

DEPARTMENT OF ZOOLOGY- BIRLA CAMPUS, HNBSU, SRINAGAR

PhD awarded during 15.1.2009 to 31.12.2020

Name of the scholar	Name Of Supervisor	Date of Registration	Ph. D. completion	Topic of research	ABSTRACT
Dr. Aadil Ayaz .	N.Singh	30 th of August 2014	06 th of June 2020	ISOLATION, CLONING AND EXPRESSION ANALYSIS OF KERATIN FAMILY GENE(S) IN PASHMINA GOAT (<i>Capra hircus</i>)	<p>Pashmina, most sought after fiber, like other animal fibers is composed of proteins mainly Keratins and Keratin associated proteins (KAPs) that are responsible for its structural and chemical properties. These proteins form a large heterogeneous group of proteins and comprise about 90% of the fiber. Recent research attempts have emphasized the role of KAPs in the regulation and development of Pashmina fiber follicle and any variation thereof in the structure, functioning and/or expression of these proteins would have a telling effect on the characteristics of the fiber. Accordingly variation in these <i>KAP</i> genes can be exploited for the development of genetic markers for selection of desirable fiber traits. Keratins and Keratin associated proteins play a very pivotal role in induction and progression of the fiber developmental phase's viz., anagen (growth), catagen (involution), telogen (resting). Owing to the importance of these genes in determining Pashmina fiber quality as well as development, the present study was undertaken to investigate the molecular characterization and expression analysis of <i>KAP 7.1</i>, <i>KAP 8.1</i> and <i>KAP 8.2</i> gene(s) at different developmental stages of Pashmina fiber in Chanthangi goats of J&K. The characterization of the gene(s) of interest was accomplished by their PCR amplification using specific primers, cloning and subsequent sequencing. The expression analysis of genes under study was done using Real-Time PCR quantification method by extracting RNA from secondary hair follicles collected at different developmental stages (anagen and telogen) of Pashmina fibre by TRIZOL method. The expression of <i>KAP 7.1</i>, <i>8.1</i> and <i>KAP8.2</i> genes were significantly higher at anagen compared to telogen stage. The up regulation of these genes in anagen phase reflects their significance in Pashmina fibre development. Moreover, sequence variation analysis of <i>KAP 7.1</i>, <i>KAP8.1</i> and <i>KAP 8.2</i> was carried out in indigenous Pashmina goat breeds (Changthangi and Chegu). The variation in sequence of above genes observed in two breeds are associated with the fibre trait, hence are important for studying the fibre at molecular level.</p> <p>Key words: <i>Pashmina, Changthangi, Chegu, KAPs, Anagen, Catagen, Telogen, Cloning, Sequencing, phylogenetic analysis, qRT-PCR, Expression analysis,</i></p>

Dr. Bijendra Kumar	N. Singh	26 April 2013	06 July 2020	THE IMPACT OF RAINFALL ON THE DEVELOPMENT AND SURVIVAL OF MALARIA VECTORS	The study aimed to assess the impact of rainfall on flushing off/ creation of larval density of malaria vectors, effect of rainfall on adult mosquito emergence and the cutoff of rainfall causing malaria outbreak. Malaria disease varies from area to area depending on climatic, geographical and epidemiological condition. Climatic factors such as temperature, humidity and rainfall affect the survival and development of mosquitoes. Rainfall influences the vectors distribution, density, development and their survival. The larval density per dip density (LDPD) of anopheline larvae before and after rainfall was calculated in order to analyze the impact of rainfall on malaria vector population. The study sites were selected Baghpat of Uttar Pradesh and Northeast (Shahdara) of Delhi. As per WHO dipping method was used for collection of immature stages of mosquitoes. Larval sampling was performed fortnightly from 07:00 to 11:00 hrs from July 2014 to September 2016. LDPD decreased at average of 45.6 mm and 50mm rainfall in different habitats of Baghpat and Northeast, Delhi respectively, except in cemented channels of Meet Nagar and pools and pits of Shakti Garden. Negative correlation was observed between rainfall (>45.6 mm) and larval density of anopheline in Baghpat and Delhi (P<0.001). In Baghpat district, <i>An. culicifacies</i> , <i>An. stephensi</i> , <i>An. subpictus</i> , and <i>An. vagus</i> were identified after adult emergence while <i>An. culicifacies</i> , <i>An. stephensi</i> and <i>An. subpictus</i> were also identified from district Northeast, Delhi. There was positive correlation between rainfall and malaria with one to two month lag.
Mr. Rajbeer Singh Reg No LZ-14240;	P. Nautiyal	11.03.2013	08.08.2019	Diversity of diatom assemblages in the lotic and lentic freshwater habitat of Doon valley.	Diatoms have diverse ecological preferences and are hence environmental indicators. This property has been used to assess water quality in variety of aquatic habitats of Doon valley. Order of species-richness in habitat :stream> wetland> spring>pond>irrigation canal> cave-rock> ephemeral> lake. No similar assemblage observed in the pond, cave-rock and wetland habitats throughout the year. Among habitats average dissimilarity was least for cave-rock and spring (64.66 %) and highest dissimilarity among the pond and spring habitats. Anthropogenic eutrophication caused moderate degradation in Doon valley. The degradation in the stream habitats was largely low to moderate; largely high for spring, it was moderate in pond and low in wetland habitat. S5 and S11 are the most impacted streams while S6 and S9 are still pristine.
Mr. Upendra Singh Reg No LZ-14240	P. Nautiyal	11.03.2013	25.02.2019	Analysis of Homogeneity, sub-speciation, phenotypic and DNA variability in Schizothoracine stocks (1200-1500 m) from the isolated Yamuna, Ganga and Kali river basins.	The present work employed different approaches as morphometrics, meristics (traditionally and truss) and genetic markers to illustrate intra and inter specific similarity or variation in three snow trout species <i>Schizothorax richardsonii</i> , <i>Schizothorax plagiostomus</i> and <i>Schizothorax progastus</i> from four different basins in Uttarakhand. The discrimination of these species could be accomplished on the basis of morphological criteria. The results showed that the population of Schizothoracinae stocks in one basin has diverged from the populations distributed in other basin and some geographical barriers prevented gene exchange among these populations. The genetic distance within a basin is very small; that the individuals of snow trout species cannot be separated by their mtDNA patterns. Moreover, recent gene flow or dispersal may be present among the populations of in Yamuna and Ganga basin; therefore, their relationships are very close and it is difficult to separate them by their distribution.
Mrs. Ritu Pant HNBGU/Res/20649	P. Nautiyal	01.06.2002	22.02.2017	Longitudinal, Regional Patterns in Biodiversity and Distribution of	The study was carried out on a typical Siwalik spring fed stream basin, the Markanda in Himachal Pradesh (West Himalaya) and compared with the lesser Himalayan streams of Mandakini basin in Uttarakhand. The purpose of study was to know how communities vary within and among basins located distantly. The Siwalik

				Epilithic Diatom Community in Mountain Streams of Uttaranchal and Himachal Pradesh	streams of Markanda basin were shallower than the lesser Himalayan Mandakini basin streams, where depth of 50 cm was recorded during monsoon in mid-section. The abundance of epilithic diatoms in Siwalik streams of the Markanda basin was observed to be distributed in a highly fragmented fashion. No taxa exhibited peculiarity in the community as the taxa attaining abundance were not consistent across the locations but for <i>C. affinis</i> and <i>A. minutissima</i> . In the Siwalik streams of the Markanda basin the observations on the diatom assemblages revealed that the number of taxa and dominants in an assemblage differed horizontally among the left, central and right sections at each location. They (the number of taxa and dominants) also varied temporally. Evidently, same dominant was rarely distributed across the temporal and spatial spectrum. Thus, among so many dominants that figured among the sections and stations various streams, only <i>A. minutissima</i> and <i>C. affinis</i> were commonly occurring dominants, that too in specific seasons only. In the lesser Himalayan streams of the Mandakini basin <i>A. minutissima</i> var. <i>minutissima</i> and <i>A. biasolettiana</i> var. <i>biasolettiana</i> , both or either figured as dominant in the Rampur and Banswara, especially during summer and monsoon. The winter dominants were different, <i>Geissleria deucussis</i> in Rampur and <i>Adlafia muscora</i> in Banswara. In winter, a guild of five diatom taxa was found to be common among the all seven stations (<i>A. minutissima</i> , <i>Cymbella affinis</i> , <i>Gomphonema olivaceum</i> , <i>G. parvulum</i> and <i>Navicula rhyncocephala</i>). In the Siwalik streams the cluster analysis clearly shows lack of similarity in abundance patterns among the sections of a station during winter.
Ms. Darpan Saraswat HNBGU/Res/22795 [Biotechnology]	P. Nautiyal Ext Dr W. Singh, CIFE	15-05-2009	2015	Population genetic characterization of <i>Clupisoma garua</i> (Hamilton) using molecular markers. .	
Ms. Swati Sharma. Reg No. 22757 .	P. Nautiyal	13-02-2009	03.03.2015	Effect of hydro-electric projects on diatom biodiversity in River Yamuna.	The study pertains to the diatom flora, diversity and assemblages of two selected Hydro electric projects, Koti dam and Dakpatthar barrage on River Yamuna and its major tributary Tons respectively. River Tons surveyed at 4 stations while the river Yamuna surveyed at 3 stations. Total 181 species from 33 genera were found in the Yamuna basin. Maximum numbers of species 144 from 28 genera were recorded for River Yamuna as compared with River Tons 116 species from 24 genera. The dam on the Tons river caused a general decline in the number of genera and species in the downstream regulated section in respect of the reference location upstream of the dam. The decline was higher in the impounded zone. In the river Yamuna a severe decline occurred at the barrage location but increased multifold in the regulated zone. The effect of Kothi dam on the river Tons were rather moderate compared to the Dakpatthar barrage on the Yamuna.
Ms. Pallavi [Biotechnology]	P. Nautiyal Ext Dr. M.	15-05-2009	22.09.2014	Genetic Divergence and Molecular Phylogenetics of	The present study was aimed to infer intraspecies and interspecies genetic diversity and establishment of the phylogenetic relationship among twelve species namely <i>Puntius chola</i> , <i>P. sophore</i> , <i>P. filamentosus</i> , <i>P. fasciatus</i> , <i>P. vittatus</i> , <i>P. chelynooides</i> ,

HNBGU/Res/22776	Goswami, NBFGR			<i>Puntius</i> spp. Inferred from Mitochondrial Genes.	<i>P. gonionotus</i> , <i>P. denisonii</i> , <i>P. ticto</i> , <i>P. gelius</i> , <i>P. conchoni</i> and <i>P. sarana</i> using three mitochondrial genes (COI, Cyt <i>b</i> and 16S rRNA). The highest interspecies sequence diversity (0.116%) was observed between <i>P. fasciatus</i> & <i>P. chelynoide</i> and <i>P. fasciatus</i> & <i>P. gelius</i> , whereas the lowest sequence divergence (0.026%) was observed between <i>P. conchoni</i> and <i>P. ticto</i> . The NJ, MP and N-net phylogeny trees revealed identical phylogenetic relationship among twelve <i>Puntius</i> species based on three mitochondrial (COI, Cyt <i>b</i> and 16S rRNA) genes. All trees were identical and showed same four clusters with only minor differences in branching orders.
Mr. Pawan Kumar HNBGU/Res/22788 [Biotechnology]	P. Nautiyal Ext: Dr. Ravindra Kumar, NBFGR	16-06-2008;	2014	Genotoxicity assessment of Chromium and Tannery effluent to fingerling and adults of <i>Cyprinus carpio</i> using biochemical, cytogenetic and molecular biomarkers.	The present study was attempted to bio-monitor the genotoxic potential of potassium dichromate and tannery effluent by determining the frequency of DNA damage using comet assay, micronuclei formation using Micronucleus Test (MNT), Random Amplified Polymorphism DNA (RAPD) and oxidative stress in various tissues of fingerling and adult <i>Cyprinus carpio</i> after in vivo exposure. The present investigations reveal that potassium dichromate and tannery effluent are highly toxic for the developmental stage of fingerling and adult of <i>Cyprinus carpio</i> . Therefore, the fish can be superbly employed as model to ascertain the potential hazards of acute exposure to aquatic organism. The study indicated that the comet and MN assays are sensitive tools for demonstration of genotoxic effects of potassium dichromate and Tannery effluent in different fish tissues. Further, the comparison of DNA damage between the tissues showed that gill cells are more sensitive than erythrocyte cells. Thus, the combined approach using both the assays opened a broad perspective in aquatic toxicology. Random Amplified Polymorphism DNA is also used in detecting DNA damage in the presence of disappearance of band and appearance of band, in conjugation with other biomarker from higher level of biological organization for detecting DNA damage would be one of the most promising new method for studying genotoxicity and mutagenicity. The effect of acute exposure of hexavalent chromium and Tannery effluent is also induced non-enzymatic antioxidant and antioxidant enzymes by increase in reactive oxygen species (ROS) in various tissues such as gill, liver and kidney in concentration and time dependent. Chromium concentration in fishes can evoke more remarkable effects, which will be helpful in organ-specific risk assessment and provide some useful information for monitoring and management of chromium in the fresh water ecosystems. Furthermore, the results obtained in the present investigation can be exploited as a broad perspective in aquatic toxicology, as fishes are constantly being exposed to environmental pollutants and these can serve as an important biomarker and the techniques used might be a potential alternative approach for monitoring heavy metal pollution in aquatic environments.
Mr K R Singh HNBGU/Res/22396	P. Nautiyal	01.11.2006	27.02.2012	Factors governing benthic macroinvertebrate assemblages in the	This study examines if benthic macroinvertebrate communities in the upper section (headwaters) of streams are same within and among two ecoregions of India, the Central Highlands (Central India) and the West Himalaya ((North India). Conductivity and current velocity are major factors influencing the

				Vindhyan and west Himalayan lotic systems	macroinvertebrate communities in both regions, especially the former in the Doon region. The above factors are important at locality level in a region, but the analysis at regional level shows that the geographical factors like latitude, altitude, longitude are important. The dependent factors like substrate, water temperature, DO, current velocity that are intimately associated with them also gain secondary importance at regional scales.
Mrs Asha Agarwal HNBGU/Res/21443	P. Nautiyal	28.12.2004	25.05 2009	Patterns in diversity of diatom communities in the high land streams of northern and central India -	A study was carried out to generate information on diatom flora and diversity of the Vindhya (Pre Cambrian) and Siwalik (Coenozoic) rivers the Betwa and Asan. The study also assumes significance in light of Ken - Betwa link and numerous hydroelectric projects in the Himalaya, Vindhya was relatively richer in the Fragilariaceae and Bacillariaceae elements while Siwalik was richer in Achnantheaceae and Naviculaceae. The number of species and varieties of Cymbella and Gomphonema decreased longitudinally, but Synedra, Navicula and Nitzschia did not vary. Only 50% diatom taxa were similar in the Betwa and Asan. Species richness, diversity and evenness did not vary much from source to mouth and among both regions.
Navneet Swami	Prof. O.P. Gusain	11/03/ 2013	17/10/2019	Molecular characterization of selected Ephemeropteran taxa inhabiting River Alaknanda, Uttarakhand. Biotechnology	<p>The present study deals with a comprehensive account of molecular analysis of mitochondrial DNA of order Ephemeroptera (Mayflies). The study was made on DNA barcoding for the identification of selected ephemeropteran taxa in River Alaknanda Uttarakhand. The use of (COI) gene as a standardized DNA marker for ephemeropteran species identification has invigorated taxonomy, and gained wider acceptance in this Garhwal region. Mayflies (order Ephemeroptera) are integral part of mountain streams. Besides, being secondary producers and important fish food. They are also used as an indicator of organic pollution.</p> <p>The present study was carried out from March 2014 to February 2016 and the sampling of order Ephemeroptera was done seasonally at eight selected sampling sites from River Alaknanda in Garhwal region of Uttarakhand. In the present study, approximately 220 sample specimens of collected ephemeropteran taxa were submitted to Eurofin Genomics, Bengaluru for sequencing. A total of 39 individuals (Order Ephemeroptera) were used for partial sequence analysis of mitochondrial COI region. Optimization of PCR conditions for amplification of COI gene of the remaining samples could not be achieved. Mitochondrial COI region was amplified using following primers. (C1J-1718 5'- GGAGGATTTGGAAATTGATTAGTT-3') (C1N-21915' CCCGGTAAAATTAATAAATAAATTC-3') Simplicity and un-ambiguity were observed among the sequence of mitochondrial control region. Sequencing of the COI region produced on an average 650 nucleotide base pairs. Stop codons were absent from all the amplified sequences of protein coding gene, COI. So in present study, no indication of pseudogenes was observed. Also, transition substitution accumulated faster than transversion. The estimated Ti/Tv bias (R) was 1.641 for all ephemeropteran individuals. The transition bias advocates that this is a recently evolved group or slowly evolving gene. A transition bias in these genes means that the groups had not yet reached saturation, therefore, COI gene was useful for developing phylogenies.</p>

					<p>The major conventional approaches to reconstructing phylogenies, the Maximum likelihoods (ML) and Neighbour-joining (NJ) algorithm were used in this study. Subsequently, the sequences of ephemeropteran individuals were submitted in the NCBI (GenBank ID: 2182619). The details of the ephemeropteran samples with GenBank accession number are generated. Therefore, in the present study 09 genera of order Ephemeroptera were identified based on molecular characterization. However, the study revealed that these genera further included a number of probable Morphotypes/ Ecotypes. More significantly, <i>Ephemera simulans</i> (ES1 and ES2) has been identified for the first time from river Alaknanda. The observation recorded during the present study suggests that for rapid identification of benthic insect's taxa morphology-based procedures could be aided with molecular taxonomy. Moreover, DNA barcoding has determined applicable to recognize ambivalent life stages of Ephemeroptera and offers a authentic and speedy approach to form regular identification of admitted species. Therefore, there is an utmost need for undertaking a holistic in depth study to ascertain the taxonomy of aquatic insects in Himalayan Rivers. The molecular characterization of the Order Ephemeroptera provides a baseline for further identification of the potential morphotypes/ecotypes as well as in other macroinvertebrates.</p>
Neeraj Kumar Sharma	Prof. O.P. Gusain	30/09/2008	12/05/2014	Community structure and ecology of macroinvertebrate benthos in river Manuni, Himachal Pradesh. Zoology	<p>Manuni is a tributary of River Beas and originates from the southern slopes of the Dhauladhar range of the Himalaya in district Kangra of Himachal Pradesh. The study area falls in the Survey of India topographic sheet 52 D/8 and lies between 76°15'-76°25' east longitude and 32°05' - 32°15' north latitude. Regular physicochemical and benthic macroinvertebrates sampling was undertaken between March 2009 and February 2011. The physicochemical parameters were analysed following standard methods. Benthic macroinvertebrates were collected by applying stratified random sampling (Cummins, 1962) and was adopted applying transect method using modified Surber's square foot sampler (Welch, 1948; 1952). Benthic macroinvertebrate were identified to lowest recognizable level as far as possible with the help of keys by Burks (1953), Usinger (1956), Edmondson (1959), Needham and Needham (1962), Hynes (1977), Macan (1979), Edington and Hildrew (1981), Elliott et al. (1988), Wallace et al. (1990), Dudgeon (1999) and Jessup et al. (2003). The benthic macroinvertebrates so collected represented their density which was expressed as individuals per square meter (Ind. m⁻²). Biomass was determined following the methods outlined in Winberg (1971) and Edmondson and Winberg (1971). The substrate material collected from all sampling sites in different season was divided into fractions of Wentworth scale after sieving. The grain sizes (Q₁M_dQ₃) were calculated from quartile values (25%, 50% and 75%) with the help of particle size cumulative curves. Also, various ecological indices viz., Density, Relative Abundance, Shannon-Wiener Species Diversity, Species diversity were determined. The data collected was further subjected to statistical analysis.</p> <p>The physicochemical parameters fluctuated during study period ranged as follows: The pH 6.6 and 8.6, conductivity varied between 0.02 and 0.21 mScm⁻¹, turbidity between 0.40 and 64.00 NTU, dissolved oxygen 7.20 and 10.80 mg l⁻¹, Free carbon between 0.66 and 3.52 mg l⁻¹, total alkalinity values between 14.0 and 94.00 mg l⁻¹, The total solids (TS) between 0.02 and 0.27 g l⁻¹. Similarly, low values of Nitrate and phosphate has been observed</p>

					<p>during the study period. 67 taxa of macroinvertebrate benthos were recorded in River Manuni during the study period. Out of which, 44 insects were identified up to generic level and 12 up to family level only. Beside insects among other benthic macroinvertebrates 8 were identified up to generic level. In addition to these, earthworm, leech and crab were also recorded in Manuni water. The benthic macroinvertebrate density was low during monsoon as compared to other season. Thus, higher values of biomass were observed mainly during winter and summer seasons and low values were recorded during monsoon.</p> <p>In general, the substrate composition in River Manuni fluctuated markedly during the study period. At higher altitude river bed consisted of a number of riffles and runs dominated by boulders. Whereas, at lower reaches pools were frequently present and sand bars over hanging bank edges developed due to decrease in gradient. During the present study the anthropogenic activities observed in the riparian zone of River Manuni namely slate mining, river bed mining, water withdrawal, micro-hydroelectric projects and miscellaneous activities seems to affect the benthic communities. The present study is a maiden attempt to understand the community structure of benthic macroinvertebrates in River Manuni in Himachal Pradesh.</p>
Alpana Bharti	Prof. O.P. Gusain	08/02/2008	2015	<p>Studies on antifungal metabolites isolated from actinomycetes of Garhwal Himalaya. Biotechnology</p>	<p>The emergence of resistance in fungal pathogens against antifungal antibiotics has resulted in serious fungal infections in humans as well as animals. Therefore the antifungal drug resistance itself demands a search for effective antifungal agents or agents with novel mode of action. In this context the present study was undertaken to exploit actinobacterial diversity for their antifungal potential.</p> <p>Out of 69 soil samples from different locations of Garhwal region of Uttarakhand, a total of 316 actinomycetes were isolated. These isolates were belonged to the 14 different genera of actinomycetes. 31.02% exhibited antifungal activity against one or more tested fungal pathogens while 68.98% isolates did not showed antifungal activity. Of these 19.39%, 68.37%, 42.86%, 37.76%, 18.37% and 25.51% isolates showed activity against <i>Candida albicans</i>, <i>Trychophyton rubrum</i>, <i>Microsporium canis</i>, <i>M. gypseum</i>, <i>Aspergillus flavus</i>, <i>A. fumigatus</i> respectively. Only 7 isolates (7.14%) showed broad spectrum. only 7 isolates i.e. AV- 3, AV- 9(II), AV- 19, AV- 92, IN2- 10, IN2- 11(II) and IN2- 11(V) showed promising activity. Out of these 7 isolates, 2 isolates (AV- 3 and IN2- 11(V)) showed most promising activity against several fungal pathogens i.e. dermatophytes (<i>T. rubrum</i>, <i>M. canis</i>, <i>M. gypseum</i>), moulds (<i>A. flavus</i>, <i>A. fumigatus</i>, <i>A. niger</i>) and yeasts (<i>C. albicans</i>, <i>C. parapsilosis</i>, <i>C. tropicalis</i>), so these isolates were tested elaborately.</p> <p>On the basis of micromorphology, chemotaxonomic characteristics and analysis of 16S rRNA gene sequences showed that among these seven isolates only isolate AV-3 belongs to <i>Saccharothrix</i> sp. and rest six AV-9(II), AV-19, AV-92, IN2-10, IN2-11(II) and IN2-11(V) were to different species of <i>Streptomyces</i> sp. However, a number of phenotypic characteristics readily distinguished these strains from their type strains. The purified product of <i>Streptomyces</i> sp. IN2- 11(V) (HPLC fraction) having RT of 21.985 and the purified fraction of <i>Saccharothrix</i> sp. AV-3 having RT of 6.430 showed activity. Nearly all the pathogens were susceptible to IN2- 11(V)</p>

					<p>and AV- 3, with an overall range of MICs of 4 to 64 µg/ml and MFCs of 2 to 32 µg/ml. Antifungal metabolite produced by <i>Streptomyces</i> sp. IN2- 11(V) and <i>Saccharothrix</i> sp. AV- 3 distinguished itself from amphotericin B and nystatin because of its potency against <i>Candida</i> spp. and <i>Microsporium</i> spp. Produced antibiotic by both the isolates is an alcoholic compound having SH group, C-C triple, double bonds and aromatic benzene.</p> <p>To conclude, the findings of the present study definitely indicate towards the possibility of further studies on actinomycetes are hitherto unexplored Garhwal Himalayan region. Moreover, it is also evident that the probability of finding potential antifungal metabolite for actinomycetes is certainly promising also.</p>
Javed Iqbal Mir	Prof. O.P. Gusain	15/05/2009	17/01/2014	<p>The stock identification of <i>Labeo rohita</i> (Hamilton-Buchanan 1822) by using biological and production traits from Ganga river basin.</p> <p>Zoology</p>	<p>The present work submitted under the title “the stock identification of <i>Labeo rohita</i> (hamilton-buchanan 1822) by using biological and production traits from Ganga river basin” incorporates the results of studies made on its life history parameters for the identification of potential stocks across the Ganga River basin. Stock identification is an interdisciplinary field that involves the recognition of self-sustaining components within natural populations and is central theme in fisheries science and management. Various tools, such as life history traits, traditional tags, parasites as natural tags, otolith chemistry, molecular genetics and electronic tags have been used for the purpose of stock identification, among which the study of life history traits is one of the most frequently employed and cost-effective method.</p> <p>This study was based on 2012 samples collected from ten drainages of Ganga River basin during 2009-2012. The sampling locations along the selected rivers were Narora (river Ganga), Faizabad (river Ghagra), Chalkghat (river Tons), Rewa (river Son), Bhojpur (river Betwa), Palia (river Sharda), Gwalior (river Chambal), Patna (river Ken), Lucknow (river Gomti) and Shivpuri (river Kalisindh). To achieve the objectives the present study included the following major parameters: Landmark-based morphometry (TRUSS), length-weight relationship (LWR), condition and relative condition factors and form factor, reproductive biology, age and growth profile, identification of descriptors.</p> <p>This study has provided fundamental biological information for fisheries management and conservation in the natural waters. The outcome of the present study have helped to initiate further research for making species specific and location specific conservation (in situ & ex situ) strategies as well as sustainable development of the wild stock of <i>L. rohita</i>. The different life history parameters as documented in the present study will initiate further investigation on critical life history traits and their linking with freshwater fish habitat for their utilization in conservation programmes by policy makers as well as researchers.</p>
Dhyal Singh	Prof. O.P. Gusain (Co-Supervisor)	30/10/2007	12/5/2014	<p>Study of the phytoplankton community structure and primary production in Lake Nachiketa Tal of Garhwal Himalaya.</p>	<p>The Himalayan region nestles a number of small and large lake bodies. Situated at an altitude of 2475 m asl, Nachiketa Tal is one such high altitude Himalayan lake in district Uttarkashi of the Uttarakhand. Lying between 30°22' - 31°25'N latitude and 75°51' - 79°27'E longitude, it is small, somewhat oval shaped lake with an approximate length of 200m, width of 90m and depth of 3m. The lake, as such, has no inlet or outlet. The lake is approached by road from Uttarkashi up to Chaurangikhal, a distance of 27 Km by road and thereafter a trek of 3 Km through dense mixed forest of <i>Rhododendron</i>, <i>Cedrus</i>, <i>Quercus</i>, <i>Myrica</i>, etc.</p>

				Zoology	<p>The lake's salubrious environment is evident from the prevailing ambient temperature (7.0 to 25.0°C) and relative humidity (2.0 to 68.0%). Among the physicochemical parameters recorded during the present study the water temperature varied between 6.5 and 26°C. The water of the lake was more or less alkaline (7.3±0.70). The dissolved oxygen annually varied between 3.2 and 11.0 mg l⁻¹. Among other parameters the free CO₂ was recorded between 1.18 to 6.1 mg l⁻¹. Turbidity in lake ranged between 0.3 to 3.3 NTU, while the hardness varied from 22.4 to 42.0 mg l⁻¹. Among the nutrients, nitrate recorded a high of 0.128 mg l⁻¹.</p> <p>In Lake Nachiketa Tal, a total of 42 phytoplankton genera were identified during the present study. These belonged to 25 families of 9 orders and 4 classes. The highest number of phytoplankton genera belonged to class Chlorophyceae (24) followed by Bacillariophyceae (15), Myxophyceae (2) and Dinophyceae (1). The primary productivity of high altitude Lake Nachiketa Tal of Garhwal Himalaya. During the study period the Gross primary productivity varied between 18.77 g C/m³/hr and 281.52 g C/m³/hr, while the respiration between 11.26 g C/m³/hr and 281.52 g C/m³/hr, and the Net Primary Productivity between -150.10 g C/m³/hr and 262.75 g C/m³/hr. GPP (r= -0.005, p<0.05 in I year; r= -0.075, p<0.05 in II year) and NPP (r= -0.334, p<0.05 in I year; r= -0.460, p<0.05 in II year) was negatively correlated with water temperature. However the respiration was positively correlated with water temperature (r= 0.275, p<0.05 in I year; r= 0.559, p<0.05 in II year). Primary Productivity was higher in winter and springs whereas, it was lower in monsoon and summer.</p> <p>The average chlorophyll 'a' content in phytoplankton varied from 0.638±0.690 mg m⁻³ (August) to 5.738±2.281 mg m⁻³ (December) in I year. During the II year it ranged between 0.648±0.141 mg m⁻³ (August) to 6.390±2.332 mg m⁻³ (January). Seasonally, chlorophyll 'a' in Nachiketa Tal varied from 0.52 mg m⁻³ (monsoon'08) at S3 to 6.15 mg m⁻³ (winter'09) at S1. The average pheophytin 'a' content in phytoplankton ranged from 1.085±0.307 mg m⁻³ (November) to 7.835±1.918 mg m⁻³ (February) in I year. Where as, during the II year it varied from 1.028±0.631 mg m⁻³ (November) to 8.025±1.660 mg m⁻³ (December). Seasonally, pheophytin 'a' in lake varied from 1.51 mg m⁻³ (autumn'09) at S4 to 8.70 mg m⁻³ (spring'08) at S1. A positive correlation between pheophytin 'a' and chlorophyll 'a' was recorded in both the years (r= 0.530, p<0.05 in I year; r= 0.254, p<0.05 in II year).</p>
Vijay Kumar	Prof. O.P. Gusain	08/02/2008	2013	<p>Antibacterial metabolites from Actinomycetes of diverse habitats and locations of Uttarakhand.</p> <p>Biotechnology</p>	<p>Searching new antibiotics has increased worldwide because of the serious problem of antibiotic resistance among the microbes. The recent discovery of novel primary and secondary metabolites from taxonomically unique population of actinomycetes suggest that these organisms could add a new dimension to microbial natural product research. The history of new drug discovery processes shows that novel skeletons have, in the majority of cases, come from natural sources. Today, the emphasis is on the exploration of unusual and previously ignored ecosystems. Actinomycetes from several unexplored environments have been intensively studied in last few decades for novel and potent molecules. In this scenario, the present study was focused on solitary wasp mud nest, swallow bird mud nest, earthworm castings, hot water springs, and plant endophytes as well as soil samples collected from different locations of Uttarakhand other than unusual habitats.</p> <p>Actinomycetes were isolated from these habitats using both selective and non selective method. These isolates were screened for their antimicrobial activity against various bacterial</p>

					<p>pathogens. The promising isolates were characterized using polyphasic taxonomy. The various fermentation factors like pH, temperature, time, carbon sources, nitrogen sources etc. were optimized. The metabolites were extracted using organic solvent as well as resin. The extracted metabolite was purified using column chromatography and HPLC. The purified product was partially characterized using UV-Vis, LC-MS and IR. The purified fractions were also checked for their synergistic activity with known molecules.</p> <p>This is the first exhaustive screening work done in the Uttarakhand region for isolation of Actinobacteria, an industrially important group of microorganisms. The viable count of actinomycetes varied greatly with altitude. Actinobacterial species isolated from solitary wasp mud nest, swallow bird mud nest and earthworm castings possess a significant capacity to produce compounds having unique antibacterial activity. These isolates were found to have excellent antimicrobial potential against several drug resistant bacterial pathogens. Three novel strains were isolated having promising antimicrobial activity, these isolates may prove to be an important step for the development of antimicrobial drug to treat evolving bacterial infections. Most promising isolates were recovered from unusual habitats as compared to terrestrial soil samples. These unusual habitats merit further attention towards screening of actinomycetes for novel drug discovery. The metabolite produced by <i>Streptomyces</i> sp. 8(1)* and EWC 7(2) differ from known antibiotics produced by <i>Streptomyces</i> species and also the antibiotics described in Dictionary of antibiotics and related substances and in Dictionary of natural products. The activity of gentamicin and cefotaxime were enhanced by the presence of the metabolite produced by <i>Streptomyces</i> sp 7(2) against Gram-positive and Gram negative bacteria including drug resistant strains. Similarly, the activity of piperacillin, gentamicin and penicillin showed significantly improved activity against both Gram-positive and Gram-negative bacterial strains when combined with the metabolite of <i>Streptomyces</i> sp. 8 (1)*.</p>
Km. Rupali Sani	Prof. O.P. Gusain	12/02/2007	14/08/ 2012	<p>Study on fish diversity of River Betwa and life history traits of <i>Rhinomugil corsula</i>. Zoology</p>	<p>Assessment of the pre-interlinking scenario of fish diversity, habitat and habitat finger printing of some threatened fish, as in India 30 rivers have been identified to interlink. Among these River Betwa (tributaries of River Yamuna) has been approved as the country's first River to be interlink with River Ken. Total of 63 fish species belonging to 20 families and 45 genera were collected from River Betwa. Habitat assessments of <i>R. corsula</i> using ecosystem scaling and habitat finger printing suggests association with moderate to high depth, D.O, conductivity and overhanging vegetation of sampling site and strong correlation to species distributions and preferences. My doctoral work suggested, <i>R. corsula</i> attracted to moderate dissolve oxygen and high conductivity, with relatively good abundance proves the available favorable conditions for these species. Since this river will be interlinked in near future, this study would be useful for conservation planning and management and also for future assessment after interlinking</p> <p>Life history traits i.e. length weight relation, age and growth study, gonadosomatic index, fecundity, length at first maturity and spawning cycle of selected threatened fish were studied. Habitat fingerprinting was utilized to identify the specific habitat of particular fish species. Specific habitat of particular fish species was assessed by elemental analysis of fish otolith (five trace elements Ba, Sr, Zn, Mn and Mg) and ambient water habitat.</p>

					Based on the present study on the threats faced by the fish community of the River Betwa, some important recommendations related to the conservation have been suggested. Development of protected areas or fish sanctuaries in the segment of river, that contributed higher species diversity; some river stretch must be considered for habitat conservation from where higher number of threatened species were recorded and remaining sites with relatively lower percentage of threatened species should be considered for habitat restoration; studies on the life history traits of threatened fishes for understanding the basic biology for planning conservation and management of those species; stocking of indigenous fish from wild population for ranching will help to restore the threatened fish species; captive breeding programmes for threatened fishes and participation of community, education and public awareness to promote mutual understanding of the problems of the diverse sectors involved with management and conservation of natural resources through training programme are the most important. Based on the present scenario, probable consequence and restoration method for seven threatened fish species (<i>Chitala chitala</i> , <i>Notopterus notopterus</i> , <i>Tor tor</i> , <i>Rita rita</i> , <i>Ompok bimaculatus</i> and <i>Rhinomugil corsula</i>) of River Betwa has also been dealt with.
Anupama	Prof. O.P. Gusain	01/10/2003	2007	Habitat ecology of the juveniles of golden mahseer, <i>Tor putitora</i> (Hamilton) in River Nayar Garhwal Himalaya. Zoology	<p>Mahseer (<i>Tor putitora</i>) also known as Himalayan mahseer is the most prized, large sized, delicious freshwater sport fish distributed all along the Indian Himalayan rivers. In Garhwal Himalaya, the Ganga River consists of two major snow-fed rivers Alaknanda and Bhagirathi along with several tributaries. River Nayar, a spring-fed tributary of River Ganga, is a well-known spawning ground of <i>Tor putitora</i>. After a preliminary survey of river Nayar, four sampling sites were selected. These were Jwalpa Devi (Western Nayar), Satpuli (Eastern Nayar), Banghat and Byasghat (Nayar). The foothill section of River Ganga which includes river Nayar harbors fingerlings and juveniles during post monsoons periods and these life stages fishes stay till entering into first year through winter and summer, and fries, adolescents and brooders during monsoons. Despite their abundance, once upon a time, as evident from descriptions of many workers, mahseers are declining in their number and size in Indian water. The National Commission on Agriculture (1976) in its report on Fisheries mentioned that, 'there has been a general decline in the mahseer fishery due to indiscriminate fishing of brood fish and juveniles and adverse effects of river valley projects' which recommended an extensive survey and declined ecological and biological investigations. To study the potential factors responsible to decline the status of mahseer, the focus was to understand the habitat characteristics that are most important to them and directly associate the fish abundance or density. In India, studies related to fish habitat have remained neglected and studies of habitat preference of larval and juvenile stages of Indian fish have largely been not attempted as such. We have studied the abiotic factors and biotic factors along with occurrence, diet and population of <i>Tor putitora</i>.</p> <p>The study concluded that there are a number of factors like overexploitation of fish, environmental degradation, construction of dams and water abstraction are largely responsible for the decline of golden mahseer in the river Nayar. These factors are directly associated with habitat and breeding of golden mahseer.</p> <p>On the basis of the observation, a number of conservation strategies for golden mahseer have been suggested.. Briefly eco-restoration, <i>in situ</i> conservation, <i>ex situ</i> conservation, creating</p>

					mass awareness and ranching are the major suggestions that can be useful. This study strongly recommends that by addressing all the conservation strategies can play an important role to regain the status of golden mahseer in Himalayan Rivers.
RaghavDatt	Prof. O.P. Gusain	01/01/2001	2005	Macroinvertebrate benthos diversity in relation to the environmental factors in different stream of a central Himalayan watershed. Zoology	<p>The present investigation in a small watershed i.e., Khanda Gad was undertaken with the objective to study the macroinvertebrate benthic diversity in streams of different orders in relation to environmental factors. The Khanda Gad watershed comprises of a number of first to fifth order streams. All owe their origin to the springs in the area. The mainstream Khanda Gad is a small spring-fed left side tributary of the mighty River Alaknanda in the Pauri district of the newly incepted state of Uttaranchal. The stream traverses a distance of 16.35 km (approximately) during its course before meeting the River Alaknanda in north-south direction. During its course downstream it descends from an altitude of 1700 to 558 m asl, indicating towards the steep gradient of the stream channel. The present investigation was carried out for a period of 24 months from July 2001 to June 2003.</p> <p>Regular monthly sampling was undertaken to collect benthic macroinvertebrates and analyze the physico-chemical characteristics of stream waters of Khanda Gad watershed at the 14 designated sampling sites representing first to fifth order streams along with the benthic macroinvertebrates. Standard methods were followed for the sampling and analysis of physico-chemical parameters of the streams of the watershed. Macroinvertebrate benthic samples were collected by stratified random sampling applying transect method using modified Surber's square foot sampler. Identification was carried out to the lowest recognizable level, usually genera, in the laboratory with the help of standard keys. Quantitatively, the macroinvertebrate benthos so collected represented their density, which was expressed as individuals per square meter (Ind. m⁻²). The biomass of benthic macroinvertebrates was determined and expressed as ash free dry weight per unit area per unit time. Substrate samples collected were divided into fractions of Wentworth scale after sieving. The grain size (Q₁M_dQ₃) was calculated by quartile values (25%, 50% and 75%) with the help of particle size cumulative curves. Various ecological indices were determined from the data collected; also, the data were statistically treated for analysis.</p> <p>The seasonal variations in the abiotic variables in the streams of the watershed showed that the water temperature was minimum (12.50±0.71°C) during Autumn at ND2 a II order stream and maximum (19.0±2.82°C) during Summer at KG1 i.e., IV order stream in the present study. Mean depth of water was observed minimum (9.16±2.12 cm) at NL3 and maximum (19.50±0.23 cm) at KG1 during Spring, both being IV order streams. The mean width of the streams was observed minimum (101.0±1.41 cm) during Spring at NL1, a III order stream and maximum (510.0±7.07 cm) during Summer at KG2 (V order). The mean velocity of water in the streams of watershed was minimum (11.66±0.47 cm s⁻¹) during Spring at NL2 (III order) and maximum (27.60±1.24 cm s⁻¹) during Monsoon at KG1 (IV order). The water discharge varied between 1.396±0.219 m³s⁻¹ during Spring at BK1, a III order stream and 19.1±0.802 m³s⁻¹ during Monsoon at KG1, a IV order stream. Turbidity of water in the streams of watershed was observed minimum (6.0±0.82 NTU) during Autumn at ND1 (I order) and maximum (103.0±24.04 NTU) during Monsoon at KG3 (V order). The pH in streams of the watershed remained alkaline and was observed minimum (7.25±0.07) at ND2 (Monsoon &</p>

Summer) and at NL3 (Autumn & Summer), the former being II and the later III order stream. It was observed maximum (7.90±0.0) during Spring at BK1, a III order stream. The dissolved oxygen content in the water was minimum (7.35±0.21 mg l⁻¹) during Monsoon at ND5 (III order) and maximum (13.35±0.21 mg l⁻¹) during Spring at KG1 (IV order). The free carbon dioxide was observed lowest (0.01±0.01) during Summer at ND2 and ND4 both being II order stream, and highest (1.4±0.56) during Monsoon at ND5, a III order stream. The total alkalinity was minimum (20.0±1.41 mg l⁻¹) during Summer at ND2 and maximum (38.5±0.70 mg l⁻¹) during Autumn at ND4, both being II order streams.

The benthic macroinvertebrate sorted to the generic level mainly comprised of insects' larvae, pupae and nymphs. In all 20 genera belonging to (18) families, seven (07) orders of class insecta (phylum Arthropoda) were recorded from the different streams in the Khanda Gad watershed. Of the genera recorded during the present study six (06) belonged to diptera, five (05) each to ephemeroptera and trichoptera and one each to coleoptera, plecoptera, neuroptera and lepidoptera. Two genera of molluscs were also recorded in addition to the insects during the present study. The total seasonal benthic density in the watershed was found minimum (170.2±18.327 Ind. m⁻²) during monsoon at ND2 (II order stream) and maximum (795.0±52.39 Ind. m⁻²) during summer at ND6 (III order stream) during the I year of study. It was found minimum (122.6±8.92 Ind. m⁻²) during Monsoon, and maximum (668.0±30.12 Ind. m⁻²) during Summer at ND1, a I order stream in the II year.

Seasonally among the macroinvertebrate benthos ephemeropteran, coleopteran, trichopteran and dipteran genera showed their presence all through the study period in all the stream of the watershed. Represented by one genus, *Perla*, plecoptera was also present during all seasons but for at ND1 during Autumn in II Year. The neuropteran, lepidopteran and molluscan genera were occasionally present at all the sampling sites during the study period. The two molluscan genera, *Grynelas* and *Campeloma* were the genera observed in all streams (I-V order) however, they showed irregular seasonal occurrence during both the study year. The biomass of macroinvertebrate benthos was between 14.48 and 35.55 g AFDW m⁻²y⁻¹ in I year. Whereas, in II year of study it ranged between 10.07 and 17.80 g AFDW m⁻²y⁻¹.

The macroinvertebrate distribution pattern in Khanda Gad watershed showed almost negligible variation in the streams of different orders. In general, the distribution pattern encountered was dominance of a few species and regular distribution of other species along with presence of some rare species. Many taxa were seasonally absent in different streams sites of the various orders. All this contributed to the comparatively low diversity of benthic taxa in Khanda Gad.

The species richness (number of species) in the present study was 22 (genera) only. The values of diversity index (\bar{H}) varied between 0.56 and 0.96. The total annual diversity in the present study ranged between 4.07 and 4.51 in I year and between 3.53 and 3.86 in II year. It increased with the increase in stream order during I year. However, during II year, it was more or less same in all the stream orders. In general, lowest diversity was observed during Spring and Monsoon during the study period, whereas the highest was during Summer in II year. The species richness index showed seasonal variation during the study period in the stream. The richness index varied between 3.32±0.59 and 4.71±0.8 during I year of study. However, during the II year, it was quite variable and ranged between 2.67±0.3 and

					<p>7.36±0.36. Low evenness values, the relative abundance of individuals among species, were recorded during the present study in Khanda Gad watershed. It varied between 0.28±0.03 and 0.35±0.02 during I year. However, the evenness index value further lowered during the II year, it was between 0.22±0.01 and 0.29±0.008.</p> <p>The more or less similar pattern of seasonal distribution of macroinvertebrate benthos in the stream is aptly supported by the high values of similarity index (<i>SCj</i>). Since the majority of species were common to all the stream orders sites a very similarity coefficient was calculated between all the sites during both the years of study.</p> <p>The substratum of the streams were analysed by measuring the mean grain size of the sample after Folk and Ward (1957). The gradual decrease in the grain size downstream as evident from the present study was related to reduction in the energy of the stream.</p> <p>Cluster analysis method was applied to find taxa with similar habitat preferences. Trichopterans (Caddis larvae) were omnipresent during the study period, probably the pebble dominated substratum along with gravel is ideal for them. <i>Hydropsyche</i> prefers gravel substrate. The <i>Hydropsyche-Philopotamus</i> assemblage was ubiquitous to all the stream order of different orders. <i>Baetis</i>, <i>Ephemerella</i> along with <i>Heptagenia</i> were the dominant mayfly in all the stream orders. Multiple regression analysis suggested that the macroinvertebrate community structure is mostly influenced by the steadily changing physical conditions of the streams. The variables like discharge, turbidity along with dissolved oxygen seems to be important.</p> <p><i>A radical change in agriculture land use at the cost of other land use and also the increasing human population have caused environmental degradation in the Khanda Gad watershed which in turn is reflected in diminishing discharge of the springs. Streams have been altered by changes in their water chemistry (quality) and in the physical structure of the habitat. The latter includes the impacts of abstraction of water also, which is predominant in the Khanda Gad watershed. During the present study reduced flow of water in all the streams of the watershed was noticeable as evident from the low mean depth of the channel (7.66 and 20.34 cm) in the watershed. The flow of water measured during the non-rainy months in the downstream section of the watershed (KG3) varied between 11.25 and 180 lpm (liter per minute). A total of twenty-four drinking water schemes provide water to the villages in the watershed. In view of the present human influences the microhabitats of the macroinvertebrates especially in the remote tributaries needs further careful identification and conservation.</i></p>
Jagmohan Singh	Prof. O.P. Gusain	29/10/1999	18/11/2003	A study of macroinvertebrate benthos substratum relationship along the altitudinal gradient in a Himalayan stream, Takoli Gad. Zoology	The Garhwal Himalayan region abounds in numerous small spring-fed fluvial systems locally known as Gads. A number of invertebrate benthic organisms inhabit these water bodies. They play a vital role in maintaining the structural and functional integrity of these stream ecosystems. Substratum, being of great importance to the benthic fauna in a way determines the nature of fauna along with other ecological factors in the streams. In many streams and rivers, the community structure vary along longitudinal gradient, in turn affected by change in grain size of the substrate particles. The study of altitudinal distribution of benthic macroinvertebrates considering their relationship with the substratum was the objective of the present investigation in a spring-fed stream Takoli Gad.

					<p>Regular monthly sampling was undertaken to analyze the physico-chemical characteristics of stream water of Takoli Gad at the designated sampling sites alongwith the benthic macroinvertebrates. The present investigation was carried out for a period of 26 months from January 2000 to February 2002.</p> <p>The bottom fauna of stream Takoli Gad constituted of 34 (Thirty four) genera of macrozoobenthos belonging to nine (09) orders and (25) families of class insecta.</p> <p>Distribution of taxa over different substrate types prevailing during the five seasons as expressed by the Index of Representation (IR) showed preferences and aversions by them. The substratum in the upstream sites during Winter was preferred by <i>Cynigma</i>, <i>Rithrogena</i> and <i>Psephenus</i>, while in the downstream by <i>Isoperla</i>, <i>Hydropsyche</i> and <i>Bibiocephala</i>. During Spring, Ephemera along with Glossosoma, Rhyacophila, Antocha and Atherix preferred the upstream sites. Ephemeropterans and trichopterans preferred the downstream sites during the same season. During Summer, the substrate in the upstream region was preferred by Ephemeropterans, while during Monsoon, <i>Philopotamus</i> and <i>Chironomus</i> showed preference to substrate. In the downstream region, the substrate was preferred by ephemeropterans. During Winter, ephemeropterans were significantly over represented showing preference to the upstream and downstream sites, whereas, <i>Hydropsyche</i> preferred the upstream sites. <i>Heptagenia</i> showed aversion to the substrate in the middle region during this season.</p> <p>Cluster analysis based on IR values showed seasonal variation in macroinvertebrate assemblages. During winter majority of taxa were present together, while during Spring, <i>Rithrogena-Perla</i> and <i>Leptocella-Bibiocephala</i> were the two main assemblages. Also, during Summer two assemblages of diverse genera was recorded. However, during Monsoon scattered type of assemblages were evident. <i>Heptagenia-Psephenus</i> and <i>Cynigma-Antocha</i> were closely associated assemblages during Autumn.</p> <p>Thus, the assemblages of macrobenthic organisms in Takoli Gad changed seasonally in relation to the substratum besides other ecological factors. The high evenness and similarity between macroinvertebrate benthic organisms occurring in different regions of the stream, from headwater to downstream, often result in similar abundance. Nevertheless, the seasonal changes are profound along altitudinal gradient.</p>
Pranav Singh	Prof. Manju Prakash Gusain	11/03/2013	15/10/2019	<p>Longitudinal pattern of benthic macroinvertebrate assemblages influenced by discontinuities along river Alaknanda in Garhwal Himalaya.</p> <p>Zoology</p>	<p>The present study envisaged study of the distribution of macroinvertebrate communities and its associated physicochemical and environmental conditions at designated sampling sites which include 06 tributaries confluences and one dam in the Alaknanda river catchment (ARC). The study area falls in the state of Uttarakhand, in the Northern part of India between the latitudes 28°43'–31°27'N and longitudes 77°34'–81°02'E. The sampling for collection of data on 17 physicochemical parameters and different benthic macroinvertebrates was undertaken during March 2014 to February 2016 (two years) at the 21 designated sampling sites adopting standard methods. At each sites samples were collected from Alaknanda and the tributary before the confluence and also the after confluence at a reach scale of about 50–150m depending upon the accessibility. Further, the seasonal analysis for different physicochemical parameters, ecological indices, biomass and substratum composition were made</p> <p>During the present study majority of the physicochemical variables tend to fluctuate seasonally. Water temperature was recorded minimum during Monsoon and maximum during</p>

					<p>Summer. The mean velocity was minimum during Winter and was maximum during Monsoon. Turbidity of water was minimum during Autumn and was maximum during Monsoon. The dissolved oxygen varied between 9.35 and 11.65 mg l⁻¹ during Autumn and Winter respectively. The phosphate and nitrate concentration were minimum during Autumn and maximum during Spring. While, the total solids and total dissolved solids concentration were minimum during Winter and maximum during Monsoon. The benthic macroinvertebrates communities comprised of 51 insects genera belonging to 9 orders and 35 families. Besides, 01 one genus of each Annelida and Mollusca were also recorded during the present study. The dominant insects order were Ephemeroptera (16 genera), followed by Trichoptera (11 genera), Diptera (9 genera), Plecoptera and Coleoptera (5 genera each), Odonata and Lepidoptera (2 genera each), Megaloptera and Hemiptera were represented by single genus. The total density of benthic macroinvertebrates was minimum during Monsoon and was maximum during Summer. A decreasing trend in the diversity with increasing the altitude was evident in River Alaknanda. The biomass varied seasonally, more or less, in accordance with the benthic density at all sites. The lowest and highest in both years was during the Monsoon and Summer/Spring season respectively.</p> <p>The substratum composition varied from the very coarse sand to cobbles at different sites on River Alaknanda and its tributaries. The CCA revealed that majority of the macroinvertebrate taxa recorded during the present study occurred in moderate velocity waters, while, a few inhabit high water velocity sites. Majority of taxa occurred at sites with moderate to high water temperature, turbidity, total solids, pH,, total alkalinity and mean depth in River Alaknanda and its tributaries. In the measurement of discontinuity due to the tributaries and dam, the physicochemical parameters such as, water temperature, mean width, mean depth, mean velocity, discharge, conductivity, pH, dissolved oxygen, total alkalinity and phosphate concentration varied significantly (p<0.05) below the confluence of tributary and downstream to dam. The benthic macroinvertebrates also showed minor shifts from the expected trend below the confluence of tributaries. The present study revealed the impact of the tributaries and dam on the physicochemical variables, which in turn, influenced the longitudinal pattern of occurrence and distribution of benthic macroinvertebrate communities in River Alaknanda. The study can be further used as a baseline for other such studies at catchment scale especially in Himalayan region. Also, the possibility of ecological restoration of segment of rivers impacted by impoundment could be explored based on the present study.</p>
Bhaskara Nand Semalty	Prof. Manju Prakash Gusain	12/12/2007	14/02/2016	Community structure and ecology of macroinvertebrates in a spring-fed stream of Garhwal Himalaya. Zoology	<p>The present study entitled, the community structure and ecology of benthic macroinvertebrates in Bachchan Gad, a left side spring-fed stream of River Alaknanda in Garhwal Himalaya. The present investigation was carried out for a period of two year study i.e. from March 2008 up to February 2010. Regular monthly samples were taken to analyze the physicochemical parameters of water along with the benthic macroinvertebrates from stream Bachchan Gad at four sampling sites (590–1600m asl).</p> <p>Selected physicochemical parameters in Bachchan Gad belonging to different sampling sites were analyzed following the standard methods. Subsequently, benthic macroinvertebrate samples were collected by stratified random sampling (Cummins, 1962) applying transects method using modified Surber's square foot sampler</p>

					<p>(Welch, 1948). Quantitatively, the macroinvertebrate benthos collected; represented their density which was expressed as individuals per square meter (Ind. m⁻²). Various ecological indices were determined from the data collected; besides relevant statistical methods were also applied.</p> <p>During the present study various physicochemical parameters operating in the stream showed seasonal and altitudinal variation. The in-stream hydraulic variables such as mean width, mean depth, mean velocity and discharge were also varied seasonally and observed highest during monsoon. However, some physicochemical parameters viz dissolved oxygen, free carbon dioxide nitrate and phosphate seems to be affected by anthropogenic activities at the various stretches of the study stream.</p> <p>Among the benthic fauna, a total of 51 benthic macroinvertebrates genera belonging to 09 orders and 38 families of Class Insecta, along with one genus each of Annelida, Crustacea and Mollusca were identified. Majority of species (30 taxa) were common to all the sampling sites showed high similarity. <i>Baetis</i>, <i>Hydropsyche</i> and <i>Heptagenia</i> were the most dominant taxa.</p> <p>The benthic density was recorded lowest at upstream region during monsoon due to a relatively unstable substrate along with high current velocity, high turbidity and discharge. However, during winter of low flow and favourable in-stream conditions supported the highest benthic density in the study stream. The diversity, species richness and evenness were recorded highest in the upstream region due to fewer perturbations than at downstream sites. Predominant agricultural land use associated with forest and the aggregate of leaves on the stream bed provide both food and habitat and typically support a high abundance of invertebrates.</p> <p>Based on the findings of the present study it can be concluded that the composition and structure of the benthic macroinvertebrates in Bachchan Gad, varied temporally and spatially due to the interaction of multiple environmental factors along with altitudinal gradient.</p>
Jitendra Singh Rana	Prof. Manju Prakash Gusain	23/12/2008	16/05/2015	<p>Impact of riparian landuse on benthic macroinvertebrate communities of river Alaknanda.</p> <p>Zoology</p>	<p>The present study envisaged recording the seasonal and taxonomical change in benthic macroinvertebrate communities of rivers and streams along different riparian land use in Alaknanda river catchment of Garhwal Himalaya. The benthic community structure and the prevailing environmental condition was monitored at 10 sites along 08 different riparian land use types i.e., forest, agriculture, barren and alpine in Alaknanda river catchment. During the present study majority of the physicochemical variables tend to fluctuate seasonally with different riparian land use types. Water temperature was recorded minimum during winter and maximum during summer. The mean channel width, mean channel depth, mean velocity and water discharge were recorded minimum and maximum during winter and monsoon respectively. The turbidity was recorded highest during monsoon. The concentration of dissolved oxygen was recorded lowest during monsoon and highest during spring. The benthic macroinvertebrate communities comprised of 73 insect's taxa of 09 orders belonging to 52 families. Besides, 01 genus of each Annelida and Crustacea</p>

				<p>and 02 taxa of Mollusca were also recorded along with some unidentified ones. The dominant insect orders were Diptera (18 genera), followed by Trichoptera (17 genera), Ephemeroptera (12 genera), Plecoptera (11 genera), Coleoptera (07 genera), Odonata (04 genera) and Lepidoptera (02 genera). Order Hemiptera and Megaloptera were represented by one genus each. The highest numbers of benthic macroinvertebrate insect genera/taxa (50) were recorded from Dense Mixed Forest II. The average density of benthic macroinvertebrates at 10 sampling sites under different riparian land use types was recorded lowest during monsoon at Chir Pine Forest II and highest during winter at Chir Pine Forest I.</p> <p>The Ash free dry weight was recorded minimum at Chir Pine Forest I and maximum at Sub- montane Barren during monsoon and spring respectively. In the present study, at most of the sites, diversity was highest during winter and spring and lowest during summer, monsoon and autumn. The highest species richness was found mostly during spring and winter, whereas the lowest was evident during monsoon and autumn exhibiting strongest response to agricultural and forested sites. Benthic macroinvertebrate taxa had more or less similar abundance during various seasons, thus not accounting for significant difference in species evenness at different riparian land use sites. The coefficient of community (similarity index) indicated that the benthic macroinvertebrate communities between Sub-montane Alpine and Montane Barren were less similar (only 16 benthic genera common). Multiple regression analysis suggests that benthic density was significantly correlated with water temperature, width, depth and velocity of water, discharge, dissolved oxygen, conductivity, phosphate, nitrate, substratum, total solids and total dissolved solids and turbidity at different riparian land use types. Hierarchical cluster analysis revealed the occurrence of <i>Heptagenia-Baetis</i>, <i>Baetis-Hydropsyche</i> and <i>Baetis-Rhyacophila</i> assemblages to be dominant at different riparian land use sites. The canonical correspondence analysis reveals that the seasonal variation in water temperature along with pH and velocity related aspects i.e., depth, discharge and total dissolved solids were among the most significant variables in explaining the distribution and abundance of benthic taxa at all sites. Seasonally the substratum composition at different sites varied between coarse sand to boulder during different seasons.</p> <p>The present study reveals that the benthic macroinvertebrate assemblages change with changing riparian characteristics at different riparian land use sites. A strong influence of physicochemical characteristics, associated land use practices (e.g., agricultural) in riparian zone, changes in stream habitat and substratum characteristics were predicted as determinants of benthic macroinvertebrate assemblages in the present study. The work can further be carried out to cover the entire catchment at sub-catchment/watershed scale with the help of land use-land cover map generated by remote sensing tools. This shall be further instrumental in identifying the riparian land use/habitat specific species especially in this Himalayan region which is undergoing environmental changes due to the ongoing developmental activities and natural hazards.</p>
--	--	--	--	--

Juhi Mishra	Prof. Manju Prakash Gusain		19.09.2014	Comparative analysis of antioxidant activity and genetic variability in selected <i>Phaseolus vulgaris</i> cultivars of Uttarakhand. Biotechnology	<p><i>Phaseolus vulgaris</i> L. (common beans) are widely cultivated at varying altitude (1400-2700 meter above sea level) in different aspect of these variations such as morphological, nutritional and genetic polymorphism. 20 cultivars of common beans collected from different parts of Uttarakhand were studied during the present investigation.</p> <p>Seed of <i>Phaseolus vulgaris</i> (L.) were collected from geographically distinct parts (Majkhali, Purola, Mori, Tapovan, Dhankot, Dwarahaat, Harsil Chakrata, Lohaghat, Chamba) of Uttarakhand, India. Seeds were directly procured from local farmers after harvesting of crop and duly authenticated by National Bureau of Plant Genetic Resources, New Delhi. Seeds of 20 cultivars of common beans were collected with varying seed coat colour, seed pattern; seed shape and size.</p> <p>All the selected cultivars of <i>Phaseolus vulgaris</i> were subjected to analysis of nutraceutical components like free phenolics, flavonoids, flavonols and condensed tannins present in the seeds. Methanolic extracts were prepared from grounded seed and subjected to analysis of polyphenolic contents and their antioxidative activity.</p> <p>Antioxidative activity of methanolic extracts of common bean seed were investigated using DPPH radical scavenging assay and B-carotene bleaching assay. Significant correlation has been reported between total phenolics (TPC) and antioxidant potential of the cultivar ($r=0.693, p<0.01$). The bean cultivars exhibited 24.35 to 84.12% antioxidant activity (AA) in inhibition of B-carotene in the linoleate model and 48.86-103.52 trolox equivalent antioxidant capacity (TEAC) in DPPH model system.</p> <p>Maximum phenolic content and antioxidant activity has been reported in small red market class and among cultivars in small red beans collected from Purola region (S5) whereas minimum in small white market class and among cultivar in white bean collected from Tapovan region (S8).</p> <p>Preliminary qualitative analysis of methanolic extracts for quercetin content has been carried out using thin layer analysis. Quercetin was detectable in 14 out of 20 common bean methanolic extracts.</p> <p>Investigation of genetic make-up of common bean cultivar has been carried out using root tip method. Karyotype of all the cultivars showed 11 pair of chromosomes.</p> <p>For molecular level diversity assessment, two molecular DNA markers were used, Random amplified polymorphic DNA (RAPD) and Simple sequence repeats (SSR). The level of polymorphism observed in the present study was moderately high, indicating a wide and diverse genetic base for the common bean cultivars in Uttarakhand. The genetic diversity of the common bean in Uttarakhand can be extremely useful in formulating proper conservation management strategy.</p>
Km. Manu Pant	Prof. Manju Prakash Gusain	28/08/2008	March 2012	In-vitro propagation of <i>Swertia chirata</i>	The present investigation was undertaken to develop appropriate tissue culture technology as a non-conventional method for mass multiplication of a medicinally important plant species. A detailed stepwise procedure was developed for <i>in vitro</i> propagation of <i>Swertia chirata</i> . The investigation concluded that <i>Swertia chirata</i>

				<p>Buch.-Ham. Ex Wall. through different regeneration pathways.</p> <p>Biotechnology</p>	<p>could be successfully multiplied through three regeneration pathways namely, axillary bud proliferation, indirect organogenesis and direct organogenesis. Using nodal segments with axillary buds, multiple shoots were produced on defined medium with optimal multiplication in 4 weeks. Various physical and chemical conditions were standardized for <i>in vitro</i> propagation of the species. Through organogenesis via <i>in vitro</i> root derived callus MS medium containing BAP, IAA and Ads proved to be the best for shoot multiplication while optimal results of direct organogenesis from <i>in vitro</i> root segments were obtained on half strength medium containing resulted in BAP and NAA. The culture conditions were standardized for <i>in vitro</i> rooting of shoots regenerated through different pathways. Over 85% survival of tissue culture plants was achieved in pots transferred to field conditions.</p> <p><i>In vitro</i> propagation is recognized as a useful technique for propagation and <i>in-vitro</i> conservation of threatened plants, especially those in which roots or rhizomes contain the active compound. The present protocol developed is an efficient and rapid method for large scale multiplication of <i>Swertia chirata</i> through culture of axillary buds and excised <i>in vitro</i> root segments. High shoot multiplication rate with healthy rooting are attractive features of this study and credited by the following aspects:</p> <ol style="list-style-type: none"> The protocol can be used for raising genetically uniform population through axillary shoot multiplication for sustainable supply of plant materials to pharmaceutical industries and conservation of germplasm. Root explants being derived aseptically, do not face the problem of contamination and are therefore ideal for germplasm exchange and cryopreservation. The system will be useful for biochemical and physiological studies in relation to organ differentiation and genetic improvement studies via indirect organogenesis. Direct organogenesis can be considered as an alternative means to enhance the <i>in vitro</i> multiplication rate for clonal propagation.
Km. Anchal Sood	Prof. Manju Prakash Gusain	14/08/2007	2012	<p>Assessment of bacterial diversity in Ganga River System in Uttarakhand.</p> <p>Biotechnology</p>	<p>The present study was undertaken to explore the cultivable bacterial diversity of River Ganga in Uttarakhand. Water samples were collected from thirty two different sites, scattered in three different stretches in three different seasons during 2007-2008. The sampling sites included sixteen sites in River Alaknanda, eleven in River Bhagirathi and seven in River Ganga i.e. after confluence at Devprayag. Among these sites ten constituted the upper stretch, fifteen constituted the middle stretch and seven constituted the lower stretch of the Ganga river system in the state of Uttarakhand.</p> <p>A composite index of microbial contamination coupled with physicochemical attributes employing standard methods was carried out to draw the complete overview of all aspects of pollution with respect to different seasons in the Ganga river system of Uttarakhand. Further, for the assessment of bacterial diversity a polyphasic approach, involving phylogenetic analyses of 16S rRNA and phenotypic characterization, was adopted. The 16S rDNA was amplified by PCR and the isolates were grouped into clusters by the analysis of restriction patterns of the PCR-amplified 16S rDNA (ARDRA using tetrameric enzyme HaeIII). The</p>

				<p>cultivable bacterial diversity profile of study area was completed by establishing the phylogenetic positions of unique bacterial isolates by 16S rDNA sequence analysis. Diversity index using Shannon index were also calculated.</p> <p>All the sampling sites circumventing the Ganga river system in Uttarakhand were found to have high total viable counts during the present study. The TVC values were relatively higher for the sites of lower stretch of the study area including holy places like Haridwar and Rishikesh which may be attributed to the presence of large population residing at the banks. The total coliform count was relatively higher in rainy season. There was no definite pattern of FC count in different stretch of study area, though the counts were again higher for the sites in the lower stretch. On the other hand, faecal streptococci remained absent in most sites of River Ganga. FC/FS ratio was obtained highest in the rainy season and was negligible in winter season. Among the physicochemical parameters of River Ganga in Uttarakhand recorded during the course of the present study, most of the attributes were within the minimum permissible limits of the water samples.</p> <p>A total of 799 bacterial strains were isolated from the Ganga river system among which upper, middle and lower stretch comprised of 221, 329 and 249 strains respectively. On the basis of phenotypic characterization tests, 772 strains were identified up to genus level. The bacterial population was dominated by Gram negative, oxidase negative, facultative anaerobic rods capable of growing at a wide range of temperature, pH and alkalinity. <i>E. coli</i>, being the most dominant member of the bacterial population of Ganga river system, was isolated from all the sites of the study area. Several other members of the family Enterobacteraceae were present in complete stretch of study area. In addition, <i>Yersinia</i>, <i>Salmonella</i>, <i>Streptococcus</i>, <i>Staphylococcus</i>, <i>Clostridium</i> and <i>Enterobacter</i> were also present in all the three stretches of Ganga in Uttarakhand. <i>Pseudomonas</i>, <i>Bacillus</i>, <i>Alcaligenes</i>, <i>Aeromonas</i>, <i>Sarcina</i>, <i>Deinococcus</i>, <i>Hafnia</i> and <i>Lactobacillus</i> were amongst the heterotrophic genera isolated.</p> <p>A total of 126 isolates of <i>E. coli</i> were obtained during the present study, among which 63 % exhibited a pattern of multiple drug resistance, being resistant to four or more antibiotics. Serotyping of some of the pathogenic <i>E. coli</i> strains revealed that the serogroups O2 (UPEC), O14 (UPEC), O35 (UPEC), O44 (EAggEC), O102 (STEC), O105 (STEC), O114 (EPEC) and O147 (ETEC) were present at various locations of River Ganga in Uttarakhand. Restriction analysis of 16S rDNA with <i>HaeIII</i> of a total of 119 isolates resulted in 42 different patterns, each corresponding to particular genotype. The clustering of strains obtained from different stretches and different seasons suggests that bacterial cells may get dispersed over a large geographical area using river current.</p> <p>The 16S rDNA sequence of thirty seven bacterial strains was obtained. Phenotypic and molecular characterization along with phylogenetic analysis of isolates showed that there were four phylogenetic lineages among the isolates subjected to 16S rDNA analysis from Ganga river system.</p> <p>Scanning electron micrographs of these strains was also obtained. Complete</p>
--	--	--	--	--

					<p>diversity analysis based on the combination of molecular and phenotypic techniques resulted into a total of 61 different bacterial species, which were distributed in 39 genera.</p> <p>Based on the present study of the bacteriological and physicochemical status of Ganga river system in Uttarakhand it was revealed that its lower stretch of is facing severe anthropogenic interventions resulting in increased level of pollution.</p> <p>The present study generated preliminary data on the composition of aquatic microbial communities in the Ganga river system of Uttarakhand. Physiological and biochemical characterization, phylogenetic analysis based on 16S rRNA gene sequences and phylogenetic neighbours showed that few of the strains were unique. Conclusively, the present study suggests that the Ganga particularly in the state of Uttarakhand comprised of a high diversity of cultivable heterotrophic bacteria.</p>
Sumit Kumar	Deepak Singh	LZ-15171 23.04.2014	5.12.2019	Analysis of Phenotypic and Genotypic Variability Within Species of Genus <i>Barilius</i> from Different Tributaries of Alaknanda and Chenab Rivers	<p><i>Barilius</i> species constitutes an important portion of the capture fishery in several parts of the Himalayan region of Uttarakhand, and Jammu & Kashmir. This species also inhabits mountain streams of India, China, Western Asia, South and mainland of South-East Asia. Stock structure analysis and molecular characterization have been important in fish biology to raise the production under fish farming. Traditional morphometry has some weaknesses in identification and discrimination of a fish stock. To overcome the problems of identification, based on morpho-meristic characters a truss based morphometry and mitochondrial markers were used to access the intra and inter-specific variations in <i>B. bendelisis</i> and <i>B. vagra</i> from Alaknanda and Chenab river basins of Central and Western Himalaya. Alaknanda and Chenab rivers are geographically isolated and there is hardly any possibility of migration of fishes in between these two rivers. The fishes were collected from six sampling sites, three each on tributaries of the Alaknanda and Chenab river basins. After proper identification of fishes, digital images of specimens were taken for the truss analysis. Tree software platforms, tpsUtil, tpsDig2 v2.1 and Paleontological Statistics (PAST) were used to measure truss distances. The tissues of some samples were preserved in 95% ethanol for molecular analysis. Ninety truss measurements based on 14 landmarks on the fish body were extracted. Eight meristic traits were also analysed.</p> <p>In case of <i>B. bendelisis</i> 89 truss measurements were found to have significant differences among the specimens. Significant differences were also found in all the 90 truss measurements of the species of <i>B. bendelisis</i> and <i>B. vagra</i> collected from Alaknanda and Chenab river basins indicating interspecific variation. 88.4% of individuals of <i>B. bendelisis</i> and 81.7% of <i>B. vagra</i> were correctly classified into their original groups. The discriminant analysis clearly showed the separation of <i>B. bendelisis</i> and <i>B. vagra</i> stocks from the six different tributaries of Alaknanda and Chenab rivers. The results from the truss based morphometry showed that both <i>B. bendelisis</i> and <i>B. vagra</i> had significant phenotypic heterogeneity among the six stocks of Alaknanda and Chenab river basins.</p> <p>The molecular characterization using COI gene was also done. All the analysed COI sequences were above 640 base pairs. The genetic distance within the same species was less as compare to the inter-specific genetic distance. Phylogenetic trees (Maximum likelihood and Neighbour joining) constructed using the COI sequences of <i>B. bendelisis</i> and <i>B. vagra</i> displayed two separate stocks of these two species collected from the Alaknanda and Chenab</p>

					river basins however, no intra-basin variations were found in both the species at the molecular level. It was concluded from the present study that six different stocks of <i>Barilius bendelisis</i> and <i>Brilius vagra</i> were found from the six different tributaries of Alaknanda and Chenab river basins. Less phenotypic plasticity was found within the tributaries of the same river basin as compared to the tributaries of two isolated river basins of Western and Central Himalaya. The present study will be helpful in suggesting separate conservation and management strategies in order to sustain the stocks of <i>B. bendelisis</i> and <i>B. vagra</i> for future use.
Gunjan Goswami	Deepak Singh	LZ-14236 11.03.2013	24.06.2018	Status of Biodiversity in the River Mandakini of Garhwal Himalaya	<p>Freshwater biodiversity encompasses ecosystems including streams, river, lakes, ponds groundwater and wetlands. These ecosystems provide a home to many species including periphyton, phytoplankton, macrophytes, zooplankton, macroinvertebrates, fish and other biota. The health of an aquatic ecosystem depends upon the physical, chemical and biological characteristics of the water body. Mandakini river is one of the important sources of drinking water for the rural and urban population of Rudraprayag district (Uttarakhand) as well as harbours a good spectrum of biodiversity. But the Mandakini valley was hit by a major flash flood during 16-17 June 2013. The river bank was widely eroded and the stream changed its route at several places. It carried huge amount of silt during flash floods consequently very high turbidity and mass mortality of the aquatic flora and fauna of this river. Therefore, the status of biodiversity in the Mandakini river after major flash flood becomes important to study. Three sampling sites near Kund (998 m a.s.l.), Agustyamuni (760 m a.s.l.) and Rudraprayag (620 m a.s.l.) were selected on the Mandanini river of Garhwal Himalaya for the study of biodiversity.</p> <p>The density and diversity of aquatic flora and fauna started increasing after flash floods in monsoon and reached its maximum in winter due to most stable substratum and onset of most favorable environmental conditions during the period. Bacillariophyceae (diatoms) contributed maximum followed by Cyanophyceae (blue green algae) and Chlorophyceae (green algae) towards the phytoplankton and periphyton diversity. A total of 18 species of macrophytes were recorded from the Mandakini river during the study period. Zooplankton were sparsely distributed in the river. None of the species of zooplankton was found in the first year (2014). However, a total of 8 genera of zooplankton were recorded from the study area during the second year (2015) of study. Ephemeroptera and Trichoptera dominated among macroinvertebrates followed by Diptera in the river. A total of 19 species of fish were also recorded after major flash flood at three different sites in the Mandakini river. Two years study revealed that the aquatic communities reestablished and ecosystem recovered soon from the damage caused by the major flash flood.</p>
Rakesh Kumar	Deepak Singh	HNBGU/Res/2 2770 30.06.2008	2015	Isolation, Purification and Scale Up of Novel Lipase for Therapeutic Significance	With the world in a global economic downturn, the market for enzymes has become challenging and growth will be significantly going forward. Recently, lipases assumed a prominent place in world enzyme market. Lipases are involved in metabolism of dietary triglycerides, cell signaling and inflammation. The study was aimed for isolation, screening and selection of potent lipase producer. Purified lipase would be used for therapeutic application. An attempt was made to acylate 5-FUR with purified lipase for therapeutic application. For the isolation of lipase producing microorganisms, the oil contaminated soil samples were collected from seven different sites. After repeated screening, three most potent lipase producing colonies of bacteria were selected. 16s rRNA sequence information was

					<p>collected and submitted to NCBI database with accession no. of GQ463238. The identified strain was <i>Bacillus pumilus</i> RK 31. SDS, CaCl₂, glucose and peptone had great impact on lipase production. During growth in shake flask cell growth, lipase activity, residual glucose, consumed glucose; protein concentration and biomass generated were estimated. Statistical methodology was applied on <i>Bacillus pumilus</i> to achieve maximum lipase production. Variance analysis showed that olive oil, tween 80 and KH₂PO₄ played significant role in lipase production. KH₂PO₄ was responsible for maximum lipase production. Lipase production was increased 3.25 fold in optimized conditions than unoptimized.</p> <p>Purification of lipase was done by various downstream processing techniques. The purification steps involves 60% ammonium sulphate saturation, gel filtration chromatography using Sephadex G200 and ion exchange chromatography using DEAE cellulose, which were effective in 7-fold, 127-fold and 186-fold increase in specific lipase activity. The enzyme exhibited optimum activity at 60°C and 6 pH. EDTA-K at 1mM completely inhibited the lipase activity. Of the 15 different organic solvents, petroleum ether greatly affected lipase production which means enzyme had property to tolerate wide range of organic solvents making it attractive towards industrial applications. The therapeutic application of enzyme was also studied using 5-FUR, a nucleotide analogue exhibiting anti-tumour activity. But the side effects restricted it in clinical use. To reduce the toxicity, while retaining its higher anti-tumour activity, 5-FUR derivative was synthesized which later showed less side effects and higher anti-tumour activity.</p> <p>The purified enzymes are less stable, when they are to be used in organic solvents. To solve this, lipase activity should be immobilized and stability of enzyme along with increased reactivity may be explored. The superiority of immobilized enzyme over free enzyme may be used for lipase enzyme as well. In this study, the moderate conversion achieved may be magnified several fold by using immobilized lipase systems. In-vivo models may be used to test anti tumour activity and lesser side effects of 5-FUR analogues by acylation with lipase enzyme.</p>
Garima Bahuguna	Deepak Singh	HNBGU/Res/2 2766 22.10.2008	2014	Study of Fish Diversity and Biology of Family Cobitidae from Four Important Hillstream Tributaries of River Ganga in Garhwal Himalaya	<p>Cobitids are commonly known as "hill stream loaches" as many species are found only in mountainous streams which are characterized by rocky beds and swift, turbulent and shooting hyperoxic water flow. Loaches are bottom dwelling carni-omnivore fishes which act as a scavenger in aquatic ecosystem and help to keep the bottom environment clean. Keeping in view the importance of these fishes, the present work "Study of Fish Diversity and Biology of Family Cobitidae from Four Important Hillstream Tributaries of River Ganga in Garhwal Himalaya" was undertaken and conducted on four tributaries namely, Gular Gad, Shivpuri Gad, River Suswa and River Song.</p> <p>During the study period, a total of 9 species, namely <i>Noemacheilus montanus</i>, <i>N. rupicola</i>, <i>N. beavani</i>, <i>N. Zonatus</i>, <i>N. denisonii</i>, <i>N. gangeticus</i>, <i>N. multifaciatus</i>, <i>N. striatus</i> and <i>N. botia</i>, were collected from four tributaries. <i>N. montanus</i> was found to be most abundant while <i>N. botia</i> was least abundant. All the collected fish species were carni-omnivores. High densities of basic food items of fishes like diatoms, protozoans, algae and macro-zoobenthos were available in Gular and Shivpuri Gad attracting comparatively good number of fishes. Very little difference was observed in quality of the food items which was attributed to similar physico-chemical nature of the habitat. The relative length of the gut (RLG) reflected a</p>

					<p>relationship with feeding habit of the fish. The RLG value also reflected the feeding nature of fish, as value of RLG increased in proportion with an increase in ingested plant food. Four parameters of fecundity were studied in species and it was observed that ovary weight is a better index of fecundity than total body length, total body weight and total ovary length. It was also recorded that same size fish had different number of eggs in their ovaries. Variation in fecundity was attributed to environmental conditions prevailing in these different tributaries of river Ganga.</p> <p>With increase in human population and rapid development, and anthropogenic stress like construction activities, habitat destruction over exploitation of fishes and water pollution resulted in shrinkage of fish population. Therefore, people awareness towards conservation and management of the aquatic resources was suggested to preserve the diversity of family Cobitidae.</p>
Irshita Bajpei	Deepak Singh	HNBGU/Res/2 2357 12.02.2008	2013	<p>Bioconversion of Lignocellulosic Waste Material (<i>Lantana camara</i>) for Production of Biofuel</p>	<p>Rising prices, geopolitics and the progressive depletion of fossil carbon sources has been causing concern regarding both the security of their supply and greenhouse gas emission. The global warming concerns on climate change are increasing the demand for biofuel production. Nowadays, there is no doubt about the benefits of using renewable energies to diversify the energy sources and diminish petroleum dependence. Among other renewable energies, biomass can be used to generate biofuels that can be easily integrated into current fuel distribution systems.</p> <p>The present research explores the possibility of using wood dust of <i>Lantana camara</i> for the production of fermentable sugars which in turn would provide cheap substrate for the production of bioethanol and other useful chemicals, single cell protein etc. In the present research, grounded dried stem wood and branches of uniform mesh size viz. 40 and 60 particle size of 2-4mm were subjected to sodium hydroxide alkali delignification followed by dilute sulphuric acid pretreatment. The chemical treatment of <i>Lantana camara</i> wood dust displayed an enhanced delignification of 90% in the presence of 3.0% (w/v) sodium hydroxide at room temperature for 4 hours. Further, the delignified biomass was pretreated using 2 % (w/v) sulphuric acid and almost 92% hemicellulose depolymerisation was obtained at room temperature. The hydrolysate obtained after dilute acid hydrolysis was subsequently detoxified sequentially by different detoxification methods.</p> <p>The fungal strains <i>Trichoderma viride</i> MTCC 1763 and <i>Aspergillus wentii</i> were selected for production of extracellular celluloses and beta-glucosidase in shake flask cultures using pure cellulose and lignocellulosic residues in submerged and solid state fermentation conditions. These studies showed that the delignified wood dust of <i>Lantana camara</i> was a good substrate for the production of the enzymes. Using the optimum conditions of solid state fermentation, the large scale production of these enzymes was carried out in an indigenously designed solid state surface fermenter. The enzymatic hydrolysis of delignified/pretreated wood dust of <i>Lantana camara</i> substrate was carried out to produce high concentration of fermentable sugars. By supplementing <i>Aspergillus wentii</i> beta- glucosidase to <i>Trichoderma viride</i> cellulase, 82% cellulose hydrolysis could be achieved. Both the acid and enzymatic hydrolysates were fermented separately by the different isolated strains of yeast <i>Saccharomyces cerevisiae</i> capable of fermenting hexose and pentose sugars. The mixed hydrolysate was also fermented to bioethanol. In the present study, the production of ethanol</p>

					from <i>Lantana camara</i> would have the dual advantage of producing energy and serving as an effective method of weed management.
Mr. Mohd Zahier Khan UGC-CSIR NET 2018 AIR-38	R.S. Fartyal	LZ-16198 & 10.07.2015	14.03.2020	Morphometric and molecular systematic study of Drosophilids from Jammu region	<p>The drosophilidae is a large family of acalyprate flies of worldwide distribution with 4,450 described species, ranging from sea level to considerable altitude, as well as in temperate and equatorial zones. Significant attempts have been made by many taxonomists to explore the biodiversity of drosophilids from India, but a few from Jammu and Kashmir. Hence keeping the above point in view the present study was conducted to explore the assemblage of drosophilids from different habitats of Jammu region. The samples for the present study were gathered from different areas of Jammu and are preserved in 70% ethanol.</p> <p>In the present study a total of 40 species from 10 genera viz., <i>Drosophila</i>, <i>Hirtodrosophila</i>, <i>Impatiophila</i>, <i>Leucophenga</i>, <i>Liodrosophila</i>, <i>Lordiphosa</i>, <i>Mycodrosophila</i>, <i>Scaptodrosophila</i>, <i>Scaptomyza</i> and <i>Zaprionus</i> were reported of which <i>Drosophila</i> was the dominant genus with 17 species. From the total 8 species were registered as novel to science.</p> <p>In the second section, 9 species of drosophilid viz., <i>Liodrosophila angulata</i>, <i>Hirtodrosophila quadrivittata</i>, <i>Impatiophila divergata</i>, <i>I. sarthalenesis</i>, <i>I. bicolorata</i>, <i>I. sp.</i> ZP16, <i>I. mikroparata</i>, <i>I. epta</i>, and <i>I. quasigladiata</i> were characterized using 3 mitochondrial gene sequence analysis viz., cytochrome c oxidase subunit I and II (COI and COII) and 16S rRNA. Lowest pairwise genetic distance (0.0000) for COI gene was observed between <i>Impatiophila sp.</i> ZP16 and <i>Impatiophila bicolorata</i> while maximum divergence (1.5294) between <i>Impatiophila divergata</i> and <i>Liodrosophila angulata</i>. The COII region in almost all the samples was in the range of 730-809 nucleotide base pairs produced an average of 799 base pairs. The pairwise genetic distance ranged between (0.0081- 0.1988) with lowest pairwise genetic distance (0.0029) was found between <i>Impatiophila quasigladiata</i> and <i>Hirtodrosophila quadrivittata</i> while maximum divergence (0.0340) between <i>Hirtodrosophila quadrivittata</i> and <i>Liodrosophila angulata</i>. The lowest pairwise genetic distance (0.0624) of 16S rRNA was found between <i>Impatiophila quasigladiata</i> and <i>Hirtodrosophila quadrivittata</i> while maximum divergence (0.1525) between <i>Hirtodrosophila quadrivittata</i> and <i>Liodrosophila angulata</i>. ML tree topology of mtCOI gene revealed <i>Impatiophila sarthalenesis</i> and <i>I. divergata</i> reflect a relationship with <i>I. ptyonosternata</i> and <i>I. yangi</i> whereas <i>Liodrosophila angulata</i> forms a clade with <i>Liodrosophila nitida</i>. ML tree topology of mtCOII gene showed <i>Impatiophila quasigladiata</i> and <i>Hirtodrosophila quadrivittata</i> clustered together forms a clade with <i>Impatiophila ptyonosternata</i> while <i>Liodrosophila angulata</i> forms a clade with <i>Liodrosophila nitida</i>. ML tree topology of 16S rRNA gene revealed that <i>Hirtodrosophila quadrivittata</i> and <i>Impatiophila quasigladiata</i> forms a clade with <i>Drosophila erecta</i> while <i>Liodrosophila angulata</i> reflect a relationship with <i>Drosophila littoris</i>.</p>
Kumari Asha	R.S. Fartyal	LZ-15173 & 24.04.2014	17.12.2019	Taxonomic Study of Drosophilids from adjoining areas of Himachal Pradesh and Uttarakhand with Molecular Characterization of some species	<p>The present study has been aimed to understand the diversity, systematic, ecology along with molecular characterization of some drosophilids. Samples for the present study were collected from adjoining areas of Shimla district of Himachal Pradesh and Uttarkashi and Dehradun district of the Uttarakhand state. From Shimla district Sungari-Bahli forest, Chaupal forest, and Narkanda-Hatu forest were chosen to collect samples and from Uttarkashi and Dehradun district, Arakot and Chakrata forest were chosen respectively. The collected samples were preserved in 70% ethanol. During the present survey total 48 species of drosophilids representing 11 genera were recorded. Among all genera, <i>Drosophila</i> altogether with 23</p>

					<p>species was most dominated genus. Genus <i>Hirtodrosophila</i> was represented with 5 species followed by <i>Leucophenga</i>, <i>Lordiphosa</i>, and <i>Mycodrosophila</i> with 3 species each. <i>Zaprionus</i>, <i>Scaptomyza</i>, and <i>Impatiophila</i> with 2 species each followed by genus <i>Hypselothyrea</i>, <i>Stegana</i>, and <i>Scaptodrosophila</i> with 1 species each. Out of the total species, 7 species i.e. <i>Drosophilaspinata</i>, <i>Hirtodrosophila neofascipennis</i>, <i>Mycodrosophila nigrosalula</i>, <i>Impatiophila quasigladiata</i>, <i>I. hexapseudorecta</i>, <i>I. curvacuminata</i>, and <i>I. tetraclavata</i> are described as new species to science and 3 species i.e. <i>Hirtodrosophila trivittata</i>, <i>Mycodrosophila poecilogastra</i> and <i>Zaprionus aungsani</i> as new records from India.</p> <p>In second section inter-specific variations were assessed in 3 mitochondrial genes viz., 16S rRNA, cytochrome c oxidase subunit I and II (COI and COII) in 18 drosophilid species viz., <i>Mycodrosophila poecilogastra</i>, <i>M. nigrosalula</i>, <i>M. gratiosa</i>, <i>Hirtodrosophila trivittata</i>, <i>H. sexvittata</i>, <i>H. fascipennis</i>, <i>H. neofascipennis</i>, <i>Drosophila spinata</i>, <i>D. gopinathi</i>, <i>D. bizonata</i>, <i>D. trizonata</i>, <i>D. novazonata</i>, <i>Lordiphosacoei</i>, <i>Impatiophila tetraclavata</i>, <i>I. quasigladiata</i>, <i>I. hexapseudorecta</i>, <i>I. curvacuminata</i>, and <i>Scaptodrosophila coracina</i>. On the basis of molecular evidences some species are described as new (<i>Drosophila spinata</i>, <i>D. gopinathi</i>, <i>Mycodrosophila nigrosalula</i>, <i>Impatiophila tetraclavata</i>) and some are recorded first time from India (<i>Hirtodrosophila trivittata</i> and <i>Mycodrosophila poecilogastra</i>). For these species mitochondrial genes (16S rRNA, COI, and COII) sequences are for the first time released to public domains through this study.</p>
Dr. Manisha Sarswat UGC-CSIR NET 2013 AIR-38	R.S. Fartyal	LZ-13036 & 23.03.2011	15.02.2016	<p>Altitudinal Variations on Morphology, Cytogenetics and Molecular Characteristics of Drosophilids of Garhwal Region</p>	<p>We explored the drosophilid assemblages along an altitudinal gradient from a few selected sites with habitats as varied as Tropical-Subtropical Forest zone, Subtropical-Temperate zone and Temperate-Subalpine zone to assess the diversity and distribution and its correlation as an indicator of habitat quality. Mid-elevations were the most equitable in terms of environmental conditions and available ecological resources, as they tend to produce mid-altitudinal peaks in diversity studies. We also illustrated altitudinal variation in several morphometric traits related to Head, Thorax, Wing and Leg apart from overall measurements for wing length, thorax length, wing width and body length in both the sexes of wild-caught populations of different species which were recorded abundantly at almost all altitude. For almost all of the traits population mean values have evident clinal increase along altitude, i.e. trait values increased for the populations from lower altitude to higher. The role of temperature along altitudinal gradient is quite compelling, hinting thermal stress has a strong effect on the phenotypic variation of these traits.</p> <p>We also explored the intra-specific variations in Nucleolar chromatin threads-NCTs in salivary gland chromosomes. Depending upon habitat conditions the morphology of the cell nucleolus and the chromatin threads was variable. Broadly categorising three main nucleolar morphologies were observed with all species sampled at lower elevations displaying distinct central fibrillo-granular structure, flanked greatly condensed masses of fibrillar material, corresponding to chromosomal heterochromatin and surrounded by clumps of nucleolus-associated chromatin. In harsh habitats at higher altitude stations the compact nucleolus was observed corresponding to an inactivated state of nucleolar activity. It comprised of a round central grainy structures, surrounded by a small electron-opaque layer of fibrillo granular material. At mid-elevations, a multilobed or reticulated nucleolar morphology was observed as in cells during exponential growth corresponding to the</p>

					<p>nucleolar expression of ribosomal RNA synthetic activity.</p> <p>We also assessed genetic variations in three mitochondrial genes, namely, 16S rRNA, COI and COII in 26 drosophilid species collected along altitudinal transect. Overall 543 sequences were generated, and almost all species were represented by 2–3 unique mitochondrial haplotypes, depicting a significant impact of environmental heterogeneity along altitudinal gradient on genetic diversity. Also for the first time, molecular data of some rare species like <i>Drosophila muktेश्वarensis</i>, <i>Liodrosophila nitida</i>, <i>Lordiphosa parantillaria</i>, <i>Lordiphosa ayarpathaensis</i>, <i>Scaptomyza himalayana</i>, <i>Scaptomyza tistai</i>, <i>Zaprionus grandis</i> and <i>Stegana minuta</i> was provided to public domains through this study.</p>
Dr. Pradeep Chandra Sati UGC-CSIR NET 2016	R.S. Fartyal	LZ-13035 & 08.04.2011	04.04.2016	Studies on the Systematics and Cytogenetics of Drosophilids in Different Habitats of Garhwal region	<p>Uttarakhand state situated in the central Himalayan Region of India encompasses tropical to alpine taxa, Garhwal Region is among the key components of the Himalayan hotspot with high conservation value and several disturbance threats. It could definitely be a potential arena for systematics, cytogenetics and evolutionary biology research. The present study on the systematics and cytogenetics of drosophilids in different habitat of Garhwal Region was an earnest attempt to record the drosophilid fauna of Garhwal Region of Uttarakhand.</p> <p>This study explored the drosophilid assemblages from Tropical- subtropical forest zone, subtropical- temperate zone and Temperate- subalpine zone. Collection sites were Mandal-Chopta forest, Srinagar- Chauras area, Gopeshwar- Banjari forest, Simli village forest (Nagad) and Tharali forest etc. Altogether 51 species representing 12 genera of the family drosophilidae were collected during the year August 2010 to February 2014, in which 15 species are new to science and 7 species are recorded first time from India. The present survey revealed 11 species of subgenus Sophophora, out of these <i>Drosophila gopinathi</i> was described as new species to science collected from Banjari forest of Gopeshwar. 8 species of subgenus <i>Drosophila</i> were collected in which <i>Drosophila immigrans</i> was cosmopolitan. <i>Drosophila teresae</i> and <i>Drosophila neoparakuntzei</i> were new species to science from this subgenus.</p> <p>Five species of subgenus Siphlodora recorded during this study, in which <i>Drosophila mandakini</i> was new to science. <i>Scaptodrosophila serrata</i> and <i>Scaptodrosophila similiensis</i> were new species to science from genus <i>Scaptodrosophila</i> collected during this study. Noticeable point is that all 5 species of genus <i>Hirtodrosophila</i> recorded during this study were either new species to science or new records. Other recorded genera were <i>Leucophenga</i>, <i>Lordiphosa</i>, <i>Zaprionus</i>, <i>Scaptomyza</i>, <i>Mycodrosophila</i>, <i>Dichaetophora</i>, <i>Phortica</i>, <i>Liodrosophila</i> and <i>Hypselothea</i>. In which 2 species from <i>Leucophenga</i>, 2 species from <i>Lordiphosa</i>, 1 species from <i>Phortica</i> and 1 species from <i>Hypselothea</i> were new to science. The chromosomal polymorphism in polytene chromosome of <i>Drosophila melanogaster</i>, <i>Drosophila repleta</i> and <i>Zaprionus indianus</i> were also carried out in this study.</p>

DEPARTMENT OF ZOOLOGY, BGR CAMPUS, PAURI GARHWAL

PhD awarded during 15.1.2009 to 31.12.2020

1	Name of Scholar	Deepesh Bhatt
	Name of Supervisor	Dr. Anoop K Dobriyal
	Date of Registration	05.02.2009
	Date of Ph.D. completion	08.04.2013 (Biotechnology)
	Topic of research	“Molecular cloning and <i>in-silico</i> characterization of ‘apx’ gene from “ <i>Eleusine coracana</i> ”
	Abstract in few words	<i>Eleusine coracana</i> (finger millet) is a stress-hardy but under-utilized cereal crop that possesses an efficient antioxidant defense system. However the plant is capable of enduring long durations of water deficit stress. The study presents the impact of drought stress on five finger millet varieties (PR202, VL146, VL315, PES400 and VR708), representing contrasting areas of Indian sub-continent. The obtained results indicate that better drought tolerance of the variety PR202 is positively related to the capacity of its antioxidant system to scavenge reactive oxygen species, resulting in a reduced incidence of oxidative damage. Ascorbate peroxidase:superoxide dismutase ratio is found to be a critical factor governing the stress tolerance potential of different varieties. Therefore, varieties PR202 and VL315 were found to be tolerant while PES400 was susceptible to drought stress. Therefore further experiments were conducted to clone a potent stress responsive isoform of ascorbate peroxidase from PR202 variety and validate its role under drought stress. Reverse transcriptase PCR was used to obtain the partial cDNA of <i>apx1</i> gene, from a meticulously screened drought tolerant genotype of <i>E. coracana</i> (PR202). Using RACE strategy, the full length <i>apx1</i> cDNA was cloned and sequenced. The cDNA length of the <i>E. coracana apx1 (Ec-apx1)</i> gene is 1,047 bp with a 750 bp ORF, encoding a 250 amino acid protein having a molecular weight of 28.5 kDa. The structure–function relationship of the protein was deduced by modelling a three-dimensional structure of <i>Ec-apx1</i> , on the basis of comparative homology using SWISS-MODEL. Real time PCR analysis of <i>Ec-apx1</i> expression at mRNA level showed that the transcript increased under drought stress, with maximum levels attained 5-days after imposition of stress. Our results suggest that <i>Ec-apx1</i> has a distinct pattern of expression and plays a pivotal role in drought stress tolerance.

2	Name of Scholar	Vikas Sharma
	Name of Supervisor	Dr. Anoop K Dobriyal
	Co-Supervisor	Dr Vikas Singh Jadon (SBSPGI Balawal)
	Date of Registration	06.10.2008
	Date of Ph.D. completion	27.03.2012 (Biotechnology)
	Topic of research	“ <i>In vitro</i> Rapid Mass Multiplication and Molecular Validation of <i>Swertia chirayita</i> ”.
	Abstract in few words	Recent global emphasis on exploitation of herbal resources and instances of patenting of developing-country

plants by developed countries emphasize the need to generate databases on indigenous medicinal plants which can be used for future reference. So, there is an urgent need to design a strategy for the conservation and improvement of these medicinally important plants and as well as to ensure a sustained supply of medicinally important herbs in the future. Thus the present research work is aimed to develop the efficient tissue culture protocol for the rapid mass multiplication of the endangered medicinal plant *Swertiachirayita* by standardization of various media composition for their best growth response. The protocol was optimized for reducing the concentration of plant growth regulators in the medium, at the same time attaining the maximum multiplication and rooting rate. The plant-microbe interactions under *in vitro* conditions were assessed to see the effect of microbes involved in the production of PGRs. For assessing the interactions, rhizospheric microbes of *Swertiachirayita* were isolated and characterized for production of PGRs and subsequent use of biohardening of *in vitro* raised plants. The *in vitro* propagated plants were further assessed through molecular markers for the validation of pure germplasm and detection of any existing somaclonal variation. This was aimed to detect and eliminate the variations persisting among the clonally propagated plant material. Thus based upon above mentioned views the protocol was aimed so that this important medicinal herb can be propagated on mass scale with clonal fidelity. The work also revealed conservation measures in natural zone of distribution of *Swertiachirayita* by mass production of clonal material with less extent of variability.

3	Name of Scholar	Nidhi Srivastava
	Name of Supervisor Co-Supervisor	Dr. Anoop K Dobriyal Dr Vikas Singh Jadon (SBSPGI Balawal)
	Date of Registration	06.10.2008
	Date of Ph.D. completion	06.10.2013 (Biotechnology)
	Topic of research	<i>In vitro</i> Rapid Mass Multiplication and Molecular Validation of <i>Aconitum heterophyllum</i>
	Abstract in few words	<p>In the present study, successful micropropagation of a critically endangered medicinal plant <i>Aconitum heterophyllum</i> Wall has been accomplished using low concentrations of plant growth regulators (PGRs) and molecular validation of the clonal stocks. The maximum rate of <i>in vitro</i> shoot multiplication was obtained on 1.0 × Murashige and Skoog (MS) medium containing 0.25 mg L⁻¹ Kinetin (Kn) plus 0.25 mg L⁻¹ Indole acetic acid (IAA). Up to 100% rooting was obtained 15 for shoots cultured on 1.0 × MS medium supplemented with 1.0 mg L⁻¹ IAA. Adding 0.25 mg L⁻¹ 2,4-dichlorophenoxyacetic acid (2, 4-D) to 1.0 × MS medium resulted in 100% callus formation, while adding 0.25 mg L⁻¹ IAA plus 0.25 mg L⁻¹ Kn to 1.0 × MS medium containing 0.25 mg L⁻¹ 2,4-D resulted in 100% generation of embryogenic callus.</p> <p>Various markers were used to validate the clonal stock <i>viz.</i>, Randomly Amplified Polymorphic DNA (RAPD), Internal Transcribed Sequence (ITS) & Inter-simple sequence repeat (ISSR) and analysis was carried out to check for possible somaclonal variation in the plantlets obtained after three consecutive subcultures.</p> <p>Using RAPD markers, <i>in vitro</i> raised shoot propagules were assessed for genetic analysis through cluster analysis along with the parental plants with <i>Aconitum balfourii</i> as an outlier and showed about 97% of similarity with the mother ex-plant of <i>Aconitum heterophyllum</i>, and thus show high uniformity throughout the stock cultures with various treatments of media components during multiplication, rooting and acclimatization.</p> <p>Of the 15 ISSR primers used, 10 were found to be monomorphic, with 95–98% similarity, and were used for</p>

		<p>cluster analysis by the unweighted pair group using arithmetic averages (UPGMA) method. The results revealed that in vitro-regenerated plantlets did not exhibit any genetic polymorphism.</p> <p>For ITS, PCR products were sequenced in the lab of Chromas Biotech Pvt Ltd., Bangalore by Automated DNA Sequencing Method. The result of sequencing was submitted to GenBank using Bankit program. The Bankit number of ITS sequences of <i>Aconitum heterophyllum</i> obtained are 1477523 and 1477528. A search for similar ITS region sequences from GenBank showed higher sequence similarity with the other species of the genus <i>Aconitum</i></p>
--	--	--

4	Name of Scholar	Maryada Goel
	Name of Supervisor	Dr. Anoop K Dobriyal
	Date of Registration	23.12.2008
	Date of Ph.D. completion	08.08.2014 (Biotechnology)
	Topic of research	“Studies on isolation, purification, kinetic characterization, and immobilization of alpha-amylase from some legumes of Garhwal Himalayan region”.
	Abstract in few words	Two legume varieties namely <i>Phaseolus vulgaris</i> HUR15 and <i>Dolichos biflorus</i> were studied. These legumes are native to the Garhwal Himalayas. The enzyme alpha amylase was extracted from these legumes; this extract was called as crude extract. Amylase assay was done using the Miller's method. Then anion exchange chromatography was carried out to purify the enzyme. Kinetic characteristics of the crude and purified extract were studied. Various parameters for kinetic study were optimum pH, optimum temperature, thermal stability, time, optimum substrate concentration, Km, and Vmax. A comparison between the two enzymes (crude and purified) was done. Then both enzymes were immobilized. The kinetic characteristics of the immobilized enzyme were also calculated. Enhancement in enzyme activity by about 200 times was observed in certain extracts. This study proved that there is a huge potential for research in the field of enzymes present in legumes. Using the above mentioned approach and biotechnology, these enzymes can be used in making biosensors. Just like amylase assay, kinase assay can be done. The immobilized kinase can be used in making biosensors for early detection of blood cancer.

5	Name of Scholar	Rattan Deep Singh
	Name of Supervisor	Dr. Anoop K Dobriyal
	Co-Supervisor	Dr Aradhna (SBSPGI Balawal)
	Date of Registration	25/02/2009
	Date of Ph.D. completion	19.05.2014 (Biotechnology)
	Topic of research	Evaluation of in-vitro digestibility, Hemagglutinating activity and characteristics of Alpha-amylase inhibitor: A Study of selected <i>Phaseolus vulgaris</i> cultivars of Uttarakhand
	Abstract in few words	<p>Diversity and versatility of beans make them an extremely beneficial legume crop which can provide nutrition, antioxidants and reduce the risks of many diseases. Thus the exploration of the properties of bean cultivars of Uttarakhand will contribute towards the protection and improvement of this important crop of the region. The proposed work is original and extremely relevant because no work has been done so far to analyze the nutritional value based on digestibility and the presence of nutraceuticals components of the common bean cultivars; therefore, the present study will be useful in promoting their cultivation and marketing.</p> <p>The purpose of this work was to investigate the nutritional potential of kidney bean (Protein content, carbohydrate content, Total phenolic content) and to study the effects of processing methods (cooking and dehulling) on the reduction/elimination of antinutritional factors in kidney beans thereby improving the digestibility of beans. The present study was also carried out to determine various physio-chemical characteristics of lectins and α-amylase inhibitor. This would help determine simple and cost-effective processing options for developing countries in order to make use of all the nutritional values of the beans.</p>

6	Name of Scholar	Shashi Yadav
	Name of Supervisor	Dr. Anoop K Dobriyal
	Co Supervisor	Dr Neeraj Sood (NBFG, Lucknow)
	Date of Registration	25.02.2009
	Date of Ph.D. completion	Viva conducted in 2016 (Biotechnology)
	Topic of research	“Isolation and genetic characterization of <i>Aeromonas</i> spp. from aquatic environment”.
	Abstract in few words	The thesis entitled, “ Isolation and genetic characterization of <i>Aeromonas</i> sp. from aquatic environment” embodies the work conducted with the objectives: i) To isolate and identify <i>Aeromonas</i> spp. from aquatic environment, ii) To characterize <i>Aeromonas</i> species by molecular techniques , iii) To detect potentially pathogenic <i>Aeromonas</i> species by amplification of virulence genes and iv) To study the pathology and pathogenesis of experimentally induced aeromoniasis with representative isolate. The present study highlights that water and fish samples are potential sources of motile aeromonads with virulence potential and can cause disease in fish and humans whenever, the conditions are favourable. PCR-RFLP analysis of

		16S rRNA and sequencing of the 16S rDNA gene proved to be rapid and powerful method for identifying isolates of <i>Aeromonas</i> to the species level. Rep-PCR provides powerful and convenient tool to analyze <i>Aeromonas</i> diversity and genetic relativity among the strains of <i>Aeromonas</i> spp. isolated from various regions. Further clinical findings with gross and histopathological alterations in tissues of rohu juveniles following experimental infection with <i>A. hydrophila</i> suggest an acute septicemic condition and these findings appear to be fundamentally similar to the findings in natural cases and experimentally induced <i>A. hydrophila</i> infection in other fish species.
--	--	--

7	Name of Scholar	Mohd Rashid
	Name of Supervisor	Dr. Anoop K Dobriyal
	Date of Registration	12/03/2013
	Date of Ph.D. completion	10/07/2020 (Zoology)
	Topic of research	Fish Biology of <i>Mastacembelus armatus</i> (Lacepede) From River Nayar, Garhwal Himalaya, Uttrakhand
	Abstract in few words	The thesis deals with the fishery biology of an important hillstream fish <i>Mastacembelus armatus</i> (Lacepede) from river Nayar of Garhwal Himalaya. Study conducted was on the morphometric and meristic characters of the fish, length weight relationship and relative condition factor, feeding behaviour of fish, its feeding preferences and seasons of better feeding through gastro somatic index, relative length of gut and feeding preference indices. Reproductive biology of the fish was also studied which included the maturation of gonads, season and size of fish at maturity, spawning tendency, month of spawning and breeding potential. Fecundity was statistically correlated with different body parameters. Age and growth of fish was also determined by scale and length frequency distribution method. Study summarises as it is a carnivore fish spawns during monsoon with low fecundity and having a life span of about 4 years. The ecology of stream was also analysed in view of feeding and spawning grounds of fish.

8	Name of Scholar	Mohd Sagir
	Name of Supervisor	Dr. Anoop K Dobriyal
	Date of Registration	17-04-2014
	Date of Ph.D. completion	10-06-2020 (Zoology)
	Topic of research	EFFECT OF VEGETATION ON BENTHIC COMMUNITIES OF RIVER WESTERN NAYAR.
	Abstract in few words	<p>Garhwal Himalaya is gifted with many lentic and lotic water bodies in the form of rivers, streams, rivulets, lakes, reservoir, ponds etc. Western Nayar River is one of the important spring-fed rivers of Garhwal Himalaya. The present study on “Effect of vegetation on benthic communities of Western Nayar River” is aimed at to attain the following objectives:</p> <ol style="list-style-type: none"> 1. Qualitative study of Riparian vegetation at selected spots (i- <i>Quercus</i> tree dominated area, ii- <i>Pinus</i> tree dominated area, iii- Herbs and Shrub dominated area, iv- Toxins producing plants covered area.). 2. Biomass estimation of Detritus standing stock at each spot throughout the year. 3. Monthly and seasonal density and diversity of periphytic and macrozoobenthic communities at each spot. <p>This hypothesis was conceived with an idea of how the riparian vegetation can have a bearing on river productivity. In fact the vegetation around River Nayar contributes significantly in soil conservation, productivity and aquatic biodiversity. The present study also suggests that the riparian vegetation directly or indirectly helps the aquatic fauna for feeding, breeding and spawning.</p> <p>The results of this study reinforced assertions that riparian-reach variables influence macroinvertebrate structure and functions less than land use catchment variables. The macroinvertebrates showed the strong relationship with leaf litters of <i>Quercus</i> than <i>Pinus</i>. The results reflected that the importance of litter as a source of food and total densities of macroinvertebrates of major taxa were greater in leaf litter of <i>Quercus</i>. This indicates that the palatable litter, which served mainly as a food source thus supported high densities of macroinvertebrates. Contrarily lower densities of macroinvertebrates associated with litter of <i>Pinus</i> indicated lesser palatability of its leaf and therefore may be useful as a substrate. This result reflects the fact that leaf litter in a subtropical stream may serve as food or substrate for macroinvertebrates</p>

9	Name of Scholar	Koshal Kumar
	Name of Supervisor	Dr C B Kotnala
	Co supervisor	Dr Anita Rawat (Govt PG College Rishikesh)
	Date of Registration	11 March 2013
	Date of Ph.D. completion	21 Nov 2017 (Zoology)
	Topic of research	Biology of freshwater prawn <i>Macrobrachium</i> Species (Bate 1868) from Rawasan Stream of Garhwal Himalaya, Uttarakhand”.
	Abstract in few words	The study on the biology of freshwater prawn was carried out in Rawasan stream which is geographically bounded by 29°55'33.82"N and 78°26'42.41"E in Yamkeshwar block of Pauri District. Five sampling sites were selected on the basis of altitudinal variation for the collection of specimens i.e., Narikatal (S1), Jarpani (S2), Seela (S3), Pupaldanga (S4), and Madhan (S5). Monthly analysis of selected nine physicochemical parameters at five selected sites of Rawasan stream has been studied, because the ecological factors play an important role in the survival of prawn fauna and other invertebrates population in a particular ecosystem. Collected specimens of prawn were identified as <i>Macrobrachiummassamensepeninsulare</i> with the help of keys to genera of <i>Macrobrachium</i> (Tiwari 1958) and sexual dimorphism was reported in this species. Food and feeding habits of the prawn were studied on the basis of qualitative and quantitative analysis of gastric mill and foregut contents and it was observed that prawn was an omnivorous species and exhibits feeding activity in the day time in comparison to the other species. The breeding biology of the specimens was also investigated to know their breeding season and fecundity. No special trend was found in the sex ratio, considered to be a normal population show a slight dominance of female over male population and observed a fecundity of 13-102 eggs. The present study is significant as it will provide important information on the population, diversity, and biology of this crustacean (Prawn) in the stream of Garhwal, Uttarakhand. The study will also be able to create fresh interest in the fishery department toward conservation and culture of prawn fishery in the region.

10	Name of Scholar	B. S. Kathait
	Name of Supervisor	Dr M S Bisht
	Date of Registration	(HNBGU/Res.21434)
	Date of Ph.D. completion	28.01.2009 (Zoology)
	Topic of research	Habitat ecology and behaviour of Cheer pheasant (<i>Catreus wallichii</i>) in Garhwal Himalaya
	Abstract in few words	For the first time an extensive and intensive study has been conducted on a very rare, monotypic threatened Cheer Pheasant <i>Catreus wallichii</i> (Gray) in Garhwal Himalaya, Uttarakhand to collect the information on distribution, habitat characteristic and use, roosting habits, food and feeding habits and breeding biology. In the district Chamoli and Pauri Garhwal, this game bird was sighted in 19 sites for the first time between altitude ranges 1950-2100m with density of 2.78 birds/km ² area. This pheasant was found inhabiting in steep rugged chir pine (<i>Pinus roxburghii</i>) and long grass covered slopes as 75% sightings were recorded from these habitats. It was found roosting on the trees of 6-15 meters with 80-90% canopy cover, feeding on seeds, flowers, buds, roots and tubers of the plants (mostly of the family Fabaceae) and insects preferably of the order Diptera. Cheer breeds in May-June, nests on open ground having less than 70% grass/litter cover, lays 4-12 eggs. Breeding success was recorded very low (41.67% only) and anthropogenic factors were recorded most effective.

11	Name of Scholar	Suneet Kumar
	Name of Supervisor	Dr M S Bisht
	Date of Registration	31/10/2007
	Date of Ph.D. completion	30/7/2012 (Zoology)
	Topic of research	Some aspects of population and feeding ecology of Kaleej pheasant <i>Lophura leucomelanos hamiltonii</i> (Gray)
	Abstract in few words	Keeping in view the importance of most common game bird the White crested kaleej pheasant <i>Lophura leucomelanos hamiltonii</i> (Gray), studies were under taken in Pauri and Chamoli district of Garhwal on distribution, current status, population structure (density, group size and male female sex ratio in different months and seasons), habitat ecology and use pattern, roosting habits, breeding behaviour and feeding habits. In comparison to earlier records this important game species was found in few sites with small numbers despite ban on hunting in the country.

12	Name of Scholar	Sunil Bhandari
	Name of Supervisor	Dr M S Bisht
	Date of Registration	06/11/2008
	Date of Ph.D. completion	19.12.2012
	Topic of research	Studies on the community structure of avian fauna in relation to distribution of invasive vegetation in Garhwal Himalaya
	Abstract in few words	Alien vegetations are emerging as threat to biodiversity and environment in Himalaya too. Three invasive weeds namely <i>Lantana</i> , <i>Parthenium</i> and <i>Eupatorium</i> have made their presence in the biodiversity rich Utrakhand. In this dissertation distribution, magnitude and effects of exotic and invasive on native flora and fauna has been studied in different localities and habitats along an altitudinal gradient (500-2500m). A through long term intensive study has been conducted on effects of invasive vegetation (lantana, parthenium and eupatorium) on distribution, abundance, communities' structure and density of the birds.

13	Name of Scholar	Ms Suman
	Name of Supervisor	Dr M S Bisht
	Date of Registration	26/11/ 2008 (HNBGU/Res/22773)
	Date of Ph.D. completion	26/9/2013 (Biotechnology)
	Topic of research	Studies on attributes of Probiotics and development of symbiotic yoghurt.
	Abstract in few words	The research work was focused on characterization of different attributes of probiotics for the development of synbiotic (a mixture of probiotics and prebiotics) yoghurt, which may improve intestinal survival and implantation of the live microbial supplement. The compatibility of probiotic <i>L. acidophilus</i> strains with yoghurt cultures was evaluated to select the suitable combination of strains. The detection of bacterial interaction between yoghurt cultures and probiotic strains was carried out using well-diffusion agar assay. After selecting the starter culture combination both prebiotics viz., honey and inulin at different concentrations, were evaluated for the probiotic and functional attributes of the two strains of <i>Lactobacillus acidophilus</i> to assess them comparatively. Various probiotic attributes checked were antimicrobial activity against indicator organisms (<i>E. coli</i> , <i>E. faecalis</i> , <i>S. typhimurium</i> and <i>S. flexneri</i>), tolerance to low pH (1.5, 2.5 and 6.5), bile toxicity (1 and 2% conc.) and lysozyme concentrations (0 and 100 ppm conc.). And the functional attributes checked were the adherence properties (autoaggregation, coaggregation with <i>E. coli</i> , autolysis and cell surface hydrophobicity) and β -galactosidase activity. After checking effectiveness of both the prebiotics against the probiotic strains, a suitable prebiotic is selected and symbiotic yoghurt was prepared.

14	Name of Scholar	Sudesh Kumar
	Name of Supervisor	Dr M S Bisht
	Date of Registration	17.4.2014
	Date of Ph.D. completion	20/6/2020 (Zoology)
	Topic of research	A study on Avian ecology of temperate forests of Garhwal Himalaya (Western Himalaya) Utrakhand.
	Abstract in few words	Keeping in view importance of the temperate forests of Himalaya (because more than 70% population of the hill area live in the middle range of altitude and depends on their daily needs on oak, rhododendron, deodar, abies, ringal bamboo etc) study has been carried out on the temperate forests with reference to ecology, bird richness and their community structure, feeding guild structure, nesting ecology and role of anthropogenic activities. During the study, individual record 152 birds on richness, abundance, micro-habitats, feeding habits and nesting behaviour at various sites of district Pauri Garhwal, Utrakhand was maintained.