

List of Papers/ articles with their abstract published by Zoology Department SRT Campus, in UGC care list and referred journals from 15 January 2009 onwards

1. Charak S. R., Chaudhary, D.K. and **Agarwal N.K.** (2020). A study on the Physical and biochemical characteristics of semen of *Tor putitora* - an endangered fish species in Himalayan water. Indian J Animal Research. DOI: 10.18805/ijar.B-4127. ISSN: 0976-0555

Impact Factor 0.395

ABSTRACT

Background: *Tor putitora* is distributed in the entire northeast Himalayan region. The declining population of *Tor putitora* in natural waters has major concern to its fishery. The knowledge of semen characteristics is helpful in the selection of good quality semen for artificial fertilization thus have a role in fishery development. The current study aimed to determine the physical and biochemical composition of seminal plasma of *Tor putitora*.

Methods: The semen samples were collected by stripping the ripe male brooders procured from the natural habitat. The sperm motility, sperm density, spermatocrit value and osmolality were determined for physical characteristics of semen. Haemocytometric method was used for sperm density. The seminal plasma was separated by centrifugation for the determination of ionic and organic component of semen through atomic absorption spectrometer.

Result: The semen of *T. putitora* has shown species-specific features of sperm density ($1.712 \pm 0.18 \times 10^9 \text{ ml}^{-1}$), spermatocrit ($62.96 \pm 2.63 \%$) and sperm motility duration ($48.16 \pm 1.68 \text{ s}$). The Na^{2+} ($102.06 \pm 5.115 \text{ mM l}^{-1}$) and K^{+} ($51.66 \pm 3.205 \text{ mM l}^{-1}$) are predominating ions among the other inorganic constituents (Ca^{2+} : $1.38 \pm 0.304 \text{ mg dl}^{-1}$, Mg^{2+} : $0.86 \pm 0.261 \text{ mg l}^{-1}$, phosphate: $4.00 \pm 1.102 \text{ mg dl}^{-1}$, Cu^{2+} : $0.004 \pm 0.001 \text{ mg l}^{-1}$ and Zn^{2+} : $0.062 \pm 0.005 \text{ mg l}^{-1}$) of the seminal plasma. The organic constituents of seminal plasma contained - Glucose: $9.6 \pm 0.678 \text{ mg dl}^{-1}$, Cholesterol: $21.0 \pm 1.049 \text{ mg dl}^{-1}$, Triglycerides: $11.0 \pm 0.316 \text{ mg dl}^{-1}$, Urea: $12.6 \pm 1.7206 \text{ mg dl}^{-1}$ and Uric acid: $0.5 \pm 0.10 \text{ mg dl}^{-1}$. The Osmolality ($256.8 \pm 31.940 \text{ mOsmol kg}^{-1}$), pH (7.34 ± 0.04) and ionic composition of semen seem to be the most important factor responsible for inhibition or activation of sperm motility. A high significant positive relationship ($r=0.807$, $P<0.01$) was found between sperm density and spermatocrit suggests the use of regression equation for quick and reliable estimation of sperm concentration in *Tor putitora*. The study is helpful in the selection of high-quality male spawners and provides baseline information for the development of extenders and dilutants for the preservation of viable semen.

Key words: Ionic and Organic components, Osmolality, Semen analysis, Seminal plasma, Sperm motility.

2. Kumar, Anand; **Sharma, Dinesh K**; Lochan, Rajeev; Dewan, Saurabh; Negi, Suman (2020). Relative abundance, habitat preference, and breeding ecology of Asian Black francolin, *Francolinus francolinus asiae* (Bonaparte, 1856) from North-Western Himalaya. **Journal of Asia-Pacific Biodiversity**. Vol 13, 13, 2:162-168. <http://doi.org/10.1016/j.iapb.2020.02.001>. eISSN 2287-9544.



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Journal of Asia-Pacific Biodiversity

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Original Article

Relative abundance, habitat preference, and breeding ecology of Asian Black francolin, *Francolinus francolinus asiae* (Bonaparte, 1856) (Galliformes: Phasianidae) from North-Western Himalaya

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ABSTRACT

Asian black francolin (*Francolinus francolinus asiae*) is an important bird species in the northwestern Himalayan region, inhabiting diverse subtropical to lower temperate habitat types. The relative abundance, habitat preference, and some aspects of breeding ecology are studied here at eleven sites in different habitat types along elevation gradient. The abundance of species at different altitude was worked both through transect trails of different lengths and point counts at some spots. At each study site, maximum activity habitats were marked and selected for breeding ecology study. Sighting of black francolin was minimal in April (0.585 ± 0.185 birds/Km) and maximum in May (2.339 ± 0.015 birds/Km). Data on breeding timings, nest site selection, clutch size, incubation period, and hatching success were collected. Breeding period of black francolin extended from March up to late July with peak egg-laying between May to June. Twelve nests were monitored throughout the breeding season using binoculars from a distance and camera traps, wherever possible and without disturbing the species. The average size of nest was 20.063 ± 1.452 cm ranging from of 18.80 cm to 22.30 cm in width. Mean clutch size was 5.417 ± 0.793 eggs/nest. The hatching success was 86.15% with 56 successfully hatched eggs, whereas the fledging success was 83.92%.

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3. Kumar, Anand; Dewan, Saurabh; Lochan, Rajeev; **Sharma, Dinesh, K.** (2020): Spatial genetic structure of black francolin (*Francolinus francolinus asiae*) in the North-Western Himalayan region based on mitochondrial control region. **Mitochondrial DNA Part A.** <https://doi.org/10.1080/24701394.2020.1757664>. ISSN:2470-1394.

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RESEARCH ARTICLE

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Spatial genetic structure of black francolin (*Francolinus francolinus asiae*) in the North-Western Himalayan region based on mitochondrial control region

Anand Kumar^a, Saurabh Dewan^b, Rajeev Lochan^b and Dinesh K. Sharma^a

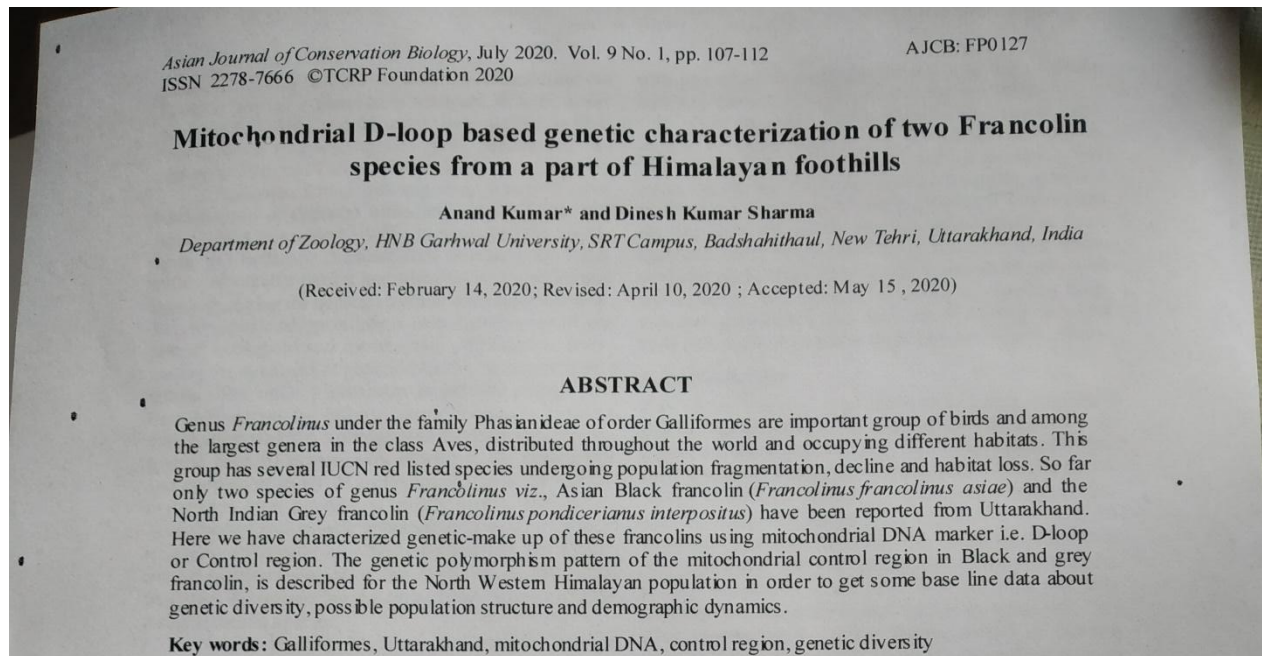
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ABSTRACT
Due to specific habitat preferences and behavioural limitations, black francolin is not uniformly distributed across the northwestern Himalayan landscape, rather is confined to certain land mosaic. The habitable zones are further reduced due to several manmade threats as logging and forest fire leading to sparse distribution. Overall 54 samples were used for partial sequence analysis of mitochondrial control region. A well evident divergence pattern was observed as individuals collected from low altitude, terai region significantly distanced from high altitude sampled individuals. Also, the individuals at lower elevation sites exhibited higher genetic diversity in comparison to the samples collected at higher elevations. This indicates that patchy distribution and low dispersal rate have resulted in fine-scale patterns of genetic diversity among the black francolin population. Further, habitat loss and forest fragmentation could lead to more small and isolated populations that could suffer from reduced genetic diversity and may be higher extinction rates.

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Galliformes; genetic diversity; D-loop; elevational gradient; habitat loss; Uttarakhand

4. Kumar, Anand; Sharma, **Dinesh Kumar**; (2020). Mitochondrial D-loop based genetic characterization of two Francolin species from a part of Himalayan foothills. **Asian Journal of Conservation Biology**. Vol. 9 No. 1, pp 107-112. ISSN 2278-7666.



5. Raghuvanshi S. K., Charak S. R. **Agarwal N. K.** (2019). Semen Characteristics and Extenders Competency during Refrigerated Storage of Snowtrout (*Schizothorax richardsonii*) Semen. Int. J. Fish. Aquat. Stud. 7(6): 350-354 Online ISSN : 2347-5129

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Semen characteristics and extenders competency during refrigerated storage of snow trout (*Schizothorax richardsonii*) semen

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ABSTRACT

The present study has investigated the semen characteristics and competency of different extenders for refrigerated storage of snow trout (*Schizothorax richardsonii*) semen. Semen samples were collected by stripping ripe male brooders during the spawning season. The pH (7.31 ± 0.07), sperm concentration ($3.77 \pm 0.78 \times 10^8/\text{ml}$), spermatocrit value ($63.13 \pm 10.27\%$), and sperm motility duration (59.70 ± 16.55 s) were determined by analysing 98 semen samples from different breeding phases. The short-term preservation of *S. richardsonii* semen was made under refrigerated conditions. Four extenders (Mounib's medium, KCl medium, extender modified from Buyukhatipoglu & Holtz, 189 M of Horton) each in two dilution ratios (1:4 & 1:10) were scrutinized for their competency. During refrigerated storage, sperm motility percentage and motility duration was evaluated after every 24 hours until the viability of semen samples. Mounib's medium was found significantly superior to the KCl medium ($P < 0.01$), extender modified from Buyukhatipoglu & Holtz ($P < 0.02$) and extender 189 M of Horton ($P < 0.002$) in retaining sperm motility up to 9 days at $0-4^\circ\text{C}$. It was also observed that the dilution ratio of 1:4 was not significantly different than the 1:10 ratio in all extender media (P ns, $n=10$).

Keywords: semen quality, extender, short-term storage, *S. richardsonii*, snow trout

6. **Agarwal N. K.**, Rawat, U. S. and Singh G. (2019). Fish assemblages and habitat ecology of River Pinder in central Himalaya, India. *Iranian J. Fisheries Sciences*.18 (1):1-14 DOI: 10.22092/ijfs.2018.118930. **ISSN:1562-2916**

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Fish assemblages and habitat ecology of River Pinder in central Himalaya, India

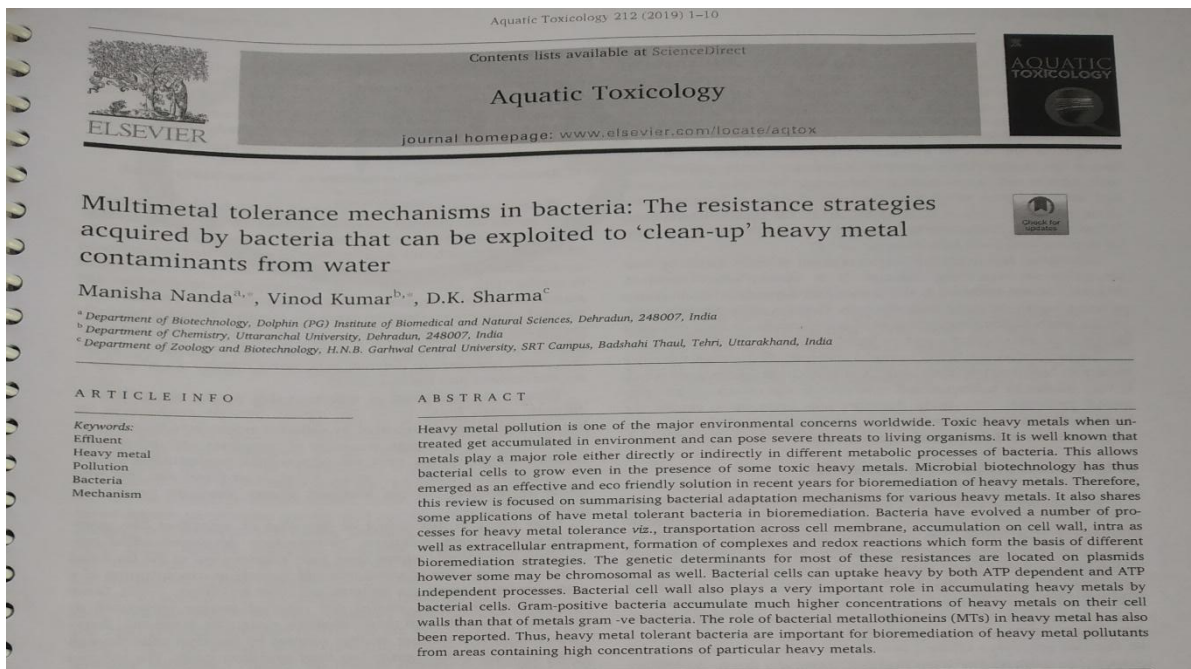
Agarwal N.K.^{1*}; Rawat U.S.²; Singh G.¹

ABSTRACT

Snow-fed River Pinder -a tributary of River Alaknanda in central Himalaya was explored for fish assemblages and habitat specificity. Altogether 27 fish species were reported from three orders, four families and nine genera. Cypriniformes order was dominating followed by Siluriformes and Salmoniformes. Shannon-Weiner diversity index (3.09 to 4.10) and Simpson index of diversity (0.81 to 0.92) of four sites specified strong relationship with species richness. The distribution of fish species showed interesting patterns, 33% species were common to all four sampling sites while 14.80% were restricted to single site and the remaining species were randomly distributed among two or three sampling sites. Habitat variability in the river significantly influenced the species assemblage structure. About 7.40% species were found common to all habitats while 3.70% species were restricted to only single habitat type. The remaining 88.90% of species were dwelling between two to three habitat types. Deep pools recorded maximum species richness followed by shallow pools, while least species richness was recorded in cascade habitats. The conservation status of fish fauna of the river was ascertained by CAMP (Conservation Assessment and Management Plan). Out of 27 species, the status of 8 species was not assessed due to data being deficient, 7 species were categorised as lower risk near threatened, 6 as vulnerable, 5 as endangered while 1 species was exotic.

Keywords: Fish assemblage, Habitat ecology, Fish diversity, Conservation, Himalayan River

7. Nanda, Manisha, Kumar Vinod and **Sharma, D.K. (2019)**. Multimetal tolerance mechanisms in bacterial: The resistance strategies acquired by bacteria that can be exploited to 'clean-up' heavy metal contaminants from water. **Aquatic Toxicology**. **212**, 1-10. Elsevier. ISSN:0166-445X.



8. **Agarwal, N. K.,** Singh, H., Singh, A. and Singh, G. (2018). Bhilangana river regulation for hydro power project in central Himalaya: Impact on Planktonic Assemblages. *Biojournal*, 13(1):1-10. **ISSN:0970-9444.**

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BHILANGANA RIVER REGULATION FOR TEHRI HYDRO POWER PROJECT IN CENTRAL HIMALAYA: IMPACT ON PLANKTONIC ASSEMBLAGES

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A B S T R A C T

Water impoundment imposes fundamental changes on natural landscapes by transforming rivers into reservoirs. The dramatic shift in physical conditions accompanying the loss of flow creates new changes in species composition and community structure due to ecosystem fragmentation. To understand the changes in basic chemistry of river water and their impact on Phytoplankton population, the river Bhilangana in its upstream, impoundment and downstream segment of Tehri Dam was studied for during the period May 2009 to April 2011. Damming of river has influenced the Phytoplanktonic populations as it was relatively high in lentic water as compared to upstream and downstream segment. The density (unit^{-1}) of Bacillariophyceae family significantly decreased in lentic sites as compared to upstream and downstream segment, while the density of Chlorophyceae increased in lentic sites as compared to lotic water. The density of *Oedogonium*, *Pediastrum*, *Selenastrum*, *Spirogyra*, *Volvo*, *Anabaena* and *Coelosphaerium* has also been increased in lentic sites. Some Phytoplanktonic taxa viz: *Cyclotella*, *Cymbella*, *Diatoma*, *Fragilaria*, *Frustulia*, *Navicula*, *Synedra*, *Tabellaria*, *Ankistrodesmus*, *Closterium*, *Ulothrix*, *Zygnema* and *Oscillatoria* were commonly reported from all the sites. Phytoplankton showed highly significant negative correlation with surface water temperature and phosphate ($P < 0.01$) at all the sampling sites. However, significant positive correlation with transparency at upstream ($r = 0.794736$) and downstream ($r = 0.777619$) sites while non significant relationship at impounded sites was observed. High positive significant correlation ($P < 0.01$) was calculated between phytoplankton and CO_2 from all the study sites.

Key words: Dams, River regulation, Plankton assemblage, Himalayan River

9. Alauddin A., Chaturvedi S., Malik, M.Y., Azmi L., Shukla I., Naseem Z., Rao C.V. and **Agarwal N K.** (2018). Formononetin and biochanin A protects against ritonavir induced hepatotoxicity via modulation of NfκB/pAkt signaling molecules. Life Sciences 213:174-182. <https://doi.org/10.1016/j.lfs.2018.10.023>. ISSN: 0024-3205

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Formononetin and biochanin A protects against ritonavir induced hepatotoxicity via modulation of NfκB/pAkt signaling molecules



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ABSTRACT

Aims: Ritonavir (RIT) is a human immune deficiency virus (HIV) protease inhibitor (PI) active against HIV-1 and HIV-2. Among various adverse effects of PIs, hepatotoxicity is a very common adverse reaction of RIT which is concentration dependent. Red clover isoflavones are found to possess anti-inflammatory, antioxidant and anti apoptosis activity. Furthermore, recent studies have demonstrated that these isoflavones can be used to alleviate the side-effects of drugs. Hence, the present study was inquested to ascertain the effect of Formononetin (FMN) and Biochanin A (BCA) on RIT induced hepatotoxicity.

Main methods: Five groups of animals were subjected to treatment as control, toxic control (RIT), third group (RIT+FMN), fourth group (RIT+BCA), the fifth group (RIT+FMN+BCA) and sixth group (FMN+BCA) for 14 days. The animals were evaluated for estimation of liver toxicity markers, inflammatory biomarkers, in-vivo biochemical antioxidant parameters. The liver tissues were further evaluated histopathologically and western blotting examination for localization of apoptotic gene expression that plays a pivotal role in hepatotoxicity.

Key findings: FMN and BCA ameliorated the increased levels of biochemical markers of liver, attenuated the RIT induced Bax, caspase-3, NFκB and eNOS activation and persuaded the Bcl2 and pAkt level. Alteration in the levels of inflammatory markers was also observed in both hepatic tissue and serum.

Significance: FMN and BCA exerts hepatoprotective effect through modulating the oxidative stress, inflammation, apoptosis and reversing the tissue degeneration suggesting its therapeutic role in hepatotoxicity and other hepatocellular diseases.

10. Alauddin A., Chaturvedi S., Azmi L., Shukla I., Naseem Z., Rao C.V. and **Agarwal N K.** (2018). Gastroprotective Effect of Formononetin against Ethanol-Induced Gastric Ulceration in Rats via Augmentation of Cytoprotective Markers and Curtailing Apoptotic Gene Expression. *Phcog Mag* 14: pp S605-12. **DOI:** 10.4103/pm.pm_205_18. **ISSN : 0973-1296**

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ABSTRACT

Background: Formononetin (FMN), one of the major isoflavones in red clover, has been shown to possess antioxidant, anti-inflammatory, antitumor, neuroprotective, and cytoprotective activities. However, there is no report on the gastroprotective effect of FMN against ethanol-induced gastric ulcer.

Objective: Excessive alcohol consumption can lead to gastric ulcer, and the purpose of the present study was to examine the protective effect of FMN on mucosal lesions induced by ethanol.

Materials and Methods: Fasted rats were orally administered with FMN at different doses, omeprazole (20 mg/kg), followed by intra gastric ingestion of ethanol (5 ml/kg) after 1 h and sacrificed after 1 h of exposure. Gross microscopic, macroscopic, and biochemical assays were scrutinized.

Results: Compared with ethanol, FMN pretreatment showed a significant increase in the gastric levels of glutathione while decreased the malondialdehyde content remarkably. FMN pretreatment also bestowed the cytoprotective efficacy against ethanol-induced ulceration by reestablishing the decreased level of nitrite (NO). Furthermore, in histopathological sections, reduced pathological changes of gastric lesions were markedly observed in the FMN-pretreated groups compared with those in the ethanol group. Western blot analysis showed upregulation of Bcl2 while downregulation of Bax in FMN-pretreated gastric tissue of rats.

Conclusion: These results indicate that FMN exerts gastroprotective effects through the antioxidative, anti-inflammatory, and antiapoptotic that are probably mediated by enhanced NO release, suggesting its therapeutic use to treat gastric ulceration by preserving mucosal glycoproteins and diminishing oxidative stress.

Key words: Apoptosis, cytoprotection, formononetin, gastric ulcer, oxidative stress

SUMMARY

- FMN is found to be highly potent against ethanol-induced gastric ulcer
- FMN decreased the oxidative stress and increased the cytoprotection through enhancement of nitrite levels
- The isoflavone is also found to decrease both inflammation and apoptosis in gastric tissue after ethanol ingestion
- Therefore, FMN exerts anti-inflammatory and cytoprotective effect along with acting as an antioxidant and depletion of apoptosis in gastric tissue.

Abbreviations used: NSAIDs: Nonsteroidal anti-inflammatory drugs; FMN: Formononetin; CMC: Carboxymethylcellulose; UI: Ulcer index; MDA: Malondialdehyde; GSH: Reduced glutathione; NO: Nitrite; TNF- α : Tumor necrosis factor-alpha; Hgb: Hemoglobin; T-RBC: Total red blood cells; Hct: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; TLC: Total leukocyte count

11. **Agarwal, N. K.,** Singh G., Singh H., Kumar, N. and Rawat, U. S. (2018). Ecological impacts of Dams on the Fish Diversity of Bhagirathi River in Central Himalaya (India). *Journal of Coldwater Fisheries* 1(1): 74-84.

Journal of Coldwater Fisheries 1(1):74-84, 2018



Ecological impacts of dams on the fish diversity of Bhagirathi river in central Himalaya (India)

N.K. AGARWAL^{1*}, GURNAM SINGH¹, HARPAL SINGH¹, N. KUMAR², AND U.S. RAWAT³

ABSTRACT

Bhagirathi river in Garhwal region of northern India is dammed at four locations (Maneri Bhali Phase I, Phase II, Tehri Hydroelectric Dam and Koteswar Dam) for hydro power generation resulting in the fragmentation of riverine habitat. Substantial part of river is forced through tunnels where the river has lost 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 increased sedimentation in impounded section of river affecting habitat quality, life-history stages and population dynamics of the biota. These effects have been found to get 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 have been found *Schizothorax*, *Glyptothorax*, *Pseudecheneis*, *Garra*, *Labeo*, *Crossocheilus*, *Noemacheilus*, *Barilius*, *Psilorhynchus*, *Clupisoma*, *Mastacembelus*, and migratory *Tor*, spp., which are indigenous rheophilic species requiring 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.

Key words: Himalaya, Dams, Fish diversity, Habitat ecology, River fragmentation.

12. Charak S. R., **Agarwal N.K.** and Shah T. K. (2018). An Approach for determination of semen quality of golden mahseer (*Tor putitora*) from central Himalaya. The Pharma Innovation Journal. 7(1):83-86.

NAAS Rating: 5.03



ABSTRACT

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 200grams to 900 grams. The colour of semen is milky white to creamy white. Semen volume varies from 0.4ml to 4.5ml in different individual brooders. The sperm density ranges from 1.28-2.23x10⁹/ml per individual brooders. The sperm motility duration ranges from 38-59 seconds and the spermatocrit value range is 35.93% to 98.07%. The present study is aimed to evaluate the semen quality of *Tor putitora* for estimating the reproductive potential of male brooders and timing of optimal fertilization for seed production in the hatcheries.

Keywords: semen quality, golden mahseer, sperm motility

13. **Agarwal N. K.**, Singh H., Singh G. and Charak S. (2018). Bhilangana River Impoundment: Consequences to riverine environment. In: Water Biology (eds Khanna D. R. Bhutiani R.) Discovery Publishing House Pvt. Ltd., New Delhi (India). pp 83-95.

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Bhilangana River Impoundment *Consequences to Riverine Environment*

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Dr. Gurnam Singh and Dr. Sapana Rani Charak

ABSTRACT

The construction of a dam results in “discontinuities” in the River Continuum. The ‘discontinuities’ in the river continuum and irreversible alteration in the natural hydrological regime of rivers affects the habitat quality and the dynamics of the biota. Impoundment of river Bhilangana has caused dramatic changes in the riverine habitat both upstream and downstream of Tehri dam and forming new artificial aquatic environment. This has resulted into change in the depth, flow pattern, temperature regime and the sediment load of water body causing major impact not only on the physicochemical characteristics but also on the distribution and occurrence of plankton and fish population. The most obvious impact of Tehri hydro power Project is the conversion of 25 km segment of fast flowing Bhilangana river into slow-moving lake-like habitat with relatively large surface area and increased depth. The natural seasonal flows has converted into, unnatural highly variable monthly and seasonal flow at the downstream. Thermal stratification with relatively warm top layer of water (epilimnion) and cool bottom layer (hypolimnion) have been formed due to rise in water column after the impoundment. The trapping of sediment within impounded zone of river and its accumulation behind a dam has restricted the amount and types of sediment that reach areas of downstream. This has caused habitat degradation in the zone immediately downstream. The change in chemistry and temperature of water within and downstream of the reservoir has affected species composition. Diurnal ‘pulse releases’ has destabilized the growth of periphyton in feeding ground. Impoundment of river Bhilangana has also changed the fish species composition by destroying the feeding as well as breeding grounds of bottom feeder fishes causing extermination of native fish species. Thus the present study has aimed to develop understanding for environmental impact of Bhilangana river impoundment.

14. Sharma, Neeraj Kumar, Akhtar, M.S., **Singh, Ravindra** and Pandey, N.N. (2018). Seasonal modulation of reproductive hormones and related biomarker in coldwater cyprinid *Barilius bendelisis* (Hamilton, 1807). **Comparative Clinical Pathology**. <https://doi.org/10.1007/s00580-018-2691-8>. ISSN 1618-5641

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ORIGINAL ARTICLE



Seasonal modulation of reproductive hormones and related biomarkers in coldwater cyprinid *Barilius bendelisis* (Hamilton, 1807)

Neeraj Kumar Sharma^{1,2} • M. S. Akhtar¹ • Ravindra Singh² • N. N. Pandey¹

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Abstract

Barilius bendelisis is a valuable ornamental and food fish from India in which the endocrine control of its reproduction activity has not been widely reported. The present study was aimed to elucidate changes in serum endocrine hormones: 17 β -estradiol (E₂), testosterone (T), progesterone (P₄), 17 α , 20 β -dihydroxyprogesterone (17 α , 20 β -P), cortisol (C), triiodothyronine (T₃), and thyroxine (T₄); aromatase activity (ARO), vitellogenin (VTG), and total antioxidant capacity (TAC) during different seasons of the year 2014. All studied parameters showed marked seasonal variations. The highest E₂ level in males and females were recorded in winter (January) and rainy (September) seasons respectively. The T level exhibited dual peaks in both sexes, and the highest values were observed during the winter (January) and rainy (September) seasons. The serum levels of P₄ and 17 α , 20 β -P during spring (March) and rainy (September) seasons were significantly higher and found associated with final sperm and oocyte maturation. The serum levels of ARO and VTG also showed bimodal pattern during the spring (March) and rainy (September) season and were well correlated with T and E₂. Serum C level was detectable throughout the year in both sexes which were related to glucose metabolism and spawning events. Fluctuations in T₃ and T₄ levels were associated with somatic growth and reproduction events during different seasons in *B. bendelisis*. Serum TAC level was highest during summer (May and July) and autumn (November) seasons suggesting better antioxidant potential during these seasons. The study confirms that *B. bendelisis* is a multiple spawner with two spawning seasons.

15. Singh Gurnam and **Agarwal N. K.** (2017). Impact of hydropower project (RoR) on the ichthyofaunal diversity of river Birahiganga in central Himalaya (India). Journal of Fisheries. 5(2) : 507-512.



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Impact of hydropower project (RoR) on the ichthyofaunal diversity of river Birahiganga in Central Himalaya (India)

Gurnam Singh • Naresh Kumar Agarwal

ABSTRACT

Study examined the present status of ichthyofaunal diversity of river Birahiganga in compliance to the construction of one hydropower project (HPP). The river is diverted through tunnel, leaving very less water in its fragmented course (~2.5 km). Sometime river gets almost dried in summer season. Altogether 20 fish species belonging to two orders, three families and eight genera were reported from fragmented and continuous flowing stretches of the river. Snow trout (*Schizothorax* and *Schizothoraichthys* spp.) have shown major share in total fish catch composition whereas the typical hill stream fishes (*Garra* and *Pseudecheneis* spp.) were the least contributor. Installation of HPP has effect on the fish population structure. Maximum species richness (20 sp.) was recorded from mainstream whereas 16 sp. were procured from the fragmented stretch. Relative abundance of most of the species was considerably high in the mainstream than the fragmented stretch, except *Glyptothorax pectinopterus* which has shown equal abundance at both the sites. Low water discharge in the fragmented stretch supports only small sized fishes. The degradation of habitat ecology and variation in physico-chemical features seems distressing the fish population structure. The threat status of fish fauna ascertain that out of 20 species, status of 6 species is under lower risk Near Threatened, 5 as Vulnerable and 4 as Endangered.

Keywords: Dams; river fragmentation; fish diversity, Central Himalaya; Birahiganga River.

16. Gupta A., Ahmad I, Kureel J., John A.A., Sultan E., Chanda D., **Agarwal N.K.**, Alauddin, Wahajuddin, Prabhaker S., Verma A., Singh D. (2016). Differentiation of skeletal osteogenic progenitor cells to osteoblasts with 3,4-diarylbenzopyran based amide derivatives: Novel osteogenic agents. *European journal of Medicinal Chemistry* 121: 82-89. <http://dx.doi.org/10.1016/j.ejmech.2016.05.023>

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Research paper

Differentiation of skeletal osteogenic progenitor cells to osteoblasts with 3,4-diarylbenzopyran based amide derivatives: Novel osteogenic agents




Atul Gupta ^{a,*}, Imran Ahmad ^a, Jyoti Kureel ^b, Aijaz A. John ^b, Eram Sultan ^c, Debabrata Chanda ^c, Naresh Kumar Agarwal ^{d,f}, Alauddin ^{d,f}, Wahajuddin ^d, S. Prabhaker ^e, Amita Verma ^a, Divya Singh ^b

ABSTRACT

A series of 3,4-diarylbenzopyran based amide derivatives was synthesized and evaluated for osteogenic activity in in vitro and in vivo models of osteoporosis. Compounds 17a, 21bec and 22aeb showed significant osteogenic activity in osteoblast differentiation assay. Among the synthesized compounds, 22b was identified as lead molecule which showed significant osteogenic activity at 1 pM concentration in osteoblast differentiation assay and at 1 mg kg⁻¹ body weight dose in estrogen deficient balb/c mice model. In vitro bone mineralization and expression of osteogenic marker genes viz BMP-2, RUNX-2, OCN, and collagen type 1 further confirmed the osteogenic potential of 22b. Gene expression study for estrogen receptor a and b (ER-a and ER-b) in mouse calvarial osteoblasts (MCOs) unveiled that possibly 22b exerted osteogenic efficacy via activation of Estrogen receptor-b preferentially. In vivo pharmacokinetic, estrogenicity and acute toxicity studies of 22b showed that it had good bioavailability and was devoid of uterine estrogenicity at 1 mg kg⁻¹ and inherent toxicity up to 1000 mg kg⁻¹ body weight dose respectively.

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17. Kumar, Anand and Sharma D.K. (2016). Molecular characterization of Asian Black Francolin (*Francolinus francolinus asiae*) from Western Himalaya based on mitochondrial control region. **International Journal of Advanced Research**. Vol. 4, Issue 4. 1577-1583.

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 ISSN NO. 2320-5407	Journal homepage: http://www.journalijar.com		INTERNATIONAL JOURNAL OF ADVANCED RESEARCH
	RESEARCH ARTICLE		
Molecular characterization of Asian Black Francolin (<i>Francolinus francolinus asiae</i>) from Western Himalaya based on mitochondrial control region.			
Anand Kumar and Dinesh Kumar Sharma*			
Department of Zoology, HNB Garhwal University, SRT Campus, Badshahithaul, New Tehri, Uttarakhand, India.			
Manuscript Info		Abstract	
Manuscript History:		Five species of francolins extend their range up to Indian sub-continent viz., Asian Black Francolin (<i>Francolinus francolinus asiae</i>), Grey Francolin (<i>Francolinus pondicerianus interpositus</i>), Chinese Francolin (<i>F. Pintadeanus</i>), Painted Francolin (<i>F. pictus</i>), Swamp Francolin, (<i>F. gularis</i>). So far, as per currently available records only two species, Asian Black Francolin and North Indian Grey francolin of genus <i>Francolinus</i> have been reported from Western Himalayan region. Being a game bird, these are under several anthropogenic threats in this region, with very less demographic or molecular data available. The present work aimed to study molecular polymorphism pattern in the Control Region gene (of mitochondrial DNA) so as to obtain some initial data on genetic diversity and probable genetic structure of the population of black francolin in this region. Overall 24 samples were collected from five sites located at different altitudes. We detected 12 polymorphic sites in an average 575bp fragment obtained for the mtDNA Control Region. The average nucleotide frequencies were A=24.54%, T/U=30.03%, C=31.06% and G=14.37% and Transition/Transversion bias (<i>R</i>) of 2.79 suggesting this is a recently evolved group or slowly evolving genes. These findings will provide a base line data for future studies on population as well as conservation genetics of francolins from this region.	
Received: xxxxxxxx Final Accepted: xxxxxxxxxxxxxxxx Published Online: xxxxxxxxxxxxxxxx			
Key words: Black francolin, mitochondrial DNA, D loop, anthropogenic threats.			
*Corresponding Author Dinesh Kumar Sharma.			
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18. Bashir A, Sharma NK, Bisht B.S, Singh R, Mir JI, Akhtar MS. (2016). Length–weight relationship of five commercially important freshwater fish species in the Kashmir Valley, India. **Journal of Applied Ichthyology**. Aug;32(4):740-1. DOI: <https://doi.org/10.1111/jai.13065> ISSN 0175-8659.

Technical Contribution

Length–weight relationship of five commercially important freshwater fish species in the Kashmir Valley, India

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³Directorate of Coldwater Fisheries Research, Amusandhan Bhawan, Bhimtal, India

Summary

Length–weight relationships were analysed for five commercially important freshwater fishes, namely, *Bangana diplostoma* (Heckel, 1838), *Schizopyge niger* (Heckel, 1838), *Schizothorax curvifrons* (Heckel, 1838), *Schizothorax plagiotomus* (Heckel, 1838) and *Glyptosternon reticulatum* (McClelland, 1842) from different water bodies in the Kashmir Valley, India. A total of 610 samples were collected between October 2013 and May 2015 using various indigenous cast nets. Of these five species, *Schizopyge niger* has a new maximum length record for the FishBase LWR database.

nomic keys of Talwar and Jhingran (1991) and Kullander et al. (1999). Spelling and validity of all scientific names were checked against FishBase.

Length–weights were determined by logarithmic transformation of the linear regression equation: $\log W = \log a + b \log TL$, where W is the weight of the fish (g), TL is the total length (cm), a is the intercept and b the slope of the regression curve (Ruiz-Campos et al., 2010). Outliers were removed by plotting log data. All statistical analyses were done using Excel 2010.

19. Sharma, N.K., **Singh, R.**, Gupta, M., Pandey, N.N., Tiwari, V.K., Singh, R. and Akhtar, M.S., (2016). Length–weight relationships of four freshwater cyprinid species from a tributary of Ganga River Basin in North India. **Journal of Applied Ichthyology**, DOI: <https://doi.org/10.1111/jai.12998> ISSN 0175-8659.

Technical contribution

Length–weight relationships of four freshwater cyprinid species from a tributary of Ganga River Basin in North India

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Summary

This paper provides length-weight relationships (LWRs) for four freshwater cyprinid fish species, namely *Barilius bendelisis* (Hamilton, 1807), *Bangana dero* (Hamilton, 1807), *Chagunius chagunio* (Hamilton, 1807) and *Labeo dyocheilus* (McClelland

health status of fish (Pauly, 1993; Froese, 2006). In the current study, LWRs of four freshwater cyprinid fish species from a tributary of the Ganga River Basin in North India were studied. All four species are commercially important for the Himalayan region, from which *Barilius bendelisis* achieves

20. Sharma, Neeraj Kumar, Akhtar, M.S., Pandey, N.N. **Singh, Ravindra** and Singh, A.K. (2016). Sex Specific Seasonal Variation in Hematological and Serum Biological Indices of *Barilius bendelisis* from Central Himalaya, India. **Proc.Natl.Acad.Sci., India, Sect.B Biol.Sci.** DOI: <https://doi.org/10.1007/s40011-015-0692-9> ISSN 0369-8211.

Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.
DOI 10.1007/s40011-015-0692-9



RESEARCH ARTICLE

Sex Specific Seasonal Variation in Hematological and Serum Biochemical Indices of *Barilius bendelisis* from Central Himalaya, India

Neeraj Kumar Sharma^{1,2} · M. S. Akhtar¹ · N. N. Pandey¹ · Ravindra Singh² · A. K. Singh¹

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Abstract The study aimed to assess the effects of sex and season on hematological and serum biochemical indices of *Barilius bendelisis*. Hematological and biochemical results showed significant differences ($p < 0.05$) among seasons as well as between sexes. In summer, hemoglobin, hematocrit, erythrocyte and WBC number were highest and significantly ($p < 0.05$) different between sexes. Differential WBC count also showed marked seasonal variation but do not show any significant difference ($p < 0.05$) between male and female. Mean corpuscular volume and mean corpuscular hemoglobin was high in winter and low in

Glucose level was higher in summer and autumn whereas, lower in winter in both male and female respectively. This study revealed that the variation in seasonal environmental parameters have direct effect on the health status of *B. bendelisis*. The baseline data generated in this study will serve as a tool for fish physiologists and pathologists in monitoring the stress, health and nutritional status of *B. bendelisis* under aquaculture production.

Keywords Season · Hematology · *Barilius bendelisis* · RBC · Cholesterol · Globulin · Glucose

21. Rawat U.S. and **Agarwal N.K.** (2015). Biodiversity: Concept, threats and conservation. Environment Conservation Journal. Vol. 16 (3): 19-28.

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Biodiversity: Concept, threats and conservation

Rawat U.S.¹ and Agarwal N.K.²✉

ABSTRACT

Biodiversity is the variety of different forms of life on earth, including the different plants, animals, micro-organisms, the genes they contain and the ecosystem they form. It refers to genetic variation, ecosystem variation, species variation (number of species) within an area, biome or planet. Relative to the range of habitats, biotic communities and ecological processes in the biosphere, biodiversity is vital in a number of ways including promoting the aesthetic value of the natural environment, contribution to our material well-being through utilitarian values by providing food, fodder, fuel, timber and medicine. Biodiversity is the life support system. Organisms depend on it for the air to breathe, the food to eat, and the water to drink. Wetlands filter pollutants from water, trees and plants reduce global warming by absorbing carbon, and bacteria and fungi break down organic material and fertilize the soil. It has been empirically shown that native species richness is linked to the health of ecosystems, as is the quality of life for humans. The ecosystem services of biodiversity is maintained through formation and protection of soil, conservation and purification of water, maintaining hydrological cycles, regulation of biochemical cycles, absorption and breakdown of pollutants and waste materials through decomposition, determination and regulation of the natural world climate. Despite the benefits from biodiversity, today's threats to species and ecosystems are increasing day by day with alarming rate and virtually all of them are caused by human mismanagement of biological resources often stimulated by imprudent economic policies, pollution and faulty institutions in addition to climate change. To ensure intra and intergenerational equity, it is important to conserve biodiversity. Some of the existing measures of biodiversity conservation include; reforestation, zoological gardens, botanical gardens, national parks, biosphere reserves, germplasm banks and adoption of breeding techniques, tissue culture techniques, social forestry to minimize stress on the exploitation of forest resources.

Key words: Biodiversity, conservation, ecosystem services

22. **Singh, R., Akhtar, M.S., Pandey, N., Mir, J.I. and Sharma, N.K. (2015). Threatened Fishes of the World: *Glyptothorax kashmirensis* (Hora, 1923) (Siluriformes: Sisoridae) a mini review. **Journal of Fisheries & Livestock Production**. 3:147 DOI: <https://doi.org/10.1111/jai.12834> . ISSN 2332-2608**



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Sharma et al., J Fisheries Livest Prod 2015, 3:4

<http://dx.doi.org/10.4172/2332-2608.1000147>

Mini Review

Open Access

Threatened Fishes of the World: *Glyptothorax kashmirensis* (Hora, 1923) (Siluriformes: Sisoridae) a mini review

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²Fish Nutrition Laboratory, Directorate of Coldwater Fisheries Research, Anusandhan Bhawan, India.

Abstract

Kashmir catfish, *Glyptothorax kashmirensis*, is a critically endangered fresh water fish species in Asia. Wild populations are severely declined due to habitat loss (breeding and nursery grounds), dam construction, over-exploitation and introduction of exotic species leading to an alarming situation, which deserves high conservation consideration. The present paper enlightens the previous work done and recommends conservation actions that should be taken into account towards the preservation of the wild population of *G. kashmirensis*.

23. Sharma, Neeraj Kumar, Akhtar, M.S., Pandey, Nityanand and Singh, Ravindra (2015). Seasonal variation in thermal tolerance, oxygen consumption, anti – oxidative enzymes and non – specific immune indices of Indian hill trout, *Barilius bendelisis* (Hamilton, 1807) from Central Himalaya, India. **Journal of Thermal Biology**, 52: 166 – 176. DOI: <https://doi.org/10.1111/jai.12836> ISSN 0306-4565.

Journal of Thermal Biology 52 (2015) 166–176



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Seasonal variation in thermal tolerance, oxygen consumption, antioxidative enzymes and non-specific immune indices of Indian hill trout, *Barilius bendelisis* (Hamilton, 1807) from central Himalaya, India



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ABSTRACT

We studied the season dependent thermal tolerance, oxygen consumption, respiratory burst response and antioxidative enzyme activities in juveniles of *Barilius bendelisis*. The critical thermal maximum (CT_{max}), lethal thermal maximum (LT_{max}), critical thermal minimum (CT_{min}) and lethal thermal minimum (LT_{min}) were significantly different at five different seasons viz. winter (10.64 °C), spring (16.25 °C), summer (22.11 °C), rainy (20.87 °C) and autumn (17.77 °C). The highest CT_{max} was registered in summer (36.02 °C), and lowest CT_{min} was recorded during winter (2.77 °C). Water temperature, dissolved oxygen and pH were strongly related to CT_{max}, LT_{max}, CT_{min} and LT_{min} suggesting seasonal acclimatization of *B. bendelisis*. The thermal tolerance polygon area of the *B. bendelisis* juveniles within the range of seasonal temperature (10.64–22.11 °C) was calculated as 470.92 °C². Oxygen consumption rate was significantly different ($p < 0.05$) between seasons with maximum value during summer (57.66 mg O₂/kg/h) and lowest in winter (32.60 mg O₂/kg/h). Total white blood cell count including neutrophil and monocytes also showed significant difference ($p < 0.05$) between seasons with maximum value during summer and minimum number in winter and were found correlated to temperature, dissolved oxygen, pH and respiratory burst activity. Respiratory burst activity of blood phagocytes significantly differed ($p < 0.05$) among seasons with higher value during summer (0.163 OD_{540 nm}) and minimum in winter season (0.054 OD_{540 nm}). The activity of superoxide dismutase, catalase and glutathione-S-transferase both in liver and gill, also varied significantly ($p < 0.05$) during different seasons. Overall results of this study suggest that multiple environmental factors play a role in seasonal acclimation in *B. bendelisis*, which modulate the thermal tolerance, oxygen consumption, respiratory burst activity and status of anti-oxidative potential in wild environment.

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24. Bashir, A., Sharma, N. K., Bisht, B. S., **Singh, R.** and Mir, J. I. (2015). Length – weight relationships of 10 fish species from two tributaries of Indus River basin in Jammu and Kashmir, India. **Journal of Applied Ichthyology**, 1 – 2. DOI: <https://doi.org/10.1111/jai.12844> ISSN 0175-8659



Technical contribution

Length-weight relationships of 10 fish species from two tributaries of Indus River Basin in Jammu and Kashmir, India

By A. Bashir^{1*}, N. K. Sharma^{1*}, B. S. Bisht¹, R. Singh¹ and J. I. Mir²

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Summary

Length-weight relationships (LWRs) are described for 10 fish species belonging to three families from the Jhelum and Beas River tributaries of the Indus river basin in India.

length (cm), a is the intercept and b the slope of the regression curve (Ruiz-Campos et al., 2010). Outliers were removed by plotting log data. All statistical analyses were done using Excel 2007.

25. Sharma, N.K., Mir, J.I., **Singh, R.**, Akhtar, M.S. and Pandey, N.N., (2015). Length–weight relationships for eight fish species from the Ravi River, north-western India. **Journal of Applied Ichthyology**, 31(6), pp.1146-1147. DOI: <https://doi.org/10.1111/jai.12836> ISSN [0175-8659](https://doi.org/10.1111/jai.12836)

Technical Contribution

Length–weight relationships for eight fish species from the Ravi River, north-western India

By N. K. Sharma¹, J. I. Mir², R. Singh¹, M. S. Akhtar² and N. N. Pandey²

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²Directorate of Coldwater Fisheries Research, Anusandhan Bhawan, Bhimtal, India

Summary

Length–weight relationships (LWRs) were evaluated for *Ba-dis badis* (n = 25), *Sperata seenghala* (n = 26), *Labeo gonius* (n = 34), *Rasbora rasbora* (n = 30), *Bagarius bagarius* (n = 24), *Gagata cenia* (n = 27), *Glyptothorax stoliczkae* (n = 24) and *Channa orientalis* (n = 28) from the Ravi River tributary in North India. Altogether 218 samples of eight species were obtained between May and November 2014 using cast nets and gill nets. LWRs for these species were unknown to FishBase, and new maximum lengths were

Basantar with the Ravi are within Pakistan. The waters of the Ravi River drain into the Indian Ocean via the Indus River in Pakistan (Joshi et al., 1978).

Length–weight relationships (LWRs) are widely used in fisheries science for estimating the weight for a given length of an individual fish and the biomass when the length–frequency distribution is known (Anderson and Gutreuter, 1983; Petrakis and Stergiou, 1995; Froese, 2006; Froese et al., 2011). The purpose of this study was to estimate LWRs for eight important fish species from the Ravi River in northern India; these species had no previous LWRs in

26. Sharma, N.K., Mir, J.I., Dobriyal, A.K. and **Singh, R.** (2015). Length–weight relationships of two cyprinid fish species, *Crossocheilus latius* (Hamilton, 1822) and *Garra gotyla gotyla* (Gray, 1830) from the Ganga River Basin, India.. **Journal of Applied Ichthyology**, 31(6), pp.1161-1162. DOI: <https://doi.org/10.1111/jai.12835> ISSN 0175-8659

Technical contribution

Length–weight relationships of two cyprinid fish species, *Crossocheilus latius* (Hamilton, 1822) and *Garra gotyla gotyla* (Gray, 1830) from the Ganga River Basin, India

By N. K. Sharma¹, J. I. Mir², A. K. Dobriyal³ and R. Singh¹

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Summary

This study provides length–weight relationship (LWR) information for two fish species (family Cyprinidae), *Crossocheilus latius* (Hamilton, 1822) and *Garra gotyla gotyla* (Gray, 1830), from a tributary of the Ganga River Basin, India. Both species had no previous LWR estimates as per Fishbase 2014.

Identification of fishes was done following Talwar and Jhingran (1991). Prior to regression analysis of log BW on log TL, log–log plots of length and weight values were performed for visual inspection of outliers (Froese, 2006). The parameters *a* and *b* were estimated by linear regression: $\log(W) = \log(a) + b \log(L)$. Statistics were performed using the SPSS package version 16.0.

27. Sharma, N. K., **Singh, R.**, Pandey, N. N., Akhtar, M. S. and Mir, J. I., (2015). Length–weight relationship of two fish species from Poonch River, Western Indian Himalaya: *Glyptothorax kashmirensis* (Hora, 1923) and *Crossocheilus diplochilus* (Heckel, 1838). **Journal of Applied Ichthyology**, 31(6), pp.1144–1145. DOI:<https://doi.org/10.1111/jai.12834> ISSN 0175-8659



Technical contribution

Length–weight relationship of two fish species from Poonch River, Western Indian Himalaya: *Glyptothorax kashmirensis* (Hora, 1923) and *Crossocheilus diplochilus* (Heckel, 1838)

By N. K. Sharma¹, R. Singh¹, N. N. Pandey², M. S. Akhtar² and J. I. Mir²

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Summary

This study provides the first report of length–weight relationships (LWRs) for two fish species, *Glyptothorax kashmirensis* and *Crossocheilus diplochilus*, collected from the Poonch River, one of the lesser tributaries to the Indus basin in India. New maximum length records are reported for both

length–weight relationships parameters for these two fish species are given for the first time.

Material and methods

Measurements of length and weight of *Glyptothorax kashmir-*

28. Sharma, N.K., Mir, J.I., Pandey, N.N., **Singh, R.**, Bashir, A. and Akhtar, M.S., (2015). Length–weight relationships of six fish species from an Indus basin tributary in the Poonch region of Jammu and Kashmir, India. **Journal of Applied Ichthyology**, 31(3), pp.585–586. DOI: <https://doi.org/10.1111/jai.12764> ISSN 0175-8659

Technical contribution

Length–weight relationships of six fish species from an Indus basin tributary in the Poonch region of Jammu and Kashmir, India

By N. K. Sharma¹, J. I. Mir², N. N. Pandey², R. Singh¹, A. Bashir¹ and M. S. Akhtar²

¹Department of Zoology, Hemwati Nandan Bahuguna Garhwal University, Tehri Garhwal, India; ²Directorate of Coldwater Fisheries Research, Anusandhan Bhawan, Bhimtal, India

Summary

Length–weight relationships are described for six fish species belonging to two families from the Poonch River, a tributary of the Jhelum River (Tributary of Indus Basin), India. Length–weight relationships for the six species were unknown to FishBase, and new maximum lengths are recorded for five of the species. These results will be useful for fishery research management and conservation of the

Mir et al., 2013). The present study was undertaken with the objective to estimate the LWRs for six fish species collected from the Poonch River in Jammu and Kashmir, India.

Materials and methods

Data on length and weight of one species of the family cobitidae *Rotia biridi* (Chaudhuri 1909) and five species of the

29. **Agarwal N. K.**, Singh Gurnam and Rawat U.S. (2014). Present status and threats to the Ichthyofaunal diversity of a snow fed river Nandakini in central Himalaya (Garhwal), India. In : Uttarakhand Disaster: Contemporary issue of Climate Change and Development with Holistic Approach (eds. Rawat U.S. & Semwal V.P.), Winsar Publication Dehradun, India. pp 173-182. **(ISBN 978-81-86844-58-8).**

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Present status and Threats to the Ichthyofaunal Diversity of a Snow Fed River Nandakini in Central Himalaya (Garhwal), India

N. K. Agarwal,^{1*} Gurnam Singh² and U S Rawat³

ABSTRACT

Study examined the present status of Ichthyofaunal diversity of river Nandakini and some major threats to its fish fauna. River water is forced through tunnels for operation of two hydropower projects namely Rajwakti hpp (3.60 MW) and Vanala hpp (15 MW). A stretch of ~09 km of this river has been drastically fragmented resulting into reduction in water discharge, seriously violating the continuity in its original course and was unbefitting for the survival of fishes. In the present study altogether 23 fish species of nine genera, three families and two orders were collected from fragmented and continuous flowing river stretches. Cypriniformes was dominating order followed by Siluriformes. Snow trout (Schizothoracines) group was dominating, contributed 33.41% of fishes followed by *Noemacheilus* spp. (18.0%), *Tor* spp. (15.34%) and *Barilius* spp. (14.57%) besides inconsequential contributions by other spp. The Shannon-Weiner diversity index (H) at four sites ranged between 2.48 to 4.2. Study sites selected in the continuous flowing stretch (S-1 and S-3) reported maximum, while fragmented sites (S-2 and S-4) recorded low species richness. The conservation status of fish fauna of Nandakini river ascertained by CAMP (1998) assessment revealed that out of 23 species, status of 6 species was not assessed due to data deficient, 7 species were categorised as lower risk near threatened, 6 as vulnerable and 4 species as endangered. The conservation and management measures for river habitat and fish diversity are also suggested in the present communication.

30. Singh Gurnam and **Agarwal N. K.** (2014). Fishing methods in upper Ganga River system of Central Himalaya, India. Journal of Fisheries. Volume 2 Issue 3 Pages: 195-202-DOI: [dx.doi.org/10.17017/jfish.v2i3.2014.43](https://doi.org/10.17017/jfish.v2i3.2014.43)



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Fishing methods in upper Ganga River system of Central Himalaya, India

Gurnam Singh • Naresh Kumar Agarwal

ABSTRACT

Present study on fishing methods in the upper Ganga River system was conducted during the period 2010- 2012. Upper Ganga river system consists of two major rivers basins viz. Alaknanda and Bhagirathi rivers and number of their 1st and 2nd order tributaries which flows through Garhwal region (Central Himalaya). This large network of fluvial water resources harbours rich Ichthyofaunal diversity. The varied potential of fish resources from these water bodies permits the utilization of wide array of fishing methods. Most of the fishing methods of the Garhwal region are primitive, based on indigenous traditional knowledge and well suited to turbulent nature of the streams. In present study eighteen fishing methods and gears have been documented from the upper Ganga River system. Study observed season, habitat and species specificity of the fishing methods. The utilization of crude and unscientific fishing methods is frequent in the streams of remote areas resulting into decline in fish resource. All the fishing methods employed in upper Ganga River system are classified into four types. The classification is based on their utilisation up to the level which will allow the sustainable harvesting and proper management of valuable fish resources.

Keywords: Fishing methods, hill streams, Central Himalaya, Ganga River system

31. Singh Gurnam and **Agarwal N. K.** (2014). Fish assemblage structure and habitat use of the snow fed stream Assiganga - a major tributary of river Bhagirathi in Central Himalaya (India). *International Journal of Aquatic Biology* 2(6): 305-312

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Original Article

Fish assemblage structure and habitat use of the snow fed stream Assiganga - a major tributary of river Bhagirathi in Central Himalaya (India)

Gurnam Singh, Naresh K Agarwal*

ABSTRACT

Assiganga stream is an important tributary of Bhagirathi River in central Himalaya (India). The stream is characterized by heterogeneity in habitat and substratum features harboring diverse fish fauna. At present this stream is facing threat of being fragmented by the construction of two hydro-electric projects. Present study aimed to study fish diversity and their habitat use in Assiganga stream. This study reports fifteen species (14 indigenous and 1 exotic) belonging to 8 genera, 4 families and 3 orders. Snow trout, *Schizothorax richardsonii* (Cyprinidae family) and *Salmo trutta* (Salmonidae family) were the dominant species (> 65% of total fish catch) throughout the entire length of stream. The presence of rich benthic food, clear water, low turbidity (01-05 NTU), high DO (8.75-10.75 mg-l), and high water velocity (1.10-1.40 m-s) with characteristic rapids and cascades in upper reaches provides ideal habitat for the existence of native snow trout and exotic trout species. Few cat fishes, loaches, *Tor* spp. and lesser barils also have been reported during the study.

Keywords: Stream habitat Fish assemblage River Bhagirathi Himalayan stream

32. Sharma, N.K., Mir, J.I., Pandey, N.N., Akhtar, M.S., Bashir, A. And **Singh, Ravindra** (2014). Meristic and Morphometric Characteristics of *Crossocheilus diplochilus* (Heckel, 1838) from the Poonch Valley of Jammu and Kashmir, India. **World Journal of Zoology**. 9(3): 184 – 189. DOI: [10.5829/idosi.wjz.2014.9.3.8570](https://doi.org/10.5829/idosi.wjz.2014.9.3.8570) ISSN 1817-3098

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Meristic and Morphometric Characteristics of *Crossocheilus diplochilus* (Heckel, 1838) from the Poonch Valley of Jammu and Kashmir, India

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Abstract: The present study aims to describe the meristic and morphometric characteristics of *Crossocheilus diplochilus* from a tributary of Indus River basin, India. Altogether 41 specimens ranging from 10.0 - 17.0 cm total length (TL) and 12.16 - 41.22 g body weight (BW) were used for the study of the morphometric and meristic characteristics using different local fishing gears. The morphometric characteristics on the head express greater variation in head height (SD=7.46) than those from the body in pre-anal fin length (SD=4.14). The highly correlated body parameter in relation to total length was standard length ($r=0.996$) and distance from anal fin to caudal fin base was found least correlated ($r=0.804$) and strong correlations were observed between head length and pre-orbital length ($r=0.931$) and least correlation between head length and head height ($r=0.829$). Even though the values of correlation coefficient (r) vary between 0.804 (distance from anal fin to caudal fin base) and 0.996 (standard length), they are all strongly significant ($P<0.001$). The correlation analysis shows that all morphometric traits change proportionally with increase in the total length. These results generate the baseline data on morphometry of *C. diplochilus* which help in easy identification and will help in the development of a strategy for conservation of the natural stocks of *C. diplochilus* in Indus basin, India.

33. Sharma, N.K., Mir, J.I, Pandey, N.N. and **Singh, Ravindra** (2014). Morphometric and Meristic Characteristics of Birdi Loach, *Botia birdi* (Chaudhuri, 1909) from a Tributary of Indus Basin, Jammu and Kashmir, India. **World journal of Fish and Marine Sciences** 6(3): 262 – 266. DOI: [10.5829/idosi.wjfm.2014.06.03.84113](https://doi.org/10.5829/idosi.wjfm.2014.06.03.84113) ISSN 2078-4589.

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Morphometric and Meristic Characteristics of Birdi Loach, *Botia birdi* (Chaudhuri, 1909) from a Tributary of Indus Basin, Jammu and Kashmir, India

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Abstract: The present study describes the morphometric and meristic characteristics of Birdi loach, *Botia birdi* from Poonch River of Jammu and Kashmir, India. A total of 59 specimens ranging from 75.2-186.0 mm in total length (TL) and 7.91-60.64 g body weight (BW) were collected between July 2013 to April 2014 by using different fishing gears. Positive correlation was observed between total length and other body parts. The highly correlated body parameters in relation to total length were fork length ($r = 0.999$) and post orbital length (PoOL) was found least correlated ($r = 0.776$) and strong correlations was observed between head length (HL) and PrOL ($r = 0.991$) and least correlation($r = 0.929$) between HL and eye diameter (ED). The meristic characters were common in all the specimens (D. I -10, A. I- 6, P. 14, V. I-7, C.19). These findings may provide useful information for the conservation and sustainable management of this important fish in the least explored tributary of Indus basin in India.

Key words: Morphometry · *Botia birdi* · Isometric Growth · Wild Population

34. **Agarwal N. K., Saini V. and Raghuvanshi, S. K. (2013).**Characterization and short-term storage of semen of a coldwater Himalayan fish species. *Biojournal*, 8(1): 1-8.

ISSN 0974-9444

NAAS Rating: 1.69

Biojournal, 8(1) 2013, 1-8

CHARACTERIZATION AND SHORT-TERM STORAGE OF SEMEN OF A COLDWATER HIMALAYAN FISH SPECIES

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ABSTRACT

Schizothoracichthys progastus is an important coldwater fish species in the foot-hills of Garhwal Himalayan region of Uttarakhand (India). Its semen is characterized in order to have baseline information for developing short-term and long-term preservation protocol for their ready availability for artificial fertilization in hatchery. The colour (creamy white), pH (7.34 ± 0.05), sperm density ($8.67 \pm 0.50 \times 10^8$ sperm ml⁻¹), spermatocrit value ($58.24 \pm 4.35\%$) and sperm motility duration (64.57 ± 11.44 sec.) of semen is determined as species characteristics. A positive correlation between spermatocrit value and sperm density was established ($r=0.836$, $P<0.001$). The fresh and non-contaminated semen always showed more than 75 percent motile sperm. The preliminary trials for short-term storage of *S. progastus* semen were made at sub-zero temperature (0-4°C). Four extenders namely, Mounib's medium, KCl medium, extender modified from Buyukhatipoglu & Holtz and Extender 189 M of Horton were prepared and tested for their competency in preserving the motility and viability of sperm during refrigerated storage for few days. Out of four extenders, KCl medium was found best in extending the life span of sperm at sub-zero temperature. Nearly 50% of sperm remained motile up to five days of storage in KCl medium, while in undiluted semen (control) 50% motility could be maintained only up to 3 days. The semen was extended in two dilution ratios- 1:4 & 1:10. The dilution ratio 1:4 was found more effective than the other one as it retained sperm viability for longer duration.

Key words: Semen characteristics, Short-term storage, Snowtrout, *Schizothoracichthys progastus*

35. Singh Gurnam and **Agarwal N. K.** (2013). Fish diversity of Laster stream, a major tributary of river Mandakini in Central Himalaya (India) with regard to altitude and habitat specificity of fishes. *Journal of Applied and Natural Science* 5 (2): 369-374.

Online ISSN: 2231-5209 | Print ISSN: 0974-9411
NAAS Rating: 4.84



Journal of Applied and Natural Science 5 (2): 369-374 (2013)



Fish diversity of Laster stream, a major tributary of river Mandakini in Central Himalaya (India) with regard to altitude and habitat specificity of fishes

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ABSTRACT

Laster stream is a major tributary of river Mandakini, which in turn is a major tributary of river Alaknanda. Stream traverses a distance of ~40 km before joining with river Mandakini at Suryaprayag (Tilwara) in Rudraprayag district (Uttarakhand), India. Present study reports existence of twenty one indigenous fish species belonging to eight genera, three families and two orders from the Laster stream. *Schizothorax richardsonii* (Cyprinidae family) was the dominating species followed by *S. plagiostomus*, *Barilius* sp., *Tor* sp., *Noemacheilus* sp., *Pseudecheneis* sp., *Glyptothorax* sp. The distribution pattern (diversity and abundance) of these species had negative co-relation with the increase in stream altitude. Habitat conditions in the stream varied considerably from headwater to main stream. Present study also describes the habitat specificity of fish assemblage. Maximum species diversity (18 species) was recorded from pool habitat and was the most preferred habitat. Least species diversity (09 species) was recorded from cascade habitat. Riffle and rapid habitat recorded no difference in species diversity.

Keywords: Fish diversity, Stream habitat, Stream gradient, Substratum heterogeneity

36. **Singh, Ravindra.** (2013). Feeding biology of *Noemacheilus botia* (Ham.). **J. Mountain Res.**, 8: 61 - 69. ISSN 0974-3030

J. Mountain Res., Vol-8 pp.61-69, December, 2013, ISSN. 0974 - 3030

FEEDING BIOLOGY OF *NOEMACHEILUS BOTIA* (HAM)

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Received: 22.2.2013

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ABSTRACT

The paper deals with food analysis and feeding behaviour of *Noemacheilus botia* (Ham) collected from Khoh river in a stretch between Dogadda and Kotdwar during 2001-2003. The fish was adjudged as carni-omnivore as it feeds mostly on insect larvae ($28.75 \pm 2.82\%$), crustacean larvae ($19.13 \pm 2.30\%$) and detritus ($20.25 \pm 1.67\%$). RLG (maximum 0.852 ± 0.032) and GaSI value (maximum 2.166 ± 0.849) also confirm the declared feeding status of the fish.

KEYWORDS: Feeding Biology, *N. botia*, GaSI, RLG, Feeding intersitv.

37. **Agarwal N. K.** and Singh Gurnam (2012). Documentation of fishes and physico-chemical characters of a stream Indrawati- a spring fed tributary of River Bhagirathi at Uttarkashi (Central Himalaya, Garhwal) India. Environment Conservation Journal. Vol. 13 (3): 117-124.

NAAS Rating: 4.52

Environment Conservation Journal 13(3) 117- 124, 2012
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed



Documentation of fishes and physico-chemical characters of a stream Indrawati- a spring fed tributary of River Bhagirathi at Uttarkashi (Central Himalaya, Garhwal) India

N.K. Agarwal and Gurnam Singh ✉

ABSTRACT

Most of the riverine resources in Garhwal region are mountainous and perennial either snow fed or spring originated. All these mountainous streams provide a good natural habitat for survival of hill stream fishes. Present communication deals with documentation of Ichthyofauna along with physico-chemical properties of a similar perennial spring fed stream Indrawati- a left side tributary of river Bhagirathi. It comes down from the hills of Baragari and through Joshiyara debouches into the river Bhagirathi at Uttarkashi (elevation 1128 masl). Major part of stream water is mainly abstracted for the irrigation purpose in the side lying fields all along its length. There is heterogeneity in the stream bed characteristics which results into the existence of varied fish fauna. Study reports eleven fish species from the stream belonging to two orders, three families and six genera. Fishes belonging to cyprinidae family are found more commonly than the cobitidae and sisoridae family. Fishery of the stream is of subsistence nature and is under intense pressure of anthropogenic activities. Fishes captured are of generally small sized. The physico-chemical characteristics recorded during the study period in the different seasons are water temperature (9.0-16.0 0C), velocity (.50 m-s-1.46 m-s), TDS (49 mg-l – 65 mg-l), pH (8.0 - 8.3), DO (7.3 mg-l – 10.5 mg-l), Free CO₂ (0.10 mg-l – 0.30 mg-l) and turbidity (06-30 NTU).

Keywords: *Hill stream, Ichthyofauna, physico-chemical characteristics, river Bhagirathi, stream habitat*

38. Chaudhary D.K., Sood N., Swaminathan T.R., Rathore G., Pradhan P. K., **Agarwal N. K.**, Jena J. K. (2012). Establishment and Characterization of an epithelial cell line from thymus of *Catla catla* (Hamilton, 1822). **Gene**. <http://dx.doi.org/10.1016/j.gene.2012.09.081>.

Impact Factor 2.319



Short Communication

Establishment and characterization of an epithelial cell line from thymus of *Catla catla* (Hamilton, 1822)

Dharmendra K. Chaudhary^a, Neeraj Sood^{a,*}, T. Raja Swaminathan^a, Gaurav Rathore^a, P.K. Pradhan^a, N.K. Agarwal^b, J.K. Jena^a

ABSTRACT

A cell line, CTE, derived from catla (*Catla catla*) thymus has been established by explant method and subcultured for more than 70 passages over a period of 400 days. The cell line has been maintained in L-15 (Leibovitz) medium supplemented with 10% fetal bovine serum. CTE cell line consists of homogeneous population of epithelial-like cells and grows optimally at 28 °C. Karyotype analysis revealed that the modal chromosome number of CTE cells was 50. Partial amplification, sequencing and alignment of fragments of two mitochondrial genes 16S rRNA and COI confirmed that CTE cell line originated from catla. Significant green fluorescent signals were observed when the cell line was transfected with phrGFP II-N mammalian expression vector, indicating its potential utility for transgenic and genetic manipulation studies. The CTE cells showed strong positivity for cytokeratin, indicating that cell line was epithelial in nature. The flow cytometric analysis of cell line revealed a higher number of cells in S-phase at 48 h, suggesting a high growth rate. The extracellular products of *Vibrio cholerae* MTCC 3904 were toxic to the CTE cells. This cell line was not susceptible to fish betanodavirus, the causative agent of viral nervous necrosis in a large variety of marine fish.

Keywords:

Catla catla, Cell line, Karyotype, Immunocytochemistry, Thymus, Transfection

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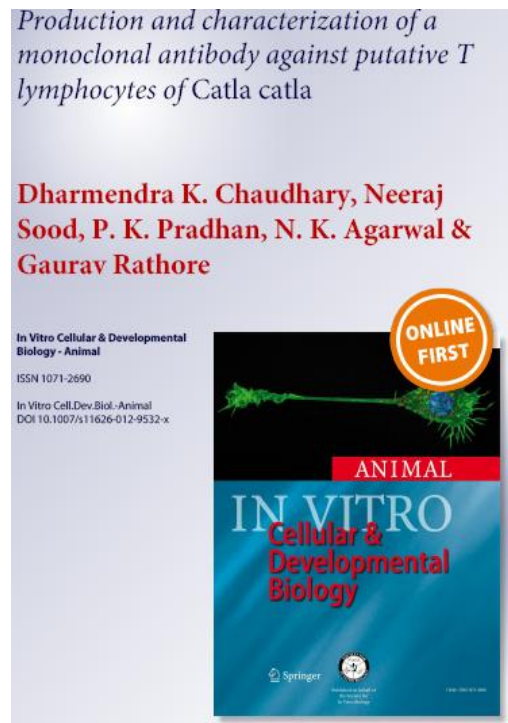
39. Chaudhary D. K., Sood N., Pradhan P. K., **Agarwal N. K.**, Rathore G. (2012). Production and characterization of monoclonal antibody against putative T lymphocytes of *Catla catla*. In Vitro Cell. Dev. Bio.-Animal DOI: 10.1007/s11626-012-9532-x

Impact Factor= 0.971

ABSTRACT

Catla catla is the fastest growing Indian major carp and one of the major aquaculture species in South Asia. A monoclonal antibody (MAb) designated B8 MAb was produced against nylon wool-enriched thymus mononuclear cells of *C. catla*. This MAb did not show reactivity with macrophage and epithelial cell lines derived from catla thymus in cellular ELISA. In flow cytometric analysis of gated lymphocytes, the percentage of B8 positive (B8+) cells in thymus (n010, 500–600 g) was determined to be 77.7 %. Similarly, the percentage of B8+ cells in kidney, spleen and blood (n05) was 15.08, 1.1 and 32.17 %, respectively. Western blotting of reduced membrane proteins showed that B8 MAb reacted with a polypeptide having a molecular weight of 168.2 kDa. In indirect immunoperoxidase test, B8+ cells appeared to be lymphoid cells with a high nucleus to cytoplasmic ratio. B8 reactive cells were densely packed in central region of thymus whereas, a few cells were found to be positive in kidney and spleen sections. B8 MAb also reacted with a significant population of lymphocytes in blood smears. Considering the economic importance of *C. catla*, this MAb should be a useful tool for studying immune response of this fish species.

Keywords: *Catla catla*. cELISA. Flow cytometry, Immunoperoxidase test. Monoclonal antibody. Thymus. T lymphocytes. Western blotting



40. Chaudhary D. K., Sood N., Rathore G., Pradhan P. K., Punia P., **Agarwal N. K.**, Jena J. K. (2012). Establishment and characterization of macrophage cell line from thymus of *Catla catla* (Hamilton, 1822). *Aquaculture Research*, 1-13 doi: 10.1111/j.1365-2109.2012.03227.x (12 July 2012).

Impact Factor= 1.475



Aquaculture Research, 2012, 1–13

doi: 10.1111/j.1365-2109.2012.03227.x

Establishment and characterization of macrophage cell line from thymus of *Catla catla* (Hamilton, 1822)

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ABSTRACT

A continuous cell line has been developed from thymus explants of *Catla catla* and the cells have been subcultured for 63 passages. The cells exhibited optimum growth at 30°C in L-15 medium containing 15% foetal bovine serum. The cultured cells engulfed yeast cells and fluorescent latex beads. These cells produced reactive oxygen and nitrogen intermediates following stimulation with lipopolysaccharide and phorbol esters. The culture supernatant from the cultured cells had lysozyme activity and these cells demonstrated Fc receptors. Almost all the cells were positive for alpha-naphthyl acetate esterase enzyme suggesting that the cells are of macrophage lineage and therefore, the cell line was designated as catla thymus macrophage (CTM) cell line. CTM cells formed aggregates around zoospores of *Aphanomyces invadans*, but were unable to inhibit the germination of spores. The karyotype analysis of CTM cells at 25th passage revealed a typical diploid model with 50 chromosomes per cell. Partial amplification, sequencing and alignment of fragments of two mitochondrial genes 16S rRNA and cytochrome c oxidase subunit 1 confirmed that the CTM cell line originated from *C. catla*. This cell line should be useful for studying the role of macrophages in differentiation and maturation of thymocytes and can be a source of macrophage-specific enzymes and cytokines.

Keywords: *Catla catla*, Cell line, Macrophage, Thymus

41. Chaudhary D. K., Sood N., Pradhan P. K., Singh A., Punia P., **Agarwal N. K.**, Rathore G. (2012). Establishment of a macrophage cell line from adherent peripheral blood mononuclear cells of *Catla catla*. In Vitro Cell. Dev. Biol.- Animal, 48(6): 340-348. DOI: 10.1007/s11626-012-9516-x.

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In Vitro Cell.Dev.Biol.—Animal (2012) 48:340–348
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REPORT

Establishment of a macrophage cell line from adherent peripheral blood mononuclear cells of *Catla catla*

Dharmendra K. Chaudhary · Neeraj Sood ·
P. K. Pradhan · Akhilesh Singh · Peyush Punia ·
N. K. Agarwal · Gaurav Rathore

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Catla catla, commonly known as catla, is endemic to the riverine system in northern India, Indus plain and adjoining hills of Pakistan, Bangladesh, Nepal and Myanmar. This fish grows best at water temperatures between 25°C and 32°C. Catla, an important culture species, has the highest growth rate amongst Indian major carps. A number of cell lines have been reported from catla (Ishaq Ahmad et al. 2008, 2009a, b). However, cell lines of leucocytic origin have not been reported from this species to the best of our knowledge. Such a cell line would provide useful information regarding functions of leucocytes in teleost species.

Macrophages are the multipotent cells of the immune system that play a central role in innate and adaptive immune response in teleosts. In the innate immune system, macrophages are believed to be the principal phagocytic cells in fish (Blazer 1991) and are considered to be important cells in disease resistance. Fish macrophages have a scavenging function (Ganassin and Bols 1998), bactericidal activity (Honda et al. 1986), larvicidal activity (Whyte et al. 1989) and tumouricidal activity (Mulero et al. 1994). These cells also act as professional antigen presenting cells and therefore, are required for eliciting specific immune response (Guidotti and Chisari 2001). In addition, macrophages are capable of producing a large array of proinflammatory, pro-coagulatory and immune-regulatory products (Ellsaesser and

Clem 1994). These cells are distributed in most of the organs of the body, some of which are specialised, fully differentiated cells specific for their resident organ.

The macrophage cell lines provide a useful tool for studying functions of these cells. Moreover, such a cell line may contribute to the development and characterisation of macrophage cell markers and may be used as a source of macrophage signal peptides such as cytokines and other factors influencing the growth and maturation of leucocytes. These cell lines can be used for preliminary screening of immunomodulatory substances and therefore can provide an alternative to animal usage for such experiments. A number of fish macrophage cell lines have been developed namely from peripheral blood (Faisal and Ahne 1990; Vallejo et al. 1991; Weyts et al. 1997), spleen (Ganassin and Bols 1998) and kidney (Wang et al. 1995; Dannevig et al. 1997) as well as peritoneal washings (Watanabe et al. 1997). To date, no macrophage cell line is available from any of the commercially important fishes of the country. In the present study, we report the establishment and characterization of a macrophage cell line designated as *C. catla* macrophage (CCM) cell line from adherent blood mononuclear cells of *C. catla*.

The heparinised blood was collected from caudal vein of a healthy catla weighing 550 g, layered over Histopaque-1077 (Sigma-Aldrich, St. Louis, MO) and centrifuged at 400×g for 30 min. Mononuclear cells (MNCs) were collected, diluted with phosphate-buffered saline (PBS) and centrifuged at 250×g for 10 min. The pellet was suspended in Dulbecco's modified Eagle's medium (DMEM) supplemented with 20 % fetal bovine serum (FBS). The cells were then seeded in 25 cm² flasks (Nunc, Roskilde, Denmark) at a concentration of 1×10⁶ cells ml⁻¹ and the flasks were incubated at 28°C. After 24 h, the non-adherent cells were removed and fresh medium was added. The adherent cells showed aggregation and multiplication at several places in the flask (Fig. 1A, B). A

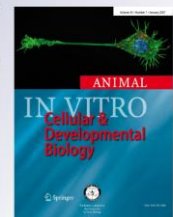
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Establishment of a macrophage cell
line from adherent peripheral blood
mononuclear cells of *Catla catla*

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Sood, P. K. Pradhan, Akhilesh Singh,
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Rathore

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42. Ayoade, A. A. and **Agarwal N. K.** (2012). Preliminary analyses of physical and chemical parameters of Tehri dam reservoir, Garhwal Himalaya, India. *Zoology and Ecology*, 22 (1): 72-77. DOI: 10.1080/21658005.2012.674656.

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Zoology and Ecology
Vol. 22, No. 1, March 2012, 72–77



RESEARCH ARTICLE

Preliminary analyses of physical and chemical parameters of Tehri dam reservoir, Garhwal Himalaya, India

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ABSTRACT

Post-impoundment studies of physical and chemical parameters of water in the Tehri dam reservoir were carried out in September 2007 and February 2008. Physicochemical parameters were analysed using standard methods for water analysis. The following parameter value ranges were obtained: water temperature 16.5–29.3°C, transparency 55–158 cm, turbidity 1–12 NTU, pH 4–9.8, dissolved oxygen 6.9–11.75 mg/l, conductivity 59.6–93.5 mg/l, total dissolved solid 31.04–46.8 mg/l, alkalinity 40–78.2 mg/l, Ca²⁺ 7.9–17.6 mg/l, and hardness 35.2–82 mg/l. A significant seasonal variation ($p < 0.05$) was observed in all the parameters except relative humidity, transparency, and alkalinity. Only relative humidity and pH showed a significant spatial variation ($p < 0.05$) of all the parameters studied. The study results revealed that all the parameters are within permissible levels except pH, which is a little above the recommended value. Consequently, water in the reservoir is suitable for drinking and fish culture.

Keywords: transparency, dissolved oxygen, Tehri reservoir, preliminary analyses

- 43. Agarwal N. K., Singh Gurnam and Singh Harpal (2011).** Present status of Ichthyofaunal diversity of Garhwal Himalayan river Bhilangna and its tributaries with reference to changing environment. *Environment Conservation Journal*, 12(3): 101-108.

NAAS Rating: 4.52

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(ISSN 0972-3099) Abstracted and Indexed



Present status of Ichthyofaunal diversity of Garhwal Himalayan river Bhilangna and its tributaries with reference to changing environment

N.K. Agarwal✉, Gurnam Singh and Harpal Singh

ABSTRACT

Fish as a group, from biodiversity view point has the highest species diversity among all vertebrate taxa. Present communication deals with the reassessment of ichthyofaunal diversity of the river Bhilangna and its two sub tributaries, the Balganga and the Nailchami of Bhagirathi river system in Garhwal Himalaya. The observation made during study showed the occurrence of 22 fish species belonging to 2 orders, 3 families and 9 genera from varying habitat of falls, cascades, rapids, riffles and pools in various sections of river Bhilangna and its tributaries. *Schizothorax richardsonii*, *S. plagiostomus* are dominate species in the riverine segment of river Bhilangna while *Cyprinus carpio* (common carp) is the dominate species in impoundment segment of river Bhilangana (reservoir area). The comparison of results of present study with earlier reports revealed that fish fauna has decreased with passage of time in the Bhilangana river system which may be due to degradation and fragmentation of riverine habitat caused by various developmental activities, changes in the natural flow pattern of river, indiscriminate fishing by the use of destructive and unscientific fishing methods, and other natural calamities.

Key words: Fish diversity, Bhilangana river, Habitat degradation, River fragmentation.

44. **Agarwal N. K.** (2011). Cryopreservation of Fish Semen. In : *Himalayan Aquatic Biodiversity Conservation & New Tools in Biotechnology* (eds. J.P.Bhatt, Madhu Thapliyal & Ashish Thapliyal), pp 104-127. Transmedia Publication, Srinagar (Garhawal) Uttarakhand.

Himalayan Aquatic Biodiversity Conservation & New Tools in Biotechnology
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Transmedia Publication, 978-81-904778-3-6, 2011, pp. 104-127

ABSTRACT

Cryopreservation is a process where biological materials such as cells and tissues are preserved by cooling to very low temperatures, usually at -196°C (the temperature of liquid nitrogen), yet remain viable after later warming to temperatures above 0°C . It makes possible almost indefinite storage of the desirable gene pools and ensures the availability of cryopreserved semen for artificial insemination/breeding.

Nearly 60 years have passed since the first demonstration of effective cryopreservation of sperm was made (Polge *et al.*, 1949). It leads a major breakthrough in animal husbandry with successful cryopreservation attempt on bull spermatozoa (Smith and Polge, 1950). Soon after, first report on fish sperm cryopreservation was published by Blaxter (1953) and since then flurry of publications demonstrating the feasibility of cryopreserving the fish semen from a large number of marine and freshwater species have appeared. To date milt of over 200 species of freshwater and marine fish have been cryopreserved (Lakra, 1993; Rana, 1995; Blesbois and Labbe, 2003; Hiemstra *et al.*, 2005).

Advantage of cryopreserving the fish semen is well established. It is not only a useful management tool, it offers several benefits such as stock protection from being totally eliminated due to sudden outbreak of disease, natural disaster, over exploitation etc. Other application of cryopreservation include stable supply of sperm for optimal utilization in hatchery production and laboratory experiments, easy stock transportation among hatcheries, improvement in selective breeding whereby stock can be maintained more economically and effectively, experimental material for advanced studies such as gene transfer.

A number of different protocols are advocated in literature for the preservation of fish semen but most of them are concerned with the salmonids, tilapia, and carp (Ott, 1975; Scott and Baynes, 1980; Chao *et al.*, 1987; Baynes and Scott, 1987; Koldras and Bienarz, 1987; Harvey and Kelley, 1988; Leung and Jamieson, 1991; Gwo, *et al.*, 1993; Rana 1995; Babiak *et al.*, 1997; Akcay *et al.*, 2004). Extenders and cryoprotectants are important and play a vital role in cryopreservation. Irrespective of the species, fish semen requires dilution before

45. Nanda, Manisha, **Sharma, Dinesh** and Kumar Arun. (2011). Isolation and Characterization of Bacteria Resistant to Heavy Metals Cadmium (Cd), Arsenic (As), Mercury (Hg) from Industrial Effluent. **Global Journal of Applied Environmental Sciences**. Vol. 1, Number 2 pp. 127-132. 2011. ISSN 2248-9932.

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Isolation and Characterisation of Bacteria Resistant to Heavy Metals Cadmium (Cd), Arsenic (As), Mercury (Hg) from Industrial Effluent

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Abstract

Along with rapid industrialization throughout the world the environment is also getting polluted day by day. The key pollutants include heavy metals, chemical wastes and oil spills etc. Heavy metal resistant bacteria have significant role in bioremediation of heavy metals in wastewater. Effluents containing heavy metals can be treated with these bacteria for the removal of the specific metal it is resistant to. The microorganisms respond to these heavy metals by several processes like biosorption, transport across the cell membrane, entrapment in extracellular capsules, precipitation, complexation and oxidation-reduction reactions. One of the heavy metals cadmium (Cd) is found to be poisonous for plants, animals and humans.. Mercury is the most toxic of the heavy metals (Gerlach, 1981) and occupies the sixth position in the list of hazardous compounds (Nascimento and Chartone-Souza, 2003). Arsenic (As), is also a toxic heavy metal element, is widely distributed in nature. The objective of this study is to determine resistance of bacteria to these heavy metals. In the present study Cd, Hg and As resistant bacteria were isolated and characterized from industrial effluent and soil samples. A total of 18 colonies were isolated out of which 07 isolates, named, Cd1, Cd2, Cd3, Hg1, Hg2, AS1, AS2 showed resistance to Cd, Hg and As respectively. Maximum tolerance to these metals was observed in the isolate Cd1 with NA and Tris- minimal media for cadmium, AS1 for arsenic and Hg2 for mercury.

47. Nanda, Manisha, **Sharma, Dinesh** and Kumar, Arun.(2011). Removal of Heavy Metals from Industrial Effluent Using Bacteria. **International Journal of Environmental Sciences**. Vol 2., No.2, 2011. pp 781-787. ISSN 0976-4402. IF: 0.1902.

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Research article

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Removal of Heavy Metals from Industrial Effluent Using Bacteria

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ABSTRACT

Industrial development results in the generation of industrial effluents, and if untreated results in water, sediment and soil pollution. (Fakayode and Onianwa, 2002; Fakayode, 2005). Industrial wastes and emission contain toxic and hazardous substances, most of which are detrimental to human health (Jimena *et al.*, 2008; Ogunfowokan *et al.*, 2005; Rajaram *et al.*, 2008). The key pollutants include heavy metals, chemical wastes and oil spills etc. Heavy metal resistant bacteria have significant role in bioremediation of heavy metals in wastewater. The objective of this work is to study the role of bacteria in removing the heavy metals present in the industrial effluent. Five effluent samples out of nine were selected for this study due to high content of heavy metals. The heavy metals Hg and Cu were removed by *Bacillus sp.* The average Hg reduction was 45% and Cu reduction was recorded as 62%. The heavy metals Cd, As and Co were removed by *Pseudomonas sp.* The average Cd reduction was 56%, average As reduction was 34% and average Co reduction was recorded as 53%. The heavy metals Cd and Cu were removed by *Staphylococcus sp.* The average Cd reduction was 44% and average Cu reduction was recorded as 34%.

Keywords: Heavy Metal, industrial effluent, cadmium, arsenic, mercury.

47. Uttam Saikia, **Sharma D.K.** and Mehta, H.S. (2010). First Record of large worm snake (*Typhlops Diardii*) in Himachal Pradesh. **Indian Forester**. Vol. 136. No.1. ISSN 0019-4816.

Impact Factor: 0.14

RESEARCH NOTES

(I)

FIRST RECORD OF LARGE WORM SNAKE (*TYPHLOPS DIARDII*) IN HIMACHAL PRADESH

Introduction

Reptiles, in spite of being a diverse and fascinating component of vertebrate biodiversity, remain one of the least explored animal groups in Himachal Pradesh. The first documentation of reptiles from the state was that of Prashad (1914) pertaining to the Saurian fauna of erstwhile Shimla Hill state. Thereafter, a few studies were conducted relating to geographical and altitudinal distribution of reptile species in the state (Acharjii and Kripalini, 1951; Waltner, 1975a, 75b, 75c and 75d; Mahajan and Agrawal, 1976 and Agrawal, 1979). Of late, fragmentary studies have resulted in addition of a number of species raising the reptilian inventory of the state to 53 species (Saikia *et al.*, 2005). In the present communication, another species *Typhlops diardii* is recorded first time from Himachal Pradesh.

Worm snakes (Family: Typhlopidae) are diminutive burrowing snakes and leads a secretive subterranean life. Because of the subterranean mode of existence, *Typhlops* are infrequently encountered and probably one of the reasons for little knowledge about their biology and ecology. Genus *Typhlops* Oppel has approximately 120 valid species and known to be distributed throughout

Africa, Australia, South Asia, Central and South America, West Indies and borders of the Mediterranean (Rooij, 1915, Annon 2006). Within Indian territory, 16 species of this genus have been reported (Das, 2003), of which only one species *Typhlops porrectus* is known earlier from Himachal Pradesh in Western Himalaya.

Diagnostic characters

T. diardii is a large earthworm like snake that grows up to 430mm in length (Daniel, 2002). Snout is rounded and projecting and nostrils lateral. The rostral is narrow and reaches the level of eyes. The prefrontal contacts the rostral. Nasals are incompletely divided with the nasal cleft passing to the second labials. Scale row count round the body is normally 24-26 and rarely 22 or 28. Mid dorsal scales range from 260-300 (Kabisch, 2002).

Material examined

The High Altitude Zoology Field Station, Zoological Survey of India, Solan, Himachal Pradesh, has a specimen of *T. diardii* from Himachal Pradesh. The specimen (Regn. No. R 212) was collected from Gadyani village (approx. 31°39'N, 76°44'E) in Sarkaghat Tehsil, Mandi District in Himachal Pradesh on October

48. Saikia, Uttam, Mehta, H.S. **Sharma, D.K.** (2010). New Distributional Record of Eastern Black Turtle, (*Melanochelys trijuga indopeninsularis*) from Simbalawara Wildlife Sanctuary. Himachal Pradesh. **Indian Forester**. Vol. 136, 2. ISSN 0019-4816.

Impact Factor: 0.14

(V)

NEW DISTRIBUTIONAL RECORD OF EASTERN BLACK TURTLE, *MELANOCHELYS TRIJUGA INDOPENINSULARIS* FROM SIMBALWARA WILDLIFE SANCTUARY, HIMACHAL PRADESH

Introduction

Simbalwara Wildlife Sanctuary (30° 24' to 30° 28' N and 77° 28' to 77° 32' E) is located in district Sirmour of Himachal Pradesh bordering Haryana in the neighborhood of Kalesar National Park. Geographically, the Sanctuary lies in the Shiwalik hills which constitute the outermost range of Himalaya with typical eroded landscape. The sanctuary occupies an area of 19.03 km². The entire area is undulating with altitude varying from 580 to 700 mtrs. Vegetation comprised of dry and moist deciduous forest dominated by *Shorea robusta* in association with *Lagerstroemia parviflora*, *Anogeissus latifolia*, *Bombax ceiba*, *Terminalia bellerica*, *Terminalia tomentosa*, *Zizyphus* spp. etc. Climate is subtropical with extremely hot summer and very cold winter. The sanctuary is home to some eighteen species of mammals including elusive tiger and over 150 species of birds (pers. obs.)

The state of Himachal Pradesh situated in north-west Himalaya harbors a rich variety of reptilian fauna comprising 53 species distributed over 14 families and Testudines are represented by three species namely *Lissemys punctata*, *Pangshura smithii* and *Kachuga kachuga*. In the present communication, *Melanochelys trijuga indopeninsularis* Annandale is

reported from Simbalwara Wildlife Sanctuary in Himachal Pradesh and is an addition to the Chelonian fauna of the state.

Diagnostic Characters

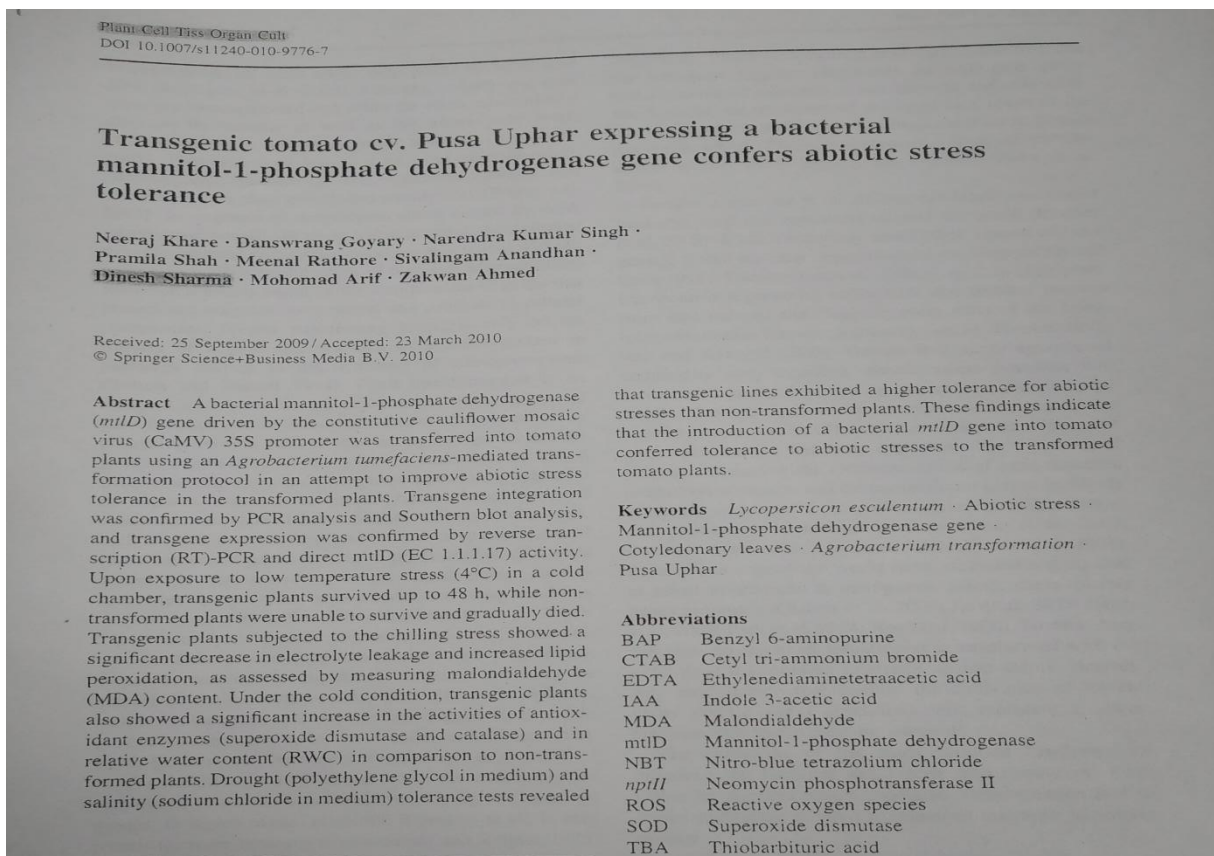
Out of the seven recognized subspecies, the eastern black turtle *M. trijuga. indopeninsularis* is a comparatively larger subspecies with a carapace length reaching 34 cm and breadth of 23cm (Schleich and Kastle, 2002). Carapace is moderately depressed, tricarinate, lateral margins more or less turned upward. Nuchal shields very small. Plastron as long as carapace, truncate or openly emarginated anteriorly, plastral lobe is narrower than the shell opening. Axillary and inguinal shields present. Body colour is dark brown to black with yellow plastral margins especially in the young. Head grayish or olive with yellow reticulations on the sides which become inconspicuous with age.

Observation and Discussion

During the course of general faunistic survey in Simbalwara Wildlife Sanctuary, on 2nd June, 2005, a dying turtle was found near the rest house of the sanctuary that was crushed by night passing vehicle. It was lying on a dry riverbed next to a pool of

49. Khare Neeraj, Goyary Danswring, Narender K.S., Shah, P., Rathore, M., Sivalingam, A., Sharma, D., Arif, M., Ahmed, Z. (2010). Transgenic tomato cv Pusa Uphar expressing a bacterial mannitol-1-phosphate dehydrogenase gene confers abiotic stress tolerance. **Plant Cell Tiss. Organ Cult.** DOI 10. 1007. S 11240-010-9776-7. Springer. ISSN : 1573-5044.

Impact Factor: 2.390



50. Ayoade, A. A., **Agarwal, N. K** and Chandola-Saklani, A. (2009). Changes in Physico-chemical Features and Plankton of Two Regulated High Altitude Rivers, Garhwal Himalaya, India. *European Journal of Scientific Research*, 27 (1): 77-92.

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Changes in Physicochemical Features and Plankton of Two Regulated High Altitude Rivers Garhwal Himalaya, India

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ABSTRACT

Flow of rivers become impeded and are regulated due to construction of dam. This brings about changes in abiotic and biotic factors compare to untamed rivers and the response of each river to dam differs. Tehri dam, the highest earthen dam in Asia is completed in 2004 about 1km after confluence of rivers Bhagirathi and Bhilangana. The post-impoundment physical, chemical and biological parameters of the parent rivers (upstream, within reservoir and downstream) were analysed for the first time by this study. The data of abiotic and biotic factors of lotic, lentic and downstream zones of each river were compared to reveal influence of dam on these regulated rivers. It was observed that the water temperature, velocity, transparency and carbon dioxide content of the parent rivers were influenced by the dam. There were significant differences in these parameters among the main zones sampled. The planktonic communities of both rivers were impacted by these changes in abiotic features. Highest planktonic abundance was recorded in lentic zone due to reduced water current and higher transparency. Green algae were the dominant group in lacustrine zones, while diatoms were encountered more in lotic community. Least plankton abundance and species diversity were recorded downstream. Lentic community has least similarity with all other zones. The dominance of large colonial green algae in lentic zone compare with smaller diatoms in lotic community suggests that the reservoir can support a more productive fishery.

51. **Agarwal N. K.** and Raghuvanshi S. K. (2009). Spermatocrit and sperm density in snowtrout (*Schizothorax richardsonii*): Correlation and variation during the breeding season. *Aquaculture*, 291: 61-64. DOI 10.1016 / j. aquaculture.2009.03.002

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Spermatocrit and sperm density in snowtrout (*Schizothorax richardsonii*): Correlation and variation during the breeding season

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ABSTRACT

The efficacy of spermatocrit (the ratio of packed sperm cell in semen after centrifugation) as an indicator of sperm density was tested in snowtrout (*Schizothorax richardsonii*). Semen samples were collected from 98 live ripe male brooders over two consecutive breeding seasons for the sperm density analysis. A significant, positive, linear relationship between spermatocrit and sperm density (measured with a haemocytometer) was established during regression analysis ($r=0.817$, $P<0.001$), thus supporting the use of spermatocrit as a rapid and reliable estimator of sperm concentration in this species. A decrease in sperm density and spermatocrit was noticed with the advancement of breeding season.

Keywords: *Schizothorax richardsonii*; Snowtrout; Spermatocrit; Sperm density

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52. **Agarwal N. K.**, Raghuvanshi S. K. and Saini V. (2009). Cryopreservation of snowtrout (*S.richardsonii*) milt as a means for propagation and ex-situ conservation of species. In: *Fish Genetic Resources*, (eds. W.S. Lakra, A.K., Singh & P.C. Mahanta), pp 273-284. Narendra Publishing House, New Delhi.

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www.nph-india.com

CRYOPRESERVATION OF SNOWTROUT (*S. RICHARDSONII*) MILT AS A MEANS FOR PROPAGATION AND EX-SITU CONSERVATION OF SPECIES

N.K. Agarwal, S.K. Raghuvanshi and Vandana Saini

ABSTRACT

Schizothorax richardsonii is an indigenous snow-trout of Garhwal Himalayas, showing continuously decreasing trend in the capture fishery of the region since past few years. For propagation and conservation of this species, first successful attempt was made to cryopreserve the milt of *S. richardsonii*. The milt samples were evaluated for pH (7.31 ± 0.07), sperm density ($3.77 \pm 0.78 \times 10^8$), spermatocrit value ($63.13 \pm 10.27\%$), and sperm motility. The sperms remained motile for 59.70 ± 16.55 sec after activation. Milt samples of good quality (sperm motility $>75\%$) were pooled and frozen within 2 hours of collection.

The four extenders and two cryoprotectants were tested to cryopreserve the snowtrout milt. The extender-Mounib's medium was found most successful. The DMSO proved better than glycerol. Equilibration time was standardized as 45 min for DMSO and 60 min for glycerol. Two Milt: diluent (extender + cryoprotectant) ratios 1:4 and 1:10 were used. The 0.5 ml French medium straws were used to store the milt in liquid nitrogen. Thawing temperature was standardized as $20-25^{\circ}\text{C}$. The success of developed protocol was tested by post-thaw motility assessment. This first successful attempt to cryopreserve the *S. richardsonii* milt explores the possibility to improve efficiency of hatchery oriented seed production and thereby propagation of the species through river ranching and ex-situ conservation of its germplasm.

Key words: Snowtrout, cryopreservation, *S. richardsonii*, ex-situ conservation.

53. **Agarwal N. K.** and Singh Harpal (2009). Snowtrout Fishery in Uttaranchal: Causes of Depletion & Strategy for Propagation. Environment Conservation Journal. Vol. 10(1&2): 135-140.

NAAS Rating: 4.52

Environment Conservation Journal 10(1-2) 141-146, 2009
(ISSN 0972-3099)



Snowtrout Fishery in Garhwal Himalaya: Causes of Depletion and Strategy for Propagation

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ABSTRACT

Snowtrout (*Schizothorax* sp.) is an important group of fishes in Indian uplands and is prone to decline due to several anthropogenic activities and natural disasters. However, the natural behaviour of the group is also one of the important constraints for its self-propagation in the nature. It requires attention for the conservation and propagation through *in-situ* as well as *ex-situ* measures. The *in-situ* refers to – aquaculture under controlled conditions for propagation of the group by developing artificial breeding programmes for high seed requirement, better management of incubation patterns and rational management of water bodies including development of sanctuaries, where the fishing would be banned. The artificial breeding and snowtrout seed production technique in flow through hatchery can be adopted at commercial level for mass scale snowtrout seed production. Sometimes unavailability of either sex of the mature brooder at the time of artificial fertilization in hatchery is a major constraint in the artificial breeding programmes. Cryopreservation of gametes has emerged as a promising and a very useful technique to facilitate artificial breeding in several fishes. The cryopreservation of milt of snowtrout finds its role right here. Initial attempts for developing cryopreservation protocol for snowtrout milt are very much promising. More concerted efforts for commercializing the reproductive techniques including cryopreservation of gametes will certainly be helpful for the strategic propagation of snowtrout in cold-water bodies.

Keywords:- *Snowtrout, Habitat destruction, Breeding, In-situ conservation, Ex-situ conservation,*

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Zool. Surv. India

Faunal Diversity of Simbalbara Wildlife Sanctuary, Conservation Area Series, 41, 2009 : 65-79.

REPTILIA

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INTRODUCTION

In the state of Himachal Pradesh, reptiles probably are the least explored vertebrate group. It was Prashad (1914) who first attempted to record the reptilian fauna of the erstwhile Shimla-Hill state. In *The Fauna of the British India*, Smith (1935,1943) reported several reptile species from various parts of Himachal Pradesh. A few workers like Acharjee and Kripalini (1951), Waltner (1975a, 75b, 75c & 75d), Mahajan and Agrawal (1976) and Agrawal (1979) studied geographic and altitudinal distribution of reptile fauna along the Himalayas including Himachal Pradesh. Recent scattered studies have added several species to the reptilian fauna of the state (Saikia *et al.* 2005, Saikia *et al.* 2007). Currently, 55 reptile species belonging to 15 families are known from Himachal Pradesh (Saikia *et al.* in press). However, because of the inadequacy of comprehensive surveys, a reasonably complete documentation of the reptile fauna of the state remains obscure and new records continue to emerge. The present account deals with the Reptilian diversity of Simbalbara Wildlife Sanctuary, a mixed deciduous forest patch in Sirmour district of Himachal Pradesh. No previous report on the reptilian fauna of the sanctuary is available although Mehta (2000) reported 14 reptile species from nearby Renuka wetland area.

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Zool. Surv. India

Faunal Diversity of Simbalwara Wildlife Sanctuary, Conservation Area Series, 41, 2009 : 103-118.

MAMMALIA

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INTRODUCTION

Mammals constitute a significant portion of vertebrate diversity of Himachal Pradesh comprising 111 species (Chakraborty *et al.* 2005, Saikia *et al.*, 2004). Despite smaller geographical area, the state harbors about 27 percent of total mammalian species in India. Varied environmental setup in areas from lofty snowy peaks to hot plains coupled with good vegetation cover in the state provide ideal conditions for colonization by specialized mammalian species besides generalist one. Mammalian fauna of Himachal Pradesh is an admixture of Palearctic and Oriental elements since the state lies in the transition zone of the two biogeographical realms. Brown Bear, Lynx, Alpine Weasel, Mountain Noctule etc. are some of the Palearctic representative of the mammalian fauna of the state that probably came from Hindukush Mountains and Russian Uzbekistan (Roberts, 1977). Some of the representative Oriental fauna of the state include Leopard cat, Yellow throated Marten, Himalayan Palm Civet, Indian Pangolin, Grey Goral, Barking Deer, Bandicoot Rat, Bush Rat, Flying Fox, False Vampire, Fulvous leaf-nosed Bat, Musk Shrew etc. However, being a part of the Himalayan Range, no species level endemism is found in the state with respect to mammalian species (Chakraborty *et al.*, 2005).

Simbalwara Wildlife Sanctuary, a dry deciduous forest patch (Dry Siwalik Sal forest, Type 5B/C1a, Champion & Seth, 1968) situated on the northernmost limit of Sal forest provides suitable habitats for herbivores like Barking Deer, Sambar, Cheetal, Wild Boar etc which in turn provide prey base for large carnivores. The Sanctuary is adjoining to Kalesar National Park in neighboring Haryana from which elephants occasionally cross over to Simbalwara. Incidentally, the sanctuary is the only conservation area in Himachal Pradesh where the occurrence of Tiger and Elephant has been reported. The present account deals with the mammalian species occurring in the Sanctuary which were recorded during field surveys from 2004-2006. The inventory comprises 21 species in 19 genera and 9 orders. Except for four species (marked with asterisk), all reported species were sighted in the field by the authors.

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