIs values and vice-versa. In males as well, GSI values were found to be highly linked with gonadal status; testicular content was found to be empty in pre-winter, initiation of spermatogenesis in winter and full of spermatozoa in following seasons. The thyroid follicles in female golden mahseer were found in the range from 1.91 (winter) to 3.07 (pre-winter) follicles/1089x817 μm^2 , higher than those in males [0.57 (monsoon) to 1.97 (pre-winter)]. In both the sexes, values of the same were highest in pre-winter, the season where GSI values were recorded to be lowest. The highest number of renal thyroid follicles in pre winter season is perhaps due to the requirement higher thyroid hormones in pre winter season for the initiation of gonadal recruitment.

Keywords: gastro-somatic, gonadosomatic, cortical alveolar, vitellogenic, thyroid follicles

**(FPB-09) SCREENING AND IDENTIFICATION OF APPETITE MARKERS IN GOLDEN
MAHSEER (*TOR PUTITORA*) JUVENILES WITHIN 24 HOURS OF FEEDING**

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Juvenile golden mahseer (*Tor putitora*) of 45 and 90 days post hatching (dph) were taken up for screening of appetite markers. From these two groups of fishes, samples of three were collected at 1/2, 6, 12, 18 and 24 hours of feeding (macerated goat liver). The samples were processed for identification of histological 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 hours, goblet cell numbers in esophagus was found to be drastically lower compared to all other time of observation, and the gradual building up of same seen was after 12 hours. Foregut distention was found to be started at 30 minutes; peak was found at 6 hours, and after that constriction continues until 24 hours. A gradual progression in density and size of supranuclear vesicles in hindgut were observed between 6 to 12 hours of feeding; in 18 to 24 hours, these were found to be progressively decreasing. There were some vesicles present even at 24 hours and 30 minutes of post feeding. The hindgut-goblet cells on the other hand, were seen to be frequent at 24 hours. Maximum reduction in pancreatic zymogen granule was seen at 6 hours of feeding, following that, the granulation was found to be increasing gradually at 12, 18, and 24 hours of feeding. Overall observation revealed that, in natural environment, digestion in golden mahseer juvenile peaks at around 6 hours of post feeding, absorption of macromolecular protein last from 6 to 12 hours. 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 hours of post feeding.

Keywords: golden mahseer, histology, gastrointestinal system, appetite markers

**(FPB-10) SINGLE AND MULTIPLE-DOSE PHARMACOKINETIC STUDY OF FENBENDAZOLE
IN *LABEO ROHITA* (HAMILTON, 1822)**

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The present research was conducted to study the pharmacokinetics and physio-metabolic responses of fenbendazole in juveniles of *Labeo rohita* (average weight 90 ± 0.5 g) following single doses of 10, 20 and 50 mg/kg and multiple oral doses administration of 20 mg/kg body weight at 1st, 3rd and 7th day. For single oral administration, Blood samples were collected at 0.5, 1, 2, 4, 8, 12, 24, 30, 48, 72, 96, and 120 h of post dose and for multiple dose samples were collected from predose to 15th day. Plasma was separated from all collected blood samples and pharmacokinetics studies were conducted to determine the plasma fenbendazole concentration using High Performance Liquid Chromatography (HPLC) technique. In the plasma of *Labeo rohita* fenbendazole was detected in 20 and 50 mg/kg doses but not in 10 mg/kg dose. The drug attained the C_{max} value 1.85 μ g/ml and 3.09 μ g/ml in the plasma at 4 h (T_{max}) after post dose of medicated feed at 20 mg and 50 mg/kg of body weight respectively. The depletion profile of single dose fenbendazole was showed with negligible amount on 96 h and 120 h after post dose of 20 and 50 mg/kg respectively. In multiple dose study, the depletion profile of fenbendazole in plasma was observed, as the concentration has not attained very high value as compared to single low and high dose, and showed fast elimination after withdrawal of the oral administration of drug. Biochemical analysis showed that 50 mg dose caused higher stress followed by 20 and 10 mg. In multiple dose, SOD and catalase level were found significantly high because of drug causing some oxidative stress. GST and GPx activity were found significantly high ($p < 0.05$) in liver of *Labeo rohita* fed with medicated feed showed efficient detoxification. The pharmacokinetics of FBZ in *Labeo rohita* displayed relatively rapid absorption and relatively rapid elimination. The drug at 20 mg/kg body weight is well tolerated and no serious adverse effect occurred in the fishes.

(FPB-11) CHANGES IN THE EXPRESSION OF Na^+ , K^+ -ATPASE AND SERUM OSMOLALITY DURING MIGRATION OF HILSA (*TENUALOSA ILISHA*) ACROSS THE SALT BARRIER

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Breeding migration essentially influence the salt balancing capabilities of the migratory fishes such as hilsa (*Tenualosa ilisha*), which performs upstream migration for spawning from off-shore of Bay of Bengal to the Bhagirathi-Hooghly stretch of the Ganga river system. The present study was conducted to examine the branchial expression of Na^+ , K^+ -ATPase (NKA) 1 α -subunit in hilsa. The live fish samples were collected from seawater (SW), brackish water (BW) and freshwater (FW) zones of the salinity levels of 28‰, 8‰, 0‰ respectively. Here, we report the molecular cloning and characterisation of cDNA encoding partial NKA 1 α -subunit in hilsa (*Tenualosa ilisha*), consisting of 598 base pair of nucleotides for the first time. We found that the SW inhabited fish exhibited the highest gill and pseudobranch NKA 1 α -subunit expression and specific activity of NKA enzyme, while the FW group was found to have the lowest expression and enzyme activity as well. The highest serum osmolality was recorded in the fish collected from SW habitat as compared to those of the BW and FW habitats. Further, the relative mRNA expression analysis by semi-quantitative method confirmed that of NKA 1 α -subunit in gill and pseudobranch increased with level of environmental salinity. This provide the direct evidence of enhance transcription of NKA 1 α -subunit gene upon increased salinity, revealing the role of NKA in the osmoregulatory acclimation of hilsa during spawning migration across the salt barriers.

Keywords: hilsa, migration, Na^+ , K^+ -ATPase, osmolality, pseudobranch, freshwater, brackishwater, seawater.

(FPB-12) NITRITE INDUCED ALTERATIONS IN SEX STEROIDS AND THYROID HORMONES OF *LABEO ROHITA* JUVENILES: EFFECT OF DIETARY VITAMIN E AND L-TRYPTOPHAN

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An experiment was conducted to study the effect of sub-lethal nitrite exposure on sex steroids (testosterone and estradiol), cortisol and thyroid hormones (T3 and T4) of *Labeo rohita* juveniles. Fishes previously fed with normal or elevated levels of vitamin E (VE) and tryptophan for 60 days were exposed to sub-lethal nitrite for another 45 days with same feeding regime. There were nine treatment groups, viz. VE0TRP₀-N, VE0TRP₆+N, VE100TRP₀-N, VE₁₀₀TRP₀+N, VE₁₀₀TRP_{0.75}+N, VE₁₀₀TRP_{1.5}+N, VE₁₅₀TRP₀+N, VE₃₀₀TRP₀+N and VE₂₀₀TRP₁+N. Except the groups VE0TRP₀-N and VE100TRP₀-N, all other groups were exposed to nitrite. At the end of the 45 days of nitrite exposure, serum samples were assayed for sex steroids, cortisol and thyroid hormones. The serum T3 and T4 levels decreased to the extent of 84.5 and 94.06 %, respectively, upon nitrite exposure. Dietary supplementation with additional amounts of VE and tryptophan appears to reduce the decline of the production of T4. The serum testosterone and estradiol decreased 97.31 and 92.86 %, respectively, upon nitrite exposure. Supplementation with additional amounts of VE was found to reverse nitrite-induced inhibition of testosterone and estradiol production. Serum cortisol increased upon nitrite exposure and unexposed (VE₁₀₀-N) group showed lower levels, which were comparable to groups fed with elevated levels of VE. The overall results of the present study revealed that environmental nitrites have a negative impact on steroidogenesis, which can be overcome by dietary supplementation of elevated amounts of VE (minimum of 150 mg VE Kg diet⁻¹) and to a lesser extent by tryptophan (only at the level of 1.5 % of the diet).

(FPB-13) MOLECULAR CLONING AND CHARACTERIZATION OF MAJOR REGULATORY COMPONENTS OF GROWTH AXIS IN SNOW TROUT, *SCHIZOTHORAX RICHARDSONII*

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The slow growth rate of indigenous snow trout, *Schizothorax richardsonii* limits its aquaculture in Indian uplands. Growth is hormonally regulated through a central circuit called growth hormone-insulin like growth factor (GH-IGF) axis. Therefore, for improving the growth of any species, understanding the molecular mechanisms that modulates skeletal muscle growth through GH-IGF system is of prime importance. Nevertheless, genetic information of GH-IGF system in snow trout, *Schizothorax richardsonii* has not been explored to date. The insulin like growth factors are principally produced in liver under the influence of GH and is bound to a number of IGF binding proteins (IGFBPs). IGF 1 is so far the most validated endocrine marker of growth. Additionally, IGFBPs are also candidates of growth indices. In the present study, the mRNA sequences of major regulatory components of growth axis namely GH, its receptor (GHR) and IGFs of snow trout was obtained by reverse transcription polymerase chain reaction (RT-PCR) and rapid amplification of cDNA ends (RACE). 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*.

(FPB-14) PHOTO-THERMAL MANIPULATION FOR INDUCING MATURITY IN GOLDEN MAHSEER (*TOR PUTITORA*) UNDER CAPTIVE CONDITIONS

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The availability of golden mahseer matured brooders in captivity has always been the major bottleneck for its mass scale seed production which has always been dependent on the wild collection of brooders. Hence, inducing maturity of golden mahseer in captivity is imperative to achieve its conservation and rehabilitation. The present study was undertaken first to gain insight on the physiological basis underlying the constraints in attaining maturity in captivity. Subsequently, photo-period (6D:18L; 12D:12L and 18D: 6L) and temperature (ambient and ambient + 30C) have been evaluated in inducing maturity in captive conditions. Maturity status of pond reared vis-a-vis wild caught golden mahseer in terms of different sex steroids like 17 β -estradiol, 17 α -20 β -DiOH progesterone, LH, vitellogenin and gonadal histology as well as stress biomarkers like cortisol, catalase, superoxide dismutase was assessed first to decipher some of the possible bottlenecks of its non-maturity in captive conditions. The comparative analysis revealed that the non-maturity of golden mahseer in captivity may be partially attributed to the lower levels of 17 β -estradiol, less number of yolk globules, poor vitellogenesis and prevailing oxidative stress in captivity. The effect of photoperiod and elevated temperature (ambient + 30C) on gonadal maturity of golden mahseer in captivity has been assessed. After through physiological (estradiol, vitellogenin, LH, FSH, 17 α -20 β -DiOH progesterone, vitellogenin and gonadal histology, aromatase activity, melatonin levels) as well as histological revelations, it is found that photoperiod (12D:12L) and elevated temperature potentiates maturity of golden mahseer in captivity. However, the final oocyte maturation (FOM) still remains a hindrance.

Keywords: *Tor putitora*, vitellogenin, estradiol, aromatase, maturity

(FPB-15) NUTRIENT COMPOSITION OF IMPORTANT COLDWATER FISHES AND THEIR POTENTIAL ROLE TO HUMAN HEALTH

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The nutrient quality of 22 important coldwater fish species, preferred by the people of upland region in their diet was analyzed and their potential contribution to human nutrition was evaluated. *Tor putitora*, *Neolissochilus hexagonolepis*, *Oncorhynchus mykiss*, *Schizothorax richardsonii* and *Cyprinus carpio*, the important food fishes of Indian uplands were examined for fatty acid and amino acid composition. All the fish species recorded excellent amounts of n-3 fatty acids (8.69–21.48 %) and the n-3/n-6 ratio ranged from 0.7 to 4.98. The amino acid score calculated based on the WHO protein standard indicated good quality proteins in the species. Limiting amino acids such as lysine, methionine and cysteine occurred at levels higher than or marginally lower than the recommended amino acid level. Six small indigenous fish species namely *Macrornathus aral*, *Setipinna phasa*, *Clupisoma garua*, *Aspidosporia morar*, *Barillius bendelisis* and *Semiplotus semiplotus*, collected from the uplands of Brahmaputra river system were subjected to muscle nutrient quality. Protein and lipid in all six fishes were found to be ranging from 15.65 (*S. phasa*) to 20.88% (*C. garua*) and 2.91 (*C. garua*) to 13.23% (*S. phasa*) respectively. Among the fatty acids, sum of n-3 polyunsaturated fatty acids (PUFAs) was found to be high in *S. semiplotus* and *S. phasa* and *B. bendelisis*, and the lower recorded in *C. garua* and so was in n-3/n-6 ratio. In most of these fishes, with slight exception, the profiles of macro minerals reveals the abundance trend, as potassium>calcium> sodium while the trend for micro minerals was iron>zinc> manganese. In terms of dietary mineral contribution, *M. aral* and *B. bendelisis* showed best dietary potential for Ca and *S. phasa* and *M. aral* contributed for Fe. *Labeo dero*, *Labeo dyocheilus*, *Sanguina sanguina*, *Barilius bendelisis*, *Garra mullya*, *L. pangusia*. The important food fishes in Himalaya recorded crude protein levels ranged from 16-20%, crude fat 9.60-1.54 %, moisture content 71-78 % and ash 3.5-0.99%. Maximum concentration of potassium was found in *Labeo dero* followed by *Labeo pangusia*. Selenium was most abundant in all the experimental fishes. Proximate composition, total fat, cholesterol, triglyceride, mineral and fatty acids profile of the flesh of five snow trout (*S. niger*, *S. progastus*, *S. plagiostomus*, *S. curvifrons* and *S. esocinus*) were also analysed. SFA, MUFA, PUFA content were ranging from 57.47-66.06%, 19.44-31.66% and 10.54-14.51%. In SFA, *palmitic acid* (C16:0) is predominant followed by *myristic acid* (C14:0). *Oleic acid* (C18:1n9) was higher in *S. plagiostomus* (16.93%) and *S. esocinus* (13.61%) while *palmitoleic acid* (C16:1n7) was principal MUFA in *S. niger* (16.49%) *progastus* (13.66%), *S.* and *S. curvifrons* (14.34%). The dominant n-6 PUFA were *linolenic acid* (C18:3n6), *linoleic acid* (C18: 2n6) and *arachidonic acid* (C20:4n6). The DHA

values are higher than EPA. The n-6/n-3 ratio ranged from 2.135-4.167. Phosphorus was maximum (5800-8300 mg/kg) followed by potassium (4500-7000 mg/kg), calcium (3500-4300 mg/kg), sodium (700-1800 mg/kg) and magnesium (700-1500 mg/kg). Trace mineral contents (mg/kg muscle) were observed 114.48-125.97 (Fe), 26.38-64.5 (Zn), 4.34-16.19 (Mn) and 7.16-18.11 (Cu). The above results conclude that all the studied fishes are having excellent nutrient qualities in terms of protein, PUFA and selected micro and macro minerals which are beneficial to human health.

Keywords: nutrient quality, human nutrition, coldwater fish, PUFA

**(FPB-16) EVALUATION OF NUTRIENT IN SEVEN SPECIES OF SNOW TROUTS
(SCHIZOTHORAX SPP.) FROM CENTRAL AND WESTERN HIMALAYA**

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Seven species of snow trout (*Schizothorax spp.*) were taken up for evaluating their nutritional values in terms of biochemical composition, amino acids, fatty acids and mineral composition along with their respective dietary potential. Protein content of these seven species of snow trout came in the range of 15.43 to 18.76%. Compared to other, *S. labiatus* was found to be the best to meet the protein requirement of pre-school children, adult and pregnant woman, while *S. Niger* appeared as the least. Fish with highest moisture (*S. richardsonii*) was found to contain lowest value of lipid and vice versa. Based on amino acid analysis and scoring, in all fishes, the principal limiting amino acid appeared to be the lysine, but the values for the same in *S. labiatus* (83.83) followed by *S. richardsonii* (69.31) and *S. curvifrons* (64.86) appeared promising. Lipid, SAFAs, MUFAs (except *S. niger*) and n-6 fatty acids (except *S. labiatus*) were found to be both statistically ($p < 0.05$) and numerically high in fishes from Kashmir than those from Uttarakhand. *S. labiatus* and *S. richardsonii*, showed the best n-6/n-3 ratio (below 1), and the high DV% for n-3 LC PUFAs (around 100% to meet the RDA of n-3 LC PUFAs for pregnant and lactating women). Among minerals, iron was high in fishes from Uttarakhand and medium to low in fishes from Kashmir (except *S. curvifrons*), while other were not site specific. Based on the overall comparison of nutrient content, *S. labiatus* came out as the superior, *S. richardsonii* came to second, *S. progastus* to third, *S. esocinus* to fourth, *S. niger* and *S. plagiostomus* equally to fifth, and *S. curvifrons* to sixth place. This outcome of the present study will complement the existing knowledge on nutritional composition of fishes of Indian subcontinent.

Keywords: nutrient composition, snow trout, fatty acid profile, mineral composition, dietary contribution

**(FPB-17) ROLE OF PHOTOPERIODIC REGIME ON THE GROWTH AND STRESS RESPONSE
OF GOLDEN MAHSEER, *TOR PUTITORA***

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Tor putitora is commonly known as golden mahseer due to its attractive golden colour. *Tor* is commonly confined in the Himalayan river foothills of Indian subcontinents. Different regimes of photoperiodic induction alter the physiological activities of juveniles in order to their growth performance. The different light dark regimes (8L: 16 D, 16L: 8D and ND) shows a significance difference in their growth performance at $P < 0.05$. The average concentration of cortisol in long day photoperiodic induced exposed juveniles was higher (0.9339 ± 0.07671 ng/ml) as compared to natural photoperiodic (0.7751 ± 0.2133 ng/ml) and short day photoperiodic exposed juveniles was (0.6942 ± 0.1087 ng/ml). But there is no significant difference in the cortisol value in all photoperiodic exposed juveniles of *Tor putitora*.

Keywords: cortisol, photoperiod, *Tor putitora*, induction

(FPB-18) PROXIMATE AND ESSENTIAL MINERAL COMPONENTS OF SOME FRESH WATER FISHES OF MANIPUR, INDIA

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Proximate composition, total amino acid (TAA) and essential mineral contents of six freshwater fish species viz., *Tor tor*, *Systomus clavatus*, *Salmotomas ladoni*, *Cabdio ukhrulensis*, *Raiamas guttatus* and *Schistura khugae* were determined. The above species were collected from different hill districts of Manipur, India. The highest moisture, total protein and TAA were recorded in the muscle tissue of *T. tor* (76.43±0.15%, 26.24±0.62% and 720.75±1.3 mg/100g respectively). The highest total lipid was recorded in *S. sladoni* (4.93±0.11%) and the highest ash content was recorded in *R. guttatus* (14.13±0.21%). When comparing the essential mineral contents among the species; calcium, sodium and iron were found highest in *R. guttatus* (2023.50±4.24, 107.60±0.08 and 24.69±0.07)mg/100gm respectively. Magnesium, manganese and zinc were found highest in *C. ukhrulensis* (120.60±0.92, 1.29±0.02 and 3.47±0.02)mg/100gm respectively. Potassium content was found highest in *S. clavatus* (132.50±0.29 mg/100gm) and copper in *T. tor* (0.41±0.15 mg/100gm). According to Recommended Dietary Allowances, the species will made potential contribution of Ca, Mg, Mn and Fe in men's health. These findings suggest that, apart from other diets these species reported from Manipur will provide a good amount of protein, TAA and certain essential mineral elements to our nutrition.

Keywords: proximate composition; essential mineral; freshwater fish; Manipur; nutrition

**(FPB-19) NUTRITIONAL QUALITY OF THREE COBITID FISH SPECIES OF MANIPUR, INDIA:
WITH SPECIAL REFERENCE TO ESSENTIAL MINERAL ELEMENTS**

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The study were carried out to determine the proximate composition and essential mineral elements of three Small Indigenous fish species of Manipur, India belonging to family Cobitids viz. *Lepidocephalichthys guntea*, *Pangia pangio* and *Synchrossus berdmorei*. Moisture (76.12 ± 0.05 mg/100g) were significantly ($P < 0.05$) higher in *Pangia pangio*. In *Synchrossus berdmorei*, significantly ($P < 0.05$) higher protein (22.57 ± 0.00 mg/100g) and lipid (12.93 ± 0.66 mg/100g) were recorded. Whereas, ash (3.23 ± 0.07 mg/100g) was significantly higher in *Lepidocephalichthys guntea*. Macro elements Ca, Mg, K and Na were abundantly found in all the fish studied whereas micro elements Mg, Ni Cu, Zn, and Fe were content in adequate amount. Results from the analysis revealed that macro elements viz. Ca (2150 ± 8.71 mg/100g) and Mg (131.7 ± 2.05 mg/100g) and micro elements viz. Na (112.5 ± 0.06 mg/100g), Ni (2.25 ± 0.02 mg/100g), Cu (0.47 ± 0.007 mg/100g) and Zn (3.05 ± 0.014 mg/100g) were found significantly ($P < 0.05$) higher in *Lepidocephalichthys guntea*. Whereas K (90.81 ± 1.14 mg/100g) and Mn (1.26 ± 0.01 mg/100g) were significantly ($P < 0.05$) higher in *Synchrossus berdmorei* among fishes studied. Fe content were recorded significantly ($P < 0.05$) higher than other minor elements studied and found highest amount of Fe (28.61 ± 0.10 mg/100g) in *Synchrossus berdmorei*. From the above studies it has been reveal that all the fishes were good sources of protein, lipid, ash and mineral contents which can provide high nutritive value for human diet.

Keywords: proximate, macro and micro elements, nutritive value, human diet.

(FPB-20) TOTAL LIPIDS FROM *LABEO ROHITA* INDUCES APOPTOSIS IN OSTEOSARCOMA CELLS THROUGH ROS GENERATION

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Lipid is a good source of omega-3. The present study was designed to extract of total lipid from fish source ie *Labeo rohita* common name is rohu which induces anticancerous activity of osteosarcoma patients. Whether we investigated antiproliferative activity against osteosarcoma. MG-63 cells cultured and treated with different concentrations (25-50 µg/ml) of fish lipid content. Cells viability analysis by MTT assay, intracellular ROS generation, jc-1 for MMP and nuclear condensation for apoptosis were carried out. Results of cells viability data showed that crude total lipid changes the characteristic morphology of cells and also decreased the cell number in a concentration-dependent manner. The results from fluorescent microscopic data of nuclear condensation and intracellular ROS generation revealed that total lipid content significantly induced the level of ROS and led to nuclear apoptosis.

Keywords: Osteosarcoma cell (MG-63), chloroform, methanol, ROS, Hoechst and pi double staining, JC1.

**(FPB-21) DIETARY AND HORMONAL MANIPULATIONS FOR ADVANCED GONADAL
MATURATION AND QUALITY SEED PRODUCTION OF INDIAN MAJOR CARPS AND
CATFISHES**

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The steadily growing importance of culture fisheries has made it imperative that the fish culturists should improve the technique necessary for securing the basic requirement of fish culture, namely the production of young ones (fry and fingerlings) for stocking. The artificial propagation technique, presently used, needs constant refinement for obtaining quality fish seed at the desired times of the year. Modern fish industry is highly specialized exploring more and more possibilities to manipulate reproduction. Altering sexual cycles, induction of advanced, delayed maturation and multiple breeding, ovulation and spermiation and artificial fertilization are to be practiced where nutritive and reproductive physiology might help for faster progress in aquaculture. The recent advances in fish endocrinology have led to a better understanding of the hormones involved in control of gamete production, mode of action and regulation of their secretion during different stages of reproductive cycle. Environmental stimuli like photoperiod and temperature are perceived by the brain which releases gonadotropin releasing hormone (GnRH) that binds specifically to receptors in the pituitary gonadotrops and stimulates secretion of gonadotropic hormone (GtH). The circulating GtH enhances gonadal development and final maturation. GtH regulates ovarian and testicular function by producing maturation-inducing steroids, 17 α ,20 β -dihydroxy-4-pregnen-3-one (17,20-P) and 17 α ,20 β ,21-trihydroxy-4-pregnen-3-one. The GtH functions at the target site in two ways - it induces synthesis and secretion of estradiol-17 β during previtellogenic phase which, in turn, induces vitellogenesis or yolk production during post-vitellogenic phase, GtH triggers the synthesis of 17 α ,20 β -dihydroxyprogesterone (17,20-P) which is responsible for the final maturation leading to ovulation and spermiatioin. Role of nutrition in broostock management for quality seed production in fishes has been appreciated during the recent years. The artificial propagation technique being employed presently needs constant refinement for obtaining quality fish seed at the desired times of the year. Altering sexual cycles, induction of advanced, delayed maturation and multiple breeding, ovulation, spermiation, and artificial fertilization of the commercially important species need to be refined where nutritive and reproductive physiology might help for faster progress in aquaculture. Role of reproductive pheromones in gonadal maturation,

synchronization of reproductive processes and spawning as well as reproductive containment of invasive species may not be overlooked. In this communication, the importance of nutrition in brood stock management for advancing sexual maturation and better quality gamete output and recent advances in hormonal biotechnology in aquaculture with particular reference to cultured Indian major carps and catfishes have been discussed in details.

Keywords: Dietary, hormonal manipulation, advanced gonadal maturation, seed production, Indian major carps and catfishes.

**(FHM-01) ANTIMICROBIAL SUSCEPTIBILITY OF CHRYSJOBACTERIUM SCOPHTHALMUM
RECOVERED FROM GILL DISEASE OF GOLDEN MAHSEER, *TOR PUTITORA*
(HAMILTON, 1822)**

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The antimicrobial susceptibility (AMS) of *Chryseobacterium scophthalmum* strains isolated from the diseased gill of wild golden mahseer, *Tor putitora* was assessed over the period 2016-2017 under the regular fish disease monitoring programme. A standardised disk diffusion method was used to determine the AMS of 55 antibiotics against isolates of *Chryseobacterium* and minimum inhibitory concentrations (MICs) was also determined against the antimicrobial compound authorised for use in aquaculture. All the isolates were found susceptible to co-trimoxazole, clindamycin, ciprofloxacin, nalidixic acid, novobiocin, ofloxacin, rifampicin, oxytetracycline and sulfamethoxazole with trimethoprim, whereas resistant to amphotericin B, bacitracin, chloramphenicol, cloxacillin, cephalaxin, cephadroxil, cefaclor, flucanazole, itraconazole, kanamycin, ketaconazole, metronidazole, nystatin, oxacillin, penicillin-G, polymyxin-B, spectinomycin and tobramycin. The MICs of oxytetracycline, erythromycin, gentamicin, novobiocin and tetracycline for isolated strain was 0.5, 16.0, 16.0, 4.0 and 2.0µg/mL, respectively. Our study suggests the possibility of use of oxytetracyclin or erythromycin to control bacterial gill disease of golden mahseer.

Keywords: Antimicrobial susceptibility, *Chryseobacterium scophthalmum*, disk diffusion method, minimum inhibitory concentrations (MICs) and gill disease.

(FHM-02) HISTOPATHOLOGICAL STUDY OF FEW METAZOAN PARASITIC INFECTIONS IN COLD WATER FISHES OF INDIAN HIMALAYAS

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Histopathological studies in the hill stream fishes of northwest Himalayan region infested with some metazoan parasites were studied during 2014-2015. Host specificity was found to be one of the fundamental characteristics features of metazoan parasites which belonged to the class cestoda, nematoda, trematoda and phylum acanthocephala. Besides this it was also observed that some parasites have even understood to benefit from the well developed antiparasitic armament in fish intestinal epithelia. Thus parasites are exploiting the antiparasitic response mechanism of the host to optimize host finding, invasion and survival in the host, such interaction between host and parasites are considered phylogenetically old. Some monogeneans, cestodes, digeneans and acanthocephalans were found to resist pronounced cellular and host reactions which even improved the attachment of parasite into the host predilection site. SEM study, histopathological examinations were conducted on in-situ parasites to understand the interaction between fish and its parasite and damage inflicted by parasite on the fish.

(FHM-03) CHARACTERIZATION OF AEROMONAS HYDROPHILLA USING FRAGMENTS OF AEROLYSIN AND HAEMOLYSIN GENES COLLECTED FROM INFECTED *SALMO TRUTTA FARIO* (BROWN TROUT) FISHES OF INDIAN HIMALAYAS

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The occurrence of Aeromoniasis in *Salmo trutta fario* (brown trout) was studied for two consecutive years in Jammu and Kashmir exploring different types of water bodies. The samples for bacteriological analysis were collected during active fish disease surveillance programme under a sponsored project, and a total of 120 samples collected in nutrient broth were used for this study. The modified Rimler-Shotts medium was used as a selective presumptive isolation medium. For preliminary identification of bacterial strain IMViC biochemical identification procedure were used wherein Indole, citrate, Voges-proskauer were positive and methyl red tested negative. For rapid detection of two virulence factors of isolated *Aeromonas hydrophila*, a polymerase chain reaction assay was used. The detected virulence factors include aerolysin (aer A) and haemolysin (hyl H) bands appear in screened fish samples showed the molecular weight of 416bp and 597bp against one kb ladder respectively. Moreover the bacteria was subjected to the antibiotic sensitivity test against some antibiotics, and among them amoxclav was found to be the best in combating the infection *in vitro*.

(FHM-04) EFFECT OF DIETARY UTILIZATION OF GARLIC, *ALLIUM SATIVUM* ON IMMUNE RESPONSE IN FINGERLINGS OF AMUR CARP, *CYPRINUS CARPIO* VAR. *HAEMATOPTERUS*

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The present study was carried out to evaluate the growth promoting, antimicrobial, immunomodulatory potential of garlic powder in fingerlings of Amur carp, *Cyprinus carpio haematopterus*. From the result of qualitative analysis of phytochemicals it was recorded that saponin, alkaloids, tannin, steroids, flavonoids, lipids, ketones, phlobutanin, glycosides and reducing sugar were present in garlic powder extracted in both water and ethanol. Bacterial isolates such as *Aeromonas hydrophila*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas fluorescens* were let to grow in tryptic soya broth and Streptococcus enrichment broth overnight. The antibacterial property of crude extract of garlic was assessed by the presence and absence of inhibition zones. The value of total erythrocyte count did not vary considerably ($p > 0.05$) within T_1 and T_2 , T_3 and T_4 in pre challenged group and T_3 and T_4 in post challenged group. The total leucocyte count, haemoglobin and lysozyme activity resulted in significant ($p < 0.05$) increment between pre challenge and post challenge in all treatment groups fed with experimental diet over a period of 245 days. The total serum protein, albumin, globulin, A/G ratio, AST and ALT varied significantly ($P < 0.05$) between the pre challenge and post challenge groups. The water quality parameters like pH, dissolved oxygen, temperature, free carbon dioxide and total alkalinity were within the tolerance range of the experimental fish, Amur carp. It is inferred from the results of the study that dried garlic powder can be safely incorporated up to 1.5 % in carp feeds for enhanced immunity against aeromonad pathogens.

Keywords: Garlic powder, *Aeromonas hydrophila*, and Amur carp

(FHM-05) SURVEILLANCE OF FISH VIRAL DISEASES IN KULLU AND MANDI DISTRICTS OF HIMACHAL PRADESH

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Survey of Trout farms in Kullu and Mandi district of Himachal Pradesh was conducted for the presence or absence of Infectious Hematopoietic necrosis virus (IHNV) and Viral hemorrhagic septicemia virus (VHSV). Preliminary screening of IHNV and VHSV was carried out by collecting 50 samples (25 kidney and 25 spleen) from 25 trout farms of Kullu and Mandi district of H.P. Samples were randomly collected from three moribund fishes showing clinical signs for screening of viral diseases from one trout farm. The samples of each tissue was pooled and stored/preserved in RNA later and transported on ice for detailed laboratory analysis. Total RNA was extracted from the collected samples and converted into cDNA. All the synthesized cDNA samples were subjected to RT-PCR along with positive controls of IHNV and VHSV. So far none of the samples have tested positive in diagnostic RT-PCR for VHSV and IHNV, which suggests that said viruses are absent from the farms surveyed.

Keywords: IHNV, VHSV, RNA later, cDNA and diagnostic RT- PCR

**(FHM-06) TAXONOMIC STUDY OF AN INTERESTING RARE TAPEWORM FROM
FRESH WATER EDIBLE FISH OF CENTRAL INDIA**

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During the cesto-piscian study of Central India. We come across this very important district Hamirpur. Twenty two fresh water fish, *Mastacembelus armatus* (Lacepede) were examined at Betwa River, district Hamirpur (U.P.), India, one of them yielded three parasites in its intestine. Parasites were unsegmented tapeworms which were preserved in 5% formalin in the laboratory these parasites were thoroughly washed, stained, mounted and ultimately identified as new member of family Parabothriocephalidae Yamaguti, 1959; order Pseudophyllides Carus, 1863.

Key words: taxonomic, rare tapeworm, fresh water fish, Parabothriocephalidae, central India

(FHM-07) SKELETAL DEFORMITIES IN CULTURED RAINBOW TROUT AT EARLY STAGE OF DEVELOPMENT

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Rainbow trout, *Onchorhynchus mykiss* is the most cultured coldwater species in India. However, skeletal anomalies or deformities are still a great concern in rainbow trout farming. The incidence of skeletal deformities could be used as an indicator of the quality of rearing conditions. The present study aimed to assess anomalies from the selected farms of Champawat district culturing rainbow trout at early development stages. Skeletal anomalies may arise due to genetic (in breeding depression, triploidy), environmental causes (fluctuations in water quality) and by parasite infections (*Myxobolus* sp.). Mortality started from June 2017 in two farms of Champawat district with 55% prevalence showing typical signs of black tail & whirling like movements. Total 200 fish died in the span of 60 days. Average water temperature in June-July was 17° -19° C, & DO was 7-8 ppm. Tissues & organs (brain, head, kidney, liver, gut, spleen & muscle) were examined under optical microscope to investigate for the myxozoan parasite infections, and found absent. For histopathological study, tissue samples (caudal fin, skin & muscle, visceral mass, spleen, kidney, gill, head and brain) were processed. After screening through the serial sectioning of these tissues, degeneration was detected only in pancreases. The pancreatic degeneration includes deterioration of acinar cells necrosis, fibrosis and macrophage aggregation. The study suggested that the mortality may be caused by the multifactorial parameters i.e. increasing in temperature, unbalanced diet etc. More research is needed to define the conditions that favor repair and prevent the spread of skeletal deformities, which could make a significant contribution in rainbow trout farming in India.

Keywords: skeletal deformities, rainbow trout, temperature, histopathology

(FHM-08) HEALTH MANAGEMENT ISSUES IN AQUACULTURE AND STRATEGIES TO CONTROL PRODUCTION DUE TO DISEASES

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Aquaculture in India is an expanding industry, with varied aquatic resources and potential, engaging over 14.50 million people at the primary level and many more along the value chain. Transformation of the fisheries sector from traditional to commercial scale has led to an increase in fish production from 7.5 lakh tonne in 1950-51 to 107.95 lakh tonne during 2015-16, while the export earnings from the sector registered at around 33,441 crore (US\$ 5.51 billion) in 2014-15 (DADE, 2017). However, occurrence of disease has become a primary constraint to sustainable aquaculture production and product trade, thereby affecting the socioeconomic status of fishers in country like India. A multitude of factors has contributed to the health problems currently faced by aquaculture. A wide range of pathogens, environmental factors and poor husbandry factors have led to cause heavy losses in aquaculture. Poor management practices, high stocking densities and seasonal climatic change were the important factors responsible for mortality and leading to economic losses to farmers. Anthropogenic activities including water harvesting for agriculture, industrial use and power generation, leading to decrease flow, loss of habitat and above all discharge of sewage and toxic factory effluents, polluting large sections of water bodies, coupled with indiscriminate fishing pressure have deeply impacted fish production from water bodies. The prevention of fish diseases is essential for the betterment of the fisheries industry, the improvement of farming production, and the increase in fish resources. Knowledge about the disease process, the pathogen, the host and the environment are very much essential for scientific aquaculture disease management (Subasinghe et al., 2001). A good understanding of biosecurity and disease causation is essential for developing and implementing farm-level plans and husbandry measures to respond to disease emergencies. The details of health management issues in aquaculture and strategies to control disease outbreaks and production loss in aquaculture have been elaborated.

(FHM-09) DEVELOPMENT OF NOVEL CELL LINES FOR THE DETECTION OF COLDWATER FISH VIRUSES

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Indian Coldwater region spans difficult mountainous terrains stretching mainly across Jammu& Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. Collection of diseased fish samples from different sites and shipping them to the laboratory is a cumbersome task. To prove viral aetiology, virus isolation is still considered as the gold standard for which the samples need to be shipped strictly maintaining the cold chain. Diagnosis of cold water fish viruses has been an arduous task. Conventional methods like PCR or serological assays employed to detect virus from suspected samples may not lead to concrete results as false positives lead to confusion. Moreover, virus isolation is quite labour intensive as well as time consuming. It is quite often observed that number of negative clinical samples outweigh the positives making the task more exhausting and cumbersome. Therefore a technique which can unambiguously tell the presence of any virus in a clinical sample is urgently required. This major research gap in diagnostic fish virology can be filled by developing a novel cell line that would enable a virologist to select the precise samples for screening as well as virus isolation. Preliminary screening of samples for the presence of a virus using a transgenic cell line would substantially reduce both cost and effort as only positives will need to be processed further for virus isolation and characterization. Such a method could also permit the detection of emerging viruses that may pose a threat to Coldwater aquaculture.

Keywords: viral etiology, diagnosis, transgenic cell line.

**(FHM-10) A CASE STUDY CAUSES DETORATING HEALTH OF *SCHIZOTHORAX*-AN
IMPORTANT FOOD FISH OF KASHMIR**

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The food we eat influence our health and fish is one of the important and healthy source of food. The food besides containing protein and other nutrients such as vitamin D, it contains a specific type of fats i.e.omega-3 fatty acids, that may reduce the risk of developing heart disease and other medical problems. In Jammu and Kashmir fisheries has the potential to grow exponentially in view of its unique agro-climatic conditions and abundant water bodies in the form of lakes and rivers. But Census reports reveal that there is a constant decrease in the fish production which is attributed to a number of factors especially parasitism and pollution; which warrants a thorough study of these factors especially parasitic infestation In order to understand level of damage caused by parasitism and pollution, parasitological investigation was carried out in the *Schizothorax niger* (Heckel 1838) for a period of one year in River Sindh. A strong positive correlation (Pearson's correlation, $r=0.9$; $p=0.038$,) between total length of *Schizothorax* and number of Helminths was observed. Prevalence and mean abundance were positively and significantly correlated with season ($r=0.7$, $p<0.01$ and $r=0.9$, $p<0.01$, respectively). Thus seasonal dynamics, total length and weight of the host significantly influenced the Helminth infection. The above findings will be useful in devising the appropriate control strategies for the Helminth in wild fish in Kashmir valley as well as in similar climatic zones of other parts of the world. Also, information from this study will be used to assess the spread and extent of the Helminth infection which is a potential threat to the indigenous fish fauna of river Sindh.

Keywords: river Sindh, *Pomphorhynchus kashmirensis*, *Schizothorax*, Kashmir.

**(FHM-11) ECTO AND ENDOPARASITES OF *SCHIZOTHORAX ESOCINUS* AND
*SCHIZOTHORAX CURVIFRONS***

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The aim of the present study was to check the ecto and endo parasites of *Schizothorax esocinus*, *Schizothorax curvifrons* of river Jhelum. This study was carried out from April 2013 to March 2014. During the study a total of 200 fishes were examined out of which 165 were found to be infected with Helminth parasites (cestodes, nematodes, trematodes and acanthocephalan). Species of *Schizothorax* were found to be abundantly infested with *Diplozoon kashmiriensis*, *Clinostomum*, *Bothriocephalus acheilognathi*, *Adenoscolex orieni*, *Rhabidocona raillieti*, *Pomphorynchus kashmiriensis*. From the present study, it may be inferred that the susceptibility of *Schizothorax* species to helminth infestation may be considered as one of the factors responsible for the decline of this native fish from the water bodies of Kashmir valley.

Keywords: river Jhelum, helminth, *Schizothorax*

(FHM-12) *LACTOCOCCUS GARVIEAE* INFECTION CAUSES HYPERACUTE HAEMORRHAGIC SEPTICAEMIA IN FARMED RAINBOW TROUT, *ONCORHYNCHUS MYKISS* (WALBAUM) IN INDIA: CHARACTERIZATION, ANTIMICROBIAL SUSCEPTIBILITY AND PATHOGENICITY STUDY

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Nine bacterial isolates were recovered from eye, anterior kidney, bucal area, lower intestine, spleen and brain of haemorrhagic septicaemic rainbow trout, and were subjected to biochemical and molecular identification. Cell surface characteristics, antimicrobial susceptibility and virulence of the bacterial isolates are also described. All the 9 bacterial isolates had homogenous biochemical characteristics, and were Gram-positive, short chains forming (2 to 8 cells long), α -haemolytic, non-motile ovoid cocci. Partial 16S rDNA nucleotide sequence (~1300 bp) of 4 representative isolates shared 99 to 100% identities with the 16S rDNA nucleotide sequence of *L. garvieae* ATCC 49156 and *L. garvieae* M12. The identity of the 4 representative isolates was further confirmed by PCR amplification of *L. garvieae* specific ~1100 bp fragment. All the 9 bacterial isolates were susceptible to erythromycin, amoxicillin, ampicillin, azithromycin and ciprofloxacin. Transmission electron microscopy (TEM) of *L. garvieae* RTCLI04 indicates that the isolated strain has thin outer capsule of ~10 nm, and is of KG+ phenotype. An intra-peritoneal and intra-muscular injection (2.6×10^5 CFU ml⁻¹), and immersion in bacterial suspension @ of 2.6×10^5 CFU ml⁻¹ to healthy rainbow trout juveniles (27.5 ± 3.7 g) with *L. garvieae* RTCLI04 caused 80, 60 and 10% cumulative mortality in challenged fish, respectively, within 15 days post-infection. The haemorrhagic septicaemic disease was reproduced experimentally. Histopathological examination of organs of experimentally infected fish revealed degenerative and inflammatory changes in several organs. In conclusion, our study highlights the need of immediate management and therapeutic measures to contain this disease in India.

Keywords: Rainbow trout, *Lactococcus garvieae*, India, disease, pathogen

(FHM-13) INVESTIGATION OF MEDICINAL PLANTS AS IMMUNOSTIMULANTS FOR HEALTH MANAGEMENT IN FISH DISEASES

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Fish production is often subjected to numerous diseases thereby leading to great losses and decrease in fish production. The chief limiting factor of realization of highly stable fish production is the lack of preventive measures for effective disease control. The use of immunostimulants in aquaculture can be a promising development and may have great potential for the prevention of diseases. Immunostimulants are drugs or nutrients (biological or synthetic) that are known to stimulate the immune system and impart protection, on their own or when coupled with an antigen by means of non-specific or specific mechanisms. Herbal products due to their easy availability, cost effectiveness and minimal side effects have a great potential as immunostimulant in fish culture, as they are capable of producing more effective sustained immune response against a broad spectrum of pathogens. Most convenient route for administration of the herbs and herbal extracts is the pre oral route. There has been relatively little research on the application of medicinal plants against fish diseases, despite of the fact that herbal remedies have been used for human therapy for centuries. Herbal drugs are eco-friendly and can be used not only as remedies but also as growth promoters, stress resistance boosters and prevention of infections. Plants are rich in a wide variety of secondary metabolites of phytochemical constituents such as tannins, alkaloids and flavonoids, which act against different diseases. The use of such plant products as immunostimulants in fish culture systems may also be of environmental value because of their biodegradability. Due to their numerous beneficiary attributes, herbal extracts can be used in fish culture as an alternative to vaccines, antibiotics or chemotherapeutic agents.

Keywords: immunostimulants, herb, drug, fish disease

**(FGB-01) STUDY OF THE GENOTOXIC EFFECTS OF POLLUTED WATER OF DAL ALKE
IN *CYPRINUS CARPIO* BY APPLYING MICRONUCLEUS ASSAY: A SENSITIVE
MONITOR FOR AQUATIC POLLUTION**

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Recognition of pesticides in fresh water Lakes (Dal and Mansbal Lake) through GC-MS technique is scarce also the recovery in micronuclei frequency of *Cyprinus carpio* after transfer to unpolluted media has not been reported yet. It was with this aim, the collection of water samples was taken from three sites and analyzed for their pesticide profile by dispersive liquid-liquid micro extraction (DLLME) followed by GC-MS. Influence of pesticides on MN frequencies of *Cyprinus carpio* was also investigated. The obtained results clearly showed the presence of pesticides like chlorpyrifos, dimethoate and dichlorvos in water samples collected from all the three sites of Dal Lake. Statistically significant ($p < 0.05$) higher values for MN was obtained in the samples from the Dal Lake compared with those from Mansbal Lake. These data, when compared with the values found in *C. carpio* from both the Dal Lake and Mansbal Lake kept under laboratory conditions after 15, 30, 45 and 60 days of maintenance in clean water found that during depuration, incidence of micronuclei frequency came down significantly ($p < 0.05$) indicating the compensatory response by the fish against the pesticide stress. Therefore, MN could be used as indicators of pesticide pollution in aquatic organisms and were recommended for environmental monitoring for investigating the mechanism involved in the recovery pattern.

Keywords: DLLME, GC-MS, micronuclei, pesticides, fish, recovery.

(FGB-02) INTEGRITY OF dsDNA (FISH) UNDER DIVERSE PRESERVATIVE CONDITION

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Successful preservation of tissue samples is a pre requisite for long field studies in remote areas. However, there is little published information concerning field preservation of fish tissues for DNA analysis. DNA was extracted from 2 cyprinid fishes preserved in non-buffered formalin (4% & 10%), buffered formalin (4% & 10%) & ethanol (70% & 90%) under 5 different time durations and two different temperature conditions {RT/DF}. The quantity and quality of extractable DNA were assessed. It was revealed that, besides buffered formalin and ethanol preserved sample showed highest quantities and quality of DNA. The higher the water content of the preserving solution the greater the damage to the DNA. The presence of formaldehyde (BF/NBF) in the solutions proved to be very detrimental to quality of DNA. Fixation with formalin, a widely adopted procedure to preserve tissue samples, leads to extensive degradation of nucleic acids and thereby compromises the quality of DNA. The length of time in storage and the storage temperature also affected the quality and quantity of DNA.

Keywords: buffered formalin, fixation, preserve, extraction, temperature.

(FGB-03) STUDIES ON THE GENETIC DIVERSITY OF SNOW TROUT (*SCHIZOTHORAX RICHARDSONII*) POPULATIONS USING MITOCHONDRIAL GENE CYTOCHROME b

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Snow trout (*Schizothorax richardsonii*) is an important food fish commonly known as known as asela. It belongs to family Cyprinidae and sub-family Schizothoracinae, and endemic to Himalayan and sub-Himalayan regions of India. Due to habitat destruction and overexploitation snow trout population is declining in wild and therefore declared as vulnerable (IUCN, 2012). Samples were collected from five different drainages of Kumaun (River- Ladhya, Gola, Kosi, Uttarawahni) and Garhwal (River-Bhilangana) regions of Uttarakhand. Genetic diversity of *Schizothorax richardsonii* was studied using Cytochrome b gene (1140 bp). Analysis of sequence data revealed 281 variable sites, out of which 8 were parsimony informative and 273 were singleton. The overall mean distance between the taxa was 0.007 while mean inter-population diversity was 2.17. The nucleotide composition in Cytochrome b gene was biased towards higher A+T content (A: 26.6%; T: 28.7%; C: 27.6%; G: 17.1%). AMOVA results indicated that majority of the genetic variations are due to variation among populations (57.21%). A total of 11 haplotypes were identified in five populations of *Schizothorax richardsonii* with haplotype diversity (Hd) 0.8967 and nucleotide diversity (π) 0.00260. The population river Bhilangana was found genetically more differentiated than other populations. The overall Fst was found as 0.572. Molecular phylogenetic analysis performed by maximum likelihood method showed two major clades, one having the populations of Kumaun region while Garhwal region formed a separate clad. The present study is helpful in identifying the snow trout population for breeding and conservation programme.

Keywords: snow trout; genetic variability; cytochrome b; nucleotide diversity; haplotype diversity

(FGB-04) MOLECULAR CHARACTERIZATION OF *SAPROLEGNIA* SPP INFESTING RAINBOW TROUT IN HATCHERIES OF KASHMIR-HIMALAYA

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A total of 50 and 95 infected samples were taken during the present study from the two main trout farms i.e. Laribal trout farm and Kokernaag trout farm from October 2013 to March 2014. Wet mount from infected lesions showed masses of mature and immature sporangia filled with spores. Hyphae appeared profusely branched, aseptate and multinucleate. The colonies on fungal agar at 37°C appeared with cysts of long hairs, whitish in color that finally turned blackish. The morphological characteristic features of the fungus confirmed it as *Saprolegnia*. DNA was isolated from the infected sample. The number of amplified DNA fragments obtained by the primers ranged from 380-1800bp. RAPD profiles obtained revealed negligible genetic variation among the isolates. Only one group could be established indicating that the group of closely related strains having high degree of homology is present.

Keywords: hyphae, parasitica, *Saprolegnia* spp. and trout

(FGB-05) BIOCHEMICAL AND MOLECULAR CHARACTERIZATION OF BACTERIAL ISOLATE FROM FRESH WATER FISH GOLDEN MAHSEER, *TOR PUTTORA* (HAMILTON, 1822)

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Fish were the first form of evolutionary higher life to appear in water, in among the earliest vertebrate. The fish are aquatic cold blooded, oviparous or ovoviviparous, streamlined vertebrate with gill for respiration and fin for locomotion. Present study was based on isolation, and characterization of various bacterial isolates from fresh water fish "*Tor putitora*" golden mahseer. Initially Seventeen bacterial strains were isolated from two different body part of golden mahseer i.e. buccle cavity and gill. All the bacterial isolates were checked for extracellular enzyme production activity under biochemical characterization. Urease activity was found in 12 of the isolates and eight isolates were positive for starch hydrolysis, However, Ten isolates exhibited positive results for catalase production, ten isolates for amylase production and four isolates showed lipase production. While checking the isolates for nitrate reductase activity ten isolates gave positive results, four isolate showed production of gelatinase. In IMVIC, thirteen isolates had given negative test for Indole, six of the isolates showed positive for methyl red, three isolates were positive for Voges Prauskeur and eleven of the isolates were able to utilize citrate as a carbon source. All the isolates also varied in their abilities to utilize various types of sugars as their sole source of carbon. Morphological characterization of these isolates showed that thirteen bacterial isolates were found to be gram negative whereas remaining five were gram positive. Further to characterization and identification of bacterial isolate on molecular basis we have chosen 2 best isolates to compare 16s-rDNA sequence from these 2 isolates, for this we have amplified 16s-rDNA gene from these isolates, PCR product was purified and send for sequencing to evaluate their phylogenetic relation.

Key words: biochemical and molecular characterization, IMVIC, phylogenetic relation, 16s-rDNA sequence

**(FGB-06) GENOTOXICITY ASSESSMENT OF SILVER NANOPARTICLES IN FOOD FISH
LABEO ROHITA (HAMILTON, 1822)**

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Silver nanoparticles (Ag-NPs) received tremendous attention due to its unique physico-chemical properties and for having highest commercial utilization. The wastes generated due to such applications are finally released to the aquatic environment which may induce deleterious effects to the aquatic lives including the food fish. Therefore it is very much needed to know the effects of such nano particles on food fish because it may enter to human gut through food chain and may cause health hazard. The present work was carried out to assess the genotoxic effects of Ag-NPs in gills and kidney of *Labeo rohita* fingerlings. Two sizes of 18nm and 29nm of Ag-NPs were synthesized and administered at different doses to investigate the effects of Ag-NPs. Ag-NPs of size 18 nm and 29nm have zeta potential of -55mV and -31.4mV, respectively. Comet assay of kidney showed higher DNA damage than the gill tissue when exposed to 400 and 800µg/l of Ag-NPs. Histological study of gill tissue showed clubbing of secondary lamellae on the tip with moderate congestion. Infiltration of haemocytes with necrotic tubules in the kidney tissue was observed. The kidney showed higher bioaccumulation of Ag-NPs as the days of exposure increased. The results suggested that both the kidney and gills were prone to toxic effect of Ag-NPs in a size and dose dependent manner.

Keywords: genotoxicity, silver nanoparticles, comet assay, histology, bioaccumulation

(FGB-07) GENE DELIVERY INTO FISH CELLS BY A FISH VIRUS DERIVED HYBRID PEPTIDE NANO SYSTEM

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Delivery of gene into fish cells is a challenging task as fish generally have a lower body temperature than mammals. In the present study, a hybrid peptide nano system (RR28) was designed from viral proteins of infectious pancreatic necrosis (IPN) and betanoda virus 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 complexes with it. The peptide RR28 was also able to release pDNA in presence of a reducing agent that mimic intracellular environment. The peptide showed potential for delivery of gene inside fish cell line, chinook salmon embryo (CHSE). This study suggest that the peptide based nano system may be an alternate gene delivery vector for fish cells and also providing new insights into the transfection of fish cells with peptide. To the best of our knowledge, this is the first report on delivery of gene into cells by fish virus derived peptide.

Keywords: fish cells, fish viral protein, transfection, peptide nano system, gene delivery.

**(FGB-08) A SIMPLE AND LOW-COST METHODOLOGY FOR RAPID AMPLIFICATION OF
CDNA ENDS (RACE)**

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Rapid amplification of cDNA ends (RACE) is a RT-PCR technique used for amplification of either 5' or 3' ends of a cDNA. RACE is also used to identify isoforms, variants and different forms of the same gene. One can perform RACE using commercially available kits, which is easy and user friendly, but involves very high cost. Different commercial RACE kits are based on different strategies which has one or more advantage or limitation over the other. Considering the constraints of high cost of RACE kits and limitations in commercial kits, we developed an in house 5' & 3' RACE protocol by applying many known strategies to enhance the specificity and efficiency. The present 5' RACE technique is based on specific terminal transferase and template switching ability of MMLV reverse transcriptase H minus and use of template switching oligo (TSO) with 5' end blocked with C3 spacer. The blocking of TSO led to reduction of nonspecific amplification due to TSO mispriming. The 3' RACE is based on use of anchored oligodT primer during cDNA synthesis protocol and subsequent use of suppression and step-out PCR to reduce non-specific amplification due to anchor binding primers. Further, we designed fish specific probes (based on zebra fish genome) and enhanced template switching and terminal transferase activity of RTaseHminus by addition of MnCl₂ and BSA. Ultimately, this led to very clear and single product amplification, and this protocol doesn't require nested PCR compared to many other protocols in vogue. Using this RACE protocol, so far we have amplified complete 5' RACE products for 7 transcripts and complete 3' RACE products for 17 transcripts. Importantly, this RACE method is 20-30 times cheaper than commercially available RACE kits.

Keywords: RACE, 5'UTR, 3'UTR, reverse transcriptase

**(PHT-01) TECHNOLOGICAL INTERVENTIONS FOR LIVELIHOOD ENHANCEMENT IN
FISHING COMMUNITIES OF KASHMIR VALLEY**

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Technological interventions in the post harvest sector of fisheries can play a pivotal role in boosting the economic status of fishers in Kashmir valley. Traditionally, fish drying in Kashmir is done during the winter season. Dried fish forms an important component of Kashmiri cuisine during winter. The fish used for drying is found in abundance in valley lakes during summers. The fishers catch the fish during summers but don't dry it as it gets spoiled thereby sell it a low price. The indigenous method used by the fishers for fish drying is unhygienic which leads to quick spoilage of fish leading to economic losses. The fish that is sold at throw away price during summer season when dried during winter season is sold by fishers at exorbitant rates. Thus fishers face huge loss by not being able to dry it during summer when catch is available plenty. In order, to make fish drying a profitable enterprise, technological intervention in the form of scientific fish drying can prevent economic losses and enhance livelihood opportunities for small scale producers.

Keywords: technological interventions, scientific fish drying, indigenous drying

**(PHT-02) NOOSE AND LINE FISHING OF SNOW TROUT IN KAMENG DRAINAGE,
ARUNACHAL PRADESH**

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Noose and line fishing is one of the most practiced fishing methods by *Monpa* community along the banks of river Dirang *chu*, Sangti and Chug in West Kameng district of Arunachal Pradesh situated at an altitude ranging from 1480-1520 m asl. The present study analyses the gear specifications, *modus operandi* and its applicability with season, habitat and species specificity. This method of fishing is very selective for catching snow trout (*Schizothoracine*) inhabiting the deeper pools and turbulent lotic water of eastern Himalayas. The nooses and lines are made of material Nylon (PA) monofilament of 0.30-0.41 mm diameter and the pole are made of bamboo measuring 2.5-5.0 m in length and 0.9-3.2 cm girth diameter. The gear is mostly operated during November to February when water of the river is mostly clear and transparent. Average catch per unit effort (CPUE) of the gear was recorded to be 1.8-2.2 kg/hr and average catch size in weight was 136.3 ± 116.34 kg. Noose and line fishing is highly energy efficient and accounts for high fish quality with low investment. Hence, this practice of harnessing the natural water resources was found to be innovative with immense commercial and recreational importance to the tribe community to earn their livelihood and food security in mountainous terrain of the eastern Himalayas.

Keywords: snow trout, fishing, noose and line, coldwater, *Monpa*, Dirang.

**(PHT-03) DESIGN ASPECTS OF FISHING CRAFTS AND GEARS OF WULAR LAKE OF
KASHMIR, INDIA**

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The present study was carried out on the design and technical characteristics of fishing craft and gear in Wular Lake, Kashmir. The study revealed the use of plank built craft, locally called as *Naav* which could be categorized into three length classes; 2 to 5m, 5 to 8m and 8 to 11m. *Naav* was divided into three sections along the length; stem, fish hold, and stern. The commonest gear used in the lake was cast net followed by hook and line, spear, scoop net and lift net. The mesh size of the main webbing in cast net ranged from 40 to 50mm. Two types of cast nets were used depending upon the number of meshes in the last panel the net; *Naushath zaal* and *Bhahshath zaal*. The long line was made up of PA multifilament and the Hooks used were made up of stainless steel. Small pebbles were used as sinkers weighing 15 to 20g each. In Pole and line, locally called as *Bislai*, the length of pole varied from 2 to 3.25m. Hook No. 5 and No. 6 were mostly used. Scoop net, a circular or semi-circular bag-like net, was operated in 1 to 1.5m depth of water with a mesh size of 10 to 15mm. PE multifilament was used for the construction of the bag. Additionally, two types of Spears were used across Lake; Multiple Head Spear and Double Pronged Spear, locally called as *Panzri* and *Narchoo* respectively. Semi-circular and hand braided lift nets made up of PA multifilament having a mesh size of 25 to 40mm, and depth of 1.5 to 2.5m were also operated in the lake. A traditional and unique method of storing the captured live fish was also documented. The fish were stored in the small ponds constructed at the periphery of the lake, wooden boxes, and netting bags.

Keywords: Wular lake, cast net, lift net, hook and line, Kashmir, fisheries.

(PHT-04) UTILIZATION OF MICROBIOLOGICALLY TESTED MINCED MEAT OF LABEO ROHITA STORED AT -20°C AS A LONG TERM PRESERVATIVE FORM OF FRESH FISH

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Microbiological, physicochemical and sensory characteristics of raw minced meat of freshwater fish (*Labeo rohita*) rohu were determined during its storage at -20°C up to a full period of three months. Total bacterial count and moisture percent of minced meat declined gradually. Minor increase in pH and change in color of the mince was reported during storage. Presence of *E. coli* and *Micrococci* ($7.0-5.0 \times 10^{-2}$ g⁻¹ mince) was observed initially which gradually declined with time. *Vibrio cholerae* and *Salmonella* were absent in the preserved mince. Texture, odour, taste and appearance of minced meat did not change significantly during the whole storage period of 90 days. Hence, during the period of short supply of fish in fresh form its frozen stored minced meat can be used for preparation of ready to eat food products.

Keywords: rohu, mince, preservation, microbiological, physicochemical, *Salmonella*

(PHT-05) EFFECT OF SLAUGHTERING METHODS ON YIELD AND QUALITY OF PACIFIC WHITE SHRIMP *LITOPENAEUS VANNAMEI*

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The present study compared the difference in the effect of the two methods of slaughtering i.e. cold shock by immersing in ice water slurry (hypothermia) and by taking out of water (asphyxia) on the quality of white shrimp (*Litopenaeus vannamei*) was evaluated. Yield proximate composition pH, calcium ATPase activity, texture and colour parameters were compared. No significant differences were found in peeled and beheaded yield, proximate composition pH and calcium ATPase activity among the shrimps killed by the two different methods. Texture and colour were found to vary significantly at P 0.05 level of acceptance. Texture parameters like hardness, resilience springiness and chewiness were found to be better in the shrimp killed by hypothermia. Similarly colour of the shrimp killed by hypothermic shock was found to be better than that killed by asphyxia. Therefore it can be projected that the ice water immersion method is better for the killing of pacific white shrimp *Litopenaeus vannamei* as for as texture and colour is concerned.

Keywords: quality evaluation, white shrimp, killing methods

(PHT-05) STATUS OF FISH DIVERSITY, FISHERS AND FISHERIES IN TERMS OF GEAR WISE CATCH COMPOSITION IN NANAK SAGAR RESERVOIR OF UTTARAKHAND, INDIA

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The present investigation was carried out to determine existing fish species status, fish catch composition, fishing gear, fishers and fisheries management practices of Nanaksagar reservoir which are situated in between 28° 45'N latitude and 79° 45'E longitude in Distt. Udham Singh Nagar of Uttarakhand. The study revealed that a total of 41 fish species belonging to 15 families were identified in the reservoir. The maximum fish species (16) were under Cyprinidae family. Two families (Bagridae and Ophiocephalidae) represented 4 species each and another family Mastacembelidae 3 species, Centropomidae 2 species and rest 11 families represented 1 species each. Five different types of fishing gear were identified has been widely used in reservoir. 4 major nets (gillnets, triangular net, drag net, cast net), 6 different number hooks and line (7-12 Nos.) in the reservoir. The highest group total catch was recorded in month of June by all the types of nets accordingly for major carps (20795Kg), for cat fishes (6131Kg), for minor carps (38191 Kg), for miscellaneous fishes (12771 Kg) and for uneconomical fishes (25524Kg) respectively. Two types of fishers were engaged in fishing in the Nanak sagar reservoir. Most of the fishers used gill net and hooks and lines where few of them were used cast net for fishing. The maximum 38% of the fishermen had medium size family, 27% had large size family and the rest 35 had small size family. Among the total fishermen 46.4% had primary or higher level education and 41.8% can sign their name while about 11.8% of them were illiterate. The contributions from other gears like triangular net, hooks and line and cast net for catfish catch were insignificant. Triangular net which is locally known as Besar jal shared alone maximum for catch of uneconomical fishes.

Keywords: fish diversity, gear, mesh size and catch composition

**(IDP-01) STRATEGIES FOR ENHANCING GROWTH AND DEVELOPMENT OF FISHERIES
SECTOR IN KASHMIR VALLEY**

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Kashmir valley being bestowed with a vast network of pristine water bodies like lakes, rivers, wetlands and streams has a tremendous potential for fish growth and development. Fisheries sector can contribute significantly in the state GDP. Government of J&K has made a significant progress in fisheries /aquaculture sector by taking various developmental initiatives like establishing ponds, promoting trout culture, providing subsidies for popularising & promoting aqua-farming. However, capture fisheries in comparison with culture fisheries is still lagging behind. Capture fisheries and its main stakeholders i.e. the fishers have by and large not been given the desired attention. Growth of both the fishers and the fisheries sector are mutually dependent on each other. Moreover, non-availability of sufficient data pertaining to the status of fishers, lack of recognition of fishers as important stakeholders, lack of interdisciplinary approach during conservation of water-bodies has been an obstacle in formulating required policy framework for their development. The paper deals in detail about the various components responsible for slow progress of capture fisheries and the fishing community and also suggests the measures to be taken for their growth and development. Integrating capture fisheries and fishers into developmental discourse is best courses of action available for the development of this sector in the valley.

Keywords: fishers, fisheries, interdisciplinary approach, water bodies

**(IDP-02) IN VITRO ANTHELMINTIC EFFECT OF *NIGELLA SATIVA* AGAINST *HAEMONCHUS*
SP. OF *CAPRA HIRCUS* (GOAT)**

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The Goat is an important livestock species all over the world and an integrated component of agricultural production system in developing countries. They are reared under a wide variety of production systems ranging from traditional smallholder and village production system to large-scale intensive commercial farms. Goats harbour a variety of helminthes parasites that affect the growth as well as production of the animal. Helminthosis is recognized as one of the most bb prevalent infections in tropical and subtropical countries due to the favourable climatic conditions existing in these regions. Nematodes remain the serious menace to livestock animals and are responsible for decreased productivities resulting in heavy economic losses in animal-based industries. *Haemonchous* sp. (Nematode) is the most prevalent among the all gastrointestinal helminths infecting goat population. Over the past several decades, the worm has been controlled through the use of anthelmintics, but the emergence of anthelmintic resistance has threatened this chemotherapeutic approach. Thus keeping in mind with above prospect this study was undertaken to determine the anthelmintic activity of *Nigella sativa* against adults of *Haemonchus* sp. In vitro adulticidal activities were screened by preparing aqueous and methanolic extract of this plant at 1mg/ml, 2.5mg/ml, 5mg/ml and 10mg/ml concentration with respect to control (PBS) and Standard drug (Albendazole). The results revealed that methanolic extract of *Nigella sativa* showed best effect within 2 hours at 5mg/ml concentration (100% death) and 10mg/ml concentration (100% death) on adult *Haemonchus*, in comparison with aqueous extract of *Nigella sativa*. It is concluded that methanolic plant extracts give a better approach against *Haemonchus* sp. and can be used against the treatment of haemonchosis in goat as an alternative of patent drug.

Keywords: goat livestock, helminthosis, gastrointestinal helminths, *Haemonchus* sp., haemonchosis

(IDP-03) DNA EXTRACTION OF NEMATODE PARASITE PREVALENT IN DOMESTIC FOWL

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Poultry plays very important role for mankind through food supply, income and employment generation, providing raw materials to some industries, facilitating research works etc. Parasitism is an important limiting factor that responsible for deteriorating the health and productivity of poultry. Nematodes are most prevalent parasite all over the world. These are one of the most pathogenic and economically important parasites of poultry. The adult affects the small intestine of the hosts and its control costs million dollars annually. The parasite infection may causes considerable damage and great economic loss to the poultry industry due to malnutrition, decreased feed conversion ratio, weight loss, lowered egg production and death in young birds. In order to provide a clear insight of its characterization, a variety of molecular approaches has been employed. The present study was designed to understand the population dynamics of this parasite. Genomic DNA extraction of nematode parasite is tricky due to the surface morphology of the parasite in domestic fowl as compared to other nematode parasites of different host so it is important to establish a manual for its easy extraction. Extracted genomic DNA can be applied in various molecular tools for parasite identification. Moreover, DNA content can be ensured through polymerase chain reactions (PCR). The identification of different species may be a powerful tool in population studies of parasite turnover within the animal host. The knowledge of the genome provides a comprehensive resource to the scientific community and underpins the development of new and urgently needed intervention (drugs, vaccines and diagnostic tests) against nematodiasis. For this, nematode parasites were collected from native chickens and DNA was extracted using a worm lysis buffer (SDS, EDTA, NaCl, Tris HCl standardised at pH-8.5). It was found that an appropriate amount of genomic DNA can be extracted by using this protocol.

Keywords: poultry, nematodiasis, PCR, genomic DNA, weight loss

**(IDP-04) STUDY ON SEASONAL PREVALENCE OF GASTROINTESTINAL NEMATODE
PARASITES OF GOAT (*CAPRA HIRCUS*) IN LUCKNOW**

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Parasitism played an important role in many parts of the world and still a serious threat to the livestock worldwide. Goat (*Capra hircus*), a member of the Bovidae family and subfamily Caprinae is one of the oldest domesticated species. Internal parasitism is one of the biggest problems in the goat livestock. Nematodiasis is a serious threat to goat livestock resulting in low productivity due to stunted growth, poor weight gain and less food utilization. In the present study, 238 gastrointestinal tracts of goats were collected from different regions of Lucknow. The gastrointestinal tracts were dissected and observed to confirm the presence of parasitic infection. 92.70% samples were found positive in monsoon season, 46.87% samples were found positive in winter and 69.23% samples were found positive for infection in summer by the nematode parasites. This observation showed that there is a very high incidence of nematode parasites in the gastrointestinal tracts of goat in the monsoon season. Overall 72.68% samples were found positive for infection by the nematode parasites.

Keywords: goat, gastrointestinal tract, nematodes parasites, seasonal prevalence.

**(IDP-05) IDENTIFICATION OF MICROSPORIDIAN INFECTION IN FLOUR BEETLE,
*TRIBOLIUM CONFUSUM***

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Flour beetles are members of the beetle genus *Tribolium*. The flour beetles consume wheat and other grains and foremost pest in the agricultural industry. In the present study, infected beetles were found in wheat showed pathological changes that were observed under dissecting microscope. Death of young larvae followed the development of large darkened areas in their fat bodies which was detected through their body wall. Light microscopic examination of crushed beetle samples were found to be massively infected with microsporidian spores. The spores observed under phase contrast microscope varied in size having diameter of approximately 4µm to 6µm and shapes were found round to oval. Internal autoinfection was observed by finding in the blood empty spore cases, presumably from the rupture of infected fat cells. The extent of infection was observed by hemocytometer and was found to be 5.9×10^6 spores/ml. Observations of living spores were supplemented by the study of smears of infected larval tissue stained with Giemsa's stain. Meronts and sporonts were differentiated on the basis of their size and nuclear arrangement. Many empty spores were observed but spontaneous extrusion was not observed. Though the specific identity of parasite is uncertain but the spore characteristics and host-parasite interaction revealed microsporidian infection.

Keywords: diseased, pathological, hemocytometer, extrusion, controlling

**(IDP-06) COMPARATIVE STUDY OF WATER QUALITY PARAMETER UNDER BOTTLE
AQUAPONIC SYSTEM AND NORMAL CONTROLLED CONDITION WITH
TRICHOPODUS TRICHOPTERUS (BLUE GOURAMI)**

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An experiment of 45 days was conducted to reveals the water quality parameter comparative study under bottle aquaponic Tank (AT) and Normal controlled Tank (NT) with early fingerlings of *Trichopodus trichopterus* (Blue gourami) as fish. During this experiment three kind of plant were used that was tomato (*Solanum lycopersicum*), Eggplant (*Solanum melongena*) and Spinach (*Spinacia oleracea*). Two experimental aquarium tanks of medium sized (2ftx1ftx1.5ft) used as rearing purpose in AT and NT system. Beside this, Bottles of capacity one liter that accommodate riverine small pebbles as grow bed. Experimental feed of 30 % protein was used as diet for fish having ingredients Rice bran 17%, Soya bean 36 %, Curry leaves 12.5%, Chicken liver 27% and Moringa 2.1%. Experiment was based on water quality parameter like pH, Ammonia, Nitrite, Nitrate and one- fourth of tank water is exchanged with fresh water in every 15 days. During starting days (1-5 days), all parameters were same in both systems at optimum level but after 5-15 days water quality parameters started showing fluctuations in AT like; pH 7.6-7.8, Ammonia 0.25-2.50, Nitrite 0-1.0, Nitrate 0-3.5 mg/lit and similarly pH 7.6-7.7, Ammonia 0-0.50, Nitrite 0-0.25, Nitrate 0 mg/lit in NT system respectively. During experiment ending water quality parameters were showing drastic changes that was pH 7.8-6.8, Ammonia 3-4, Nitrite 2-3, Nitrate 4-5 mg/lit in AT system and pH 7.7-7.2, Ammonia 0.25, Nitrite 0, Nitrate 0 mg/lit in NT system respectively. Experiment shows that optimum range of nitrate can be produce for better plant growth through aquaponic system.

Keywords: *Trichopodus trichopterus*, water quality parameters and experimental feed.

(IDP-07) MOTHER EARTH AND ENVIRONMENTAL CONSEQUENCE

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Our upanishad speaks "Vasudhaiva Kutumbakam" (Mother Earth is the original global village) and Sarbabhuta Hita (mother earth is for the welfare of all beings) Brihadaranayaka Upanishad speaks about creature and creation "the earth is honey for all creatures and all creatures are honey for earth". Our beloved earth so touchably looked upon as the universal mother, has nurtured mankind through millions of years of growth and evolution mother earth is our only home who gives life to all every living being is responsible for respecting and living in harmony with mother earth

Earth is critically wounded, degraded, poisoned and depleted by the action of human family. Colonialism, industrialization, consumerism, warfare and a lack of value based understanding are primarily drivers of this growing and relentless assault on our beloved mother earth. Now rapacious exploitation of the planet has caught up with us and a radical change in our relationship with the nature is no longer an option. If we believe the dominator ethos "Man's conquest of nature", we will likely do irreparable harm to the mother earth. Through technology and industrialization we have changed the face of our planet and caused devastation.

More people, hotter climate, less forests, depleted soils, melting glaciers, dry rivers, drained aquifers, disappearing species, acidic oceans, toxic pollution, dirty energy and depleted material resources are all causing environmental crisis.

Measured on range of indicators, including fertilizer use, natural forest loss, habitat conservation, fisheries and other marine captures, water pollution, carbon emission and species threat ten countries identified with causing worst environmental damage are Brazil, US, China, Indonesia, Japan, Mexico, India, Russia, Australia and Peru.

Human beings took the best land, best trees, best oil, and so forth and now we have to do with lower quality materials, energy and natural bounty.

“It is healthy for people to go Fishing”, as number of international medical authorities reported it. Sports Fishing of Golden Mahseer is a form of Eco-tourism; it enhances environmental consciousness among people, promotes healthy way of living by associated oneself with nature, more importantly it provides solution for sustainable development of the area. The catch, photograph, weight and release back to water is the order of the day for anglers today. In India there has been a shift of rural population towards urban areas in search of livelihood; Sports fishing can be an answer to job creation; and it helps in data creation, creel census, research on fish in breeding and migration. The angling-tourism will provide a platform for area specific livelihood opportunities, this might help in counteracting urban migration and urbanization. There is a huge need for detail study on Mahseer migration, breeding in the nature, and breeding habitat. The awareness generated through the eco-tourism will impart sense of belongingness to nature, particularly rivers, streams, rural heritage and culture of the area. There is need for capacity development for conservation, curriculum development wildlife and fisheries people for training on sports fishing.



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