CHAPTER 18

ENVIRONMENTAL STUDIES

Doctoral Theses

01. KARMAKAR (Swagata)
Spatially Heterogeneous Soil Environment of Mined Habitat Drives Interaction Patterns in Phage and Bacterial Communities.
Supervisors: Prof. RadheyShyam Sharma and Dr. Vandana Mishra
Th 23349

Abstract
(Not Verified)

Microbial technologies play a significant role in the restoration of abandoned mines. However, selection pressure from bacteriophage leads to bacterial inoculation failure. Therefore, the presentthesis investigates the phage bacterium interaction patterns in spatially differentiated microbial communities of abandoned mines. Bacterial and phage communities were purified from soils sampledfrom three microhabitats of Bhatti mine; and different soil particle size fractions, gravel, sand, silt andclay, of the mine spoil. The interaction patterns between the phage and bacterial communities wereanalyzed as phage infectivity, phage latent period, bacterial resistance, potential lysogeny andbacterial autoplaque phenomenon. The study deciphered that despite phylogenetic closeness, thespatially distributed bacterial communities differed in co-evolutionary parameters. However, thepresumably diverse phage communities were quite similar. The phage and bacteria showed anasymmetric coevolution due to the heterogeneous microenvironment. Therefore, the phagecommunities tend to be a generalist, whereas the bacterial communities tend to be a specialist andcolonize all possible ecological niches. The EDX-SEM analyses showed a significant difference(p<0.05) in heavy metal loadings of the different soil particles, i.e., gravel, coarse sand, fine sand,coarse silt, fine silt and clay. Based on the heavy metals loading of different soil particles, wesuggested three designs criteria for improving filter fences for mine management. Based on theevidence on the role filamentous phage influencing the ecological fitness of host bacteria and ability todisplaying targeting peptides/proteins on the surface of phage, we suggest the role of filamentousphage in influencing the ecological and evolutionary potential of bacterial inoculants for facilitatingplant growth. Also, we suggest the role of filamentous phage to develop real-time label-free andultrasensitive biomonitoring methods to track inoculants, pathogens, contaminants in the environment.The present study would be useful to improve the microbial technologies for ecological restoration ofdegraded ecosystems.

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application of filamentous phages in the context of environmental restoration 7. Summary and conclusions. References.List of publications.

02. KUMAR MANISH
Macro-Ecological Patterns and Drivers of Himalayan Plant Species Diversity and Distribution Through Ages.
Supervisors: Prof. Maharaj K. Pandit
Th 23351

Abstract
(Not Verified)

The Himalaya represents the youngest and the highest mountain chain of the World; it is also referredto as the water tower of Asia and roof of the World. It harbours nearly 10,000 plant species, 4000 plantendemics and approximately 2.5% of the global plant diversity. However, to start with, Himalaya wasdevoid of any native plant diversity. The results in this doctoral study points towards a positivecoincidence between the diversification of endemic plant taxa and changes in geo-physicalcharacteristics and climate in the Himalayan region. In particular, the monsoon system is postulated tohave played the most dominant role in the evolution of endemic taxa in the region. It was also found inthis study that plant species richness patterns and phylogenetic diversity patterns are hump–shaped,spatial scale dependent and growth form specific. Endemics peaked at higher elevations than non–endemics across all growth forms (trees, shrubs, climbers, and herbs). Species composition andassemblage at higher elevations are determined by process of ecological filtering, while at mid or lowelevations, interspecific competition between species determines their presence. When currentspecies distribution patterns were analyzed under future climate change scenarios, it was found thatabout 17% and 18% of endemic plant species were likely to lose their potential habitat by 2050 and2070, respectively. Meadows may likely lose about 1% and 3% of their current geographical spread to shrublands by 2050 and 2070, respectively. The results also revealed that priority conservation areaswere best located at mid and high elevations in the Himalaya under future climate change scenarios. Itwas also revealed that in order to mitigate the effects of ensuing climate change in the region, a singlelarge Protected Area with wide geographical and elevational extents be established instead of severalsmaller Protected Areas.

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03. MALHOTRA (Sarthak)
Environmental Predictors of Functional Diversity of Microbial Communities at Contaminated Sites.
Supervisors: Prof. RadheyShyam Sharma
Th 23350

Abstract
(Not Verified)

Restoration of degraded and contaminated ecosystems is the key strategy for sustainable development.Ecological theories provide guidelines to restore the contaminated sites. Degraded ecosystems areemerging ecosystems, which provide new opportunities to evolve and test ecological theories for restorationand management of degraded lands. Therefore, the present thesis investigates the environmentalpredictors of functional diversity of rhizobacterial communities of wild grasses naturally colonizing fly ashdumps and Bhatti abandoned mine. Rhizosphere and bulk ash and soil were characterized for geochemicaltraits. Based on multivariate analyses, we showed NO -N,

PO -P, pH, Fe, and Na as the majorenvironmental predictors of functional diversity of rhizobacterial IAA producers of *S. ravennae*and *C.dactylon*colonizing fly ash environment. We propose N or P amendment to stimulate rhizobacterial IAAproducers and facilitate the spread of *S. ravennae*and *C. dactylon*, respectively. Such a biostimulationapproach based on plant-soil feedback process would serve as a nature-based solution for vegetationrestoration at fly ash dumps. The study also provided evidence on the crucial role of PO -P and NO -N (*C.ciliaris*) and Cu (*S. munja*; *C. setigerus*) along with pH (bulk), Mg and K (*C. setigerus*) in driving functionaldiversity of IAA producers at different topography of abandoned mine. These predictors are useful todevelop topography-based ecological restoration programme. The also revealed environmental predictorsfor diazotrophs of *S. ravennae*(Fe, NO -N, and % organic matter) and *C. dactylon*(PO -P), which would beuseful to develop specific microbe-assisted phytoremediation and revegetation of ash dumps. Based onstudies on plant strategies to compete at the ash dumps, we recommend *S. ravennae*for phytostabilizationand *C. dactylon*for phytoextraction and decontamination of ash dumps. We provided ecological theorybasedguidelines for environmental restoration of fly ash dumps of thermal power plants and abandonedmines.

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04. MISHRA (Ruchi)
***Viscumarticulatum* Extract and its Ribosome Inactivating Protein Trigger Apoptosis in Leukemia Cell Lines..**
Supervisors: Dr. Vandana Mishra
Th 23348

Abstract
(Not Verified)

Bioprospecting contributes to achieving the ecological and socio-economic securities. It uses ecological, evolutionary and ethnobotanical approaches to identify the novel products, processes orwhole organisms from nature for human well-being and improve the environmental health. *Viscumarticulatum*(leafless mistletoe) has been widely used in traditional system of medicines of India, China,Nepal, Vietnam, and Taiwan, especially for the treatment of inflammatory and blood diseases. I usedethnobotanical and evolutionary approaches and (i) provided scientific evidence to the efficacy oftraditionally used *Viscumarticulatum*aqueous abstract to control leukemia cell lines; and (ii) elucidatedthe molecular mechanism of its ribosome inactivating protein or RIP (Articulatin-D) to trigger apoptosis.The study showed that VAQE triggered cytotoxic effect on Jurkat and THP1 cells in a dose- and timedependentmanner. The apoptosis induction and arrest of the cell cycle at G2/M are the primarycauses of VAQE-induced cytotoxicity in leukemia cells. The purified ribosome inactivating protein of *V.articulatum*(Articulatin-D) is cytotoxic and triggers apoptosis in leukemia cell lines. Elevation of mitochondrial membrane potential and exposure of phosphatidylserine are the early events ofapoptosis induction. The study provided evidence that Articulatin-D activates caspase-8 involvingextrinsic pathway of apoptosis. Furthermore, a novel lectinaceous RIP from *V. articulatum*(Articulatin-G) has also been purified. This isoform of RIP possessed multifunctional enzymatic activities, such assuperoxide dismutase, chitinase, and topoisomerase which suggest the potential role of Articulatin inplant defense against abiotic and biotic stresses. Finally, a perspective is evolved on potential use ofRIPs in development of stress tolerant transgenic plants for ensuring the food and environmentalsecurities. The present study would be useful to

develop novel chemotherapeutic agent from *V.articulatum*to treat leukemia. The report of a multifunctional isoform of RIP and the perspectiveevolved would be useful to bioprospect RIP for environmental security.

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1. Review of literature to establish the pharmacological significance of ribosome inactivating proteins (RIPs)2. To generate empirical evidences to conform the anticancer potential viscumarticulatum aqueous extract (VAQE) used in traditional system of medicine to cure leukemia 3.To unravel the mechanism of anticancer activity (apoptosis) of purified RIP (Articulation – D) of Viscumarticulatum on leukemia cells 4. To demonstrate multifunctional properties of lectinaceous isoform of articulation for environmental application 5.To evolve perspective on ribosome inactivating protein as a potential transgene to develop stress tolerant plants. Summary and conclusions. References. Appendix.

05. TIWARY (Nawin Kumar)
Modelingnest Survival and Habitat Utilization in Painted Stork (Mycterialeucocephala) Colonies of North India.
Supervisors: Dr. Abdul Jamil Urfi
Th 23347

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1. General Introduction 2. Literature Review 3.Distribution of panted stork (Mycterialeucocephala) nesting colonies 4. Nest survival in painted stork (Mycterialeucocephala) colonies of North India 5. Occupancy of painted storks (Mycterialeucocephala) in relation to their habitats 6. General conclusions. References. Appendices.