

## CHAPTER 18

### ENVIRONMENTAL STUDIES

#### Doctoral Theses

01. ANUPAM SUNNY

**Interactions of Insects with Native and Non-Native plants.**

Supervisor: Dr. Swati Diwakar

Th 24475

*Abstract  
(Verified)*

I investigated the arthropod abundance, richness, biomass, herbivory damage and preference of native insects on abundant native and non-native plants across various sites in India. Abundance and richness of arthropods were quantified on the basis of arthropod trophic guilds (herbivores, predators and detritivores) and plant taxonomic relatedness. Taxonomically close related native (*Plectranthus mollis*) and non-native (*Hyptis suaveolens*) plant species and taxonomically distant native (*Justicia adhatoda*) and non-native (*Lantana camara*) were investigated for the comparison. A total of 2,697 arthropods were estimated belonging to 14 taxonomic orders. Similar level of herbivore assemblages were observed on taxonomically distant and close related native and non-native plants. Predator abundance was found to be more on non-native *H. suaveolens* than native *P. mollis*. Similar observations were made for distant non-native *L. camara* and native *J. adhatoda* indicating the importance of plant relatedness and role of arthropod trophic guilds especially predators increase/decrease on non-native plants. Further my study also found that there was similar level of arthropod biomass and damage on co-occurring native- *J. adhatoda* and non-native- *L. camara* plant species. My dissertation work also investigated the preference of native insect, *Oecanthus indicus* on non-native *L. camara* and *H. suaveolens* based on their call character and calling site. Chirp duration and chirp repetition rate of *O. indicus* singing on *H. suaveolens* was found to be different than that of native *J. adhatoda*. Also, *O. indicus* choose non-native *H. suaveolens* leaves extensively as a site to baffle (36.84%) as compared to other plants. The study suggests that future research relating arthropods assemblage on native and non-native studies should employ factors of plants (chemical constituent of leaves, nectar chemistry, and flower colour etc. and insect traits (insect body size, diet breadth, oviposition sites and egg characteristics) to achieve a holistic view of the entire interaction.

*Contents*

1. Native insects and invasive plants encounters 2. Lavish or mixed bag: Arthropod assemblages on native and non-native plant species 3. Arthropod biomass and damages on co-occurring native (*Justicia adhatoda*) and non native (*Lantana camara*) species 4. Singing preference of *Oecanthus indicus* on native and non-native plants. Conclusion and future directions. References. Appendices. List of publication.

02. GARG (Abhinav)  
**Pollutants in Urban Indoor Environment and their Impacts on Human Health.**  
 Supervisor: Dr. Chirashree Ghosh  
Th 24474

*Contents*

1. General Introduction 2. Air pollution scenario in urban delhi: Establishment of the study site 3. Qualitative variation in indoor air quality at different social-economic zones in urban delhi 4. Qualitative analysis of indoor air quality at different socio-economic zones in urban delhi 5. Impact of indoor air quality on human health. Conclusion and recommendations.

03. SANWAL (Urvashi)  
**Litter Chemistry, Soil Processed and Plant Community Structure.**  
 Supervisor: Prof. Inderjit Singh  
Th 24477

*Abstract*  
*(Not Verified)*

In this dissertation the interaction of plant chemicals, soil processes and plant communities was studied in context of non-native and native species in different communities of arid (Rajasthan) and mid-montane temperate (the southern Western Ghats and the central Himalaya) ecosystems. A series of experiments showed Sorghum halepense impacts soil properties and plant growth. Growth of assay species in S. halepense root or shoot leachate-amended soil was linked to lower available nitrogen, which may be mediated by soil phenolics. To further investigate the links amongst litter chemistry, soil processes, nitrogen availability and plant community structure, a study was carried out in a temperate forest in the Nilgiris, Udthagamandalam, Tamil Nadu. In general, Acacia dealbata and Acacia mearnsii invaded areas had lower above ground species biomass than un-invaded areas, but such invasion effects were not recorded in Almora, Uttarakhand confirm region specific variation in invasion impacts (Chapter 2). Further studies carried out in Nilgiris revealed that introduced species, A. dealbata, A. mearnsii, Eucalyptus globulus, Pinus roxburghii, A. melanoxylon formed distinct undercanopy community structure (Chapter 3), which is explained by litter condensed tannin, its influence on soil nitrogen forms and under canopy soil properties. A. mearnsii and A. dealbata experienced positive feedbacks when grown with soil inoculum of abovementioned tree species and open areas. Another study in native ecosystems in Chamba, Uttarakhand illustrated distinct understory composition under canopies of P. roxburghii and Q. leucotrichophora-R. arboreum and is correlated to soil NO<sub>3</sub>-N and pH in April and soil NH<sub>4</sub><sup>+</sup>-N in December (Chapter 4). The work included in the dissertation validates the hypothesis that soil nitrogen availability is influenced by litter chemistry and ecosystem characteristics and provides empirical evidence on its impact on plant community structure. This work demonstrates commonalities in drivers of plant community structure in native and introduced communities.

*Contents*

1. Introduction 2. Invasion impact of acacia dealbata and acacia mearnsii 3. Tannin producing introduced tree species: Litter chemistry, soil processed and plant community structure 4. Pine and oak rhododendron communities 5. Plant chemistry and nitrogen availability in sorghum halepense invaded soils. Summary. Abstract. References. List of publication and conference contribution.

04. SAVITA  
**Bioprospecting of Prosopis Juliflora for Peroxidases to Remediate Phenolics from the Environment.**  
 Supervisor: Dr. Vandana Mishra  
Th 24476

*Abstract*  
*(Not Verified)*

Phenolics, an essential component and by-product of several industries deteriorate the environment and human health. Remediation of phenolic contaminated environment is essential for sustainable development. Enzymes like peroxidases are a feasible and eco-friendly alternative because of their versatility and stability to different physicochemical conditions. However, their high purification cost from crop plants and tendency to inactivation by reaction by-products limit their large-scale implementation. *Prosopis juliflora*, a world's worst invasive plant produces several negative ecological impacts. Identifying alternate uses of different parts of *P. juliflora* is one of the strategies for managing it in the environment. So, we undertook the present research on 'Bioprospecting of *Prosopis juliflora* for peroxidases to remediate phenolics from the environment' in order to investigate the potential of low purity peroxidase from *Prosopis juliflora* (MPx) to remediate and detoxify phenolics from soil and water. We found, that the MPx is more efficient than Horseradish peroxidase (HRP) over a wide range of pH (2.0–9.0), temperature (up to 80°C), with a lower enzyme unit (0.3U/ml) and residence time (30 min). Further, root elongation and plant growth bioassays confirmed that significant toxicity reductions were achieved for all phenolic compounds after MPx treatment. MPx also exhibited high potential to remedify and detoxify phenolic contaminated soils, and restore soil enzyme activities and promote plant growth. Further, we evaluated the relative efficacy of MPx and HRP in restoring phenol contaminated soil and water matrices of the environment. In conclusion MPx shows superiority over HRP in phenol removal from soil and water. The complexity of MPx and phenol interaction in soil matrices results in a differential effect on the phytotoxic potential of soil and water after MPx treatment. MPx has potential to be a suitable candidate for large-scale remediation projects.

*Contents*

1. Introduction 2. Bioremediation of phenolics from environment: Current status, challenges and opportunities 3. Phenol remediation by peroxidase from an invasive mesquite: Turning an environmental wound into wisdom 4. Using peroxidases from invasive species acts as biological thaumaturges for restoring fertility of phenolic contaminated soil 5. Comparative analysis of the efficiency of peroxidases from mesquite and horseradish to remediate phenol from different environmental phases. Summary and conclusion. References. Appendix. Publications and conferences.

05. SHARMA (Saurabh)  
**Evidence on Environmental Roots of Non-Communicable Diseases and Putative Mechanism of Phytochemical-Based Cure.**  
 Supervisor: Dr. Vandana Mishra  
Th 24745

*Abstract*  
*(Not Verified)*

Non-communicable diseases (NCDs) like breast cancer (BC) and cardiovascular diseases (CVDs) accounting for >60% of mortality and morbidity due to NCDs, have emerged as major challenges of human health of the world. Genetic, diet-, and life-style factors govern NCDs, however the exponential rise of NCDs indicate their roots in environmental health, which needs better insights. Modern medicines have though increased life-span of patients of BC and CVDs but triggers secondary

ill-health effects; however phytotherapy-based cure or adjuvant therapy may serve as safe alternatives provided we unravel the mechanism, phytochemical involved and its therapeutic target in the cellular pathway. We demonstrated that breast cancer patients carry pesticides in blood at levels higher than the healthy controls. Bioinformatics analysis revealed the endocrine disrupting mechanism of pesticides. Population-based studies showed that case group with metabolic syndrome coupled with history of miscarriages exclusively show increased expression of TTR. Networking analyses suggest cross talk between the four dysregulated proteins, (HP, TF, ApoA1, and TTR), which explains links between miscarriage history and MeS. Bioinformatic studies demonstrated potential of targeted phytochemicals as an alternate to synthetic anticancer drug to protect activity of targeted hormone. Bioinformatics analyses confirm one of the targeted phytochemicals as a potent anti-inflammatory and anti-tumorigenic agent influencing STAT3 dependent carcinogenesis. Cell culture studies confirm cytotoxic potential of selected phytochemical in breast cancer cells at ultra low levels. Based on systematic review we provided evidence on mistletoe-based phyto-therapy for cancer specifically via regulating inflammatory pathways. We demonstrated leaf-less mistletoe varies in anti-oxidant and anti-cancer potential as it differ in the tree host species. Our study unravels the environmental roots of breast cancer and metabolic syndrome via identifying their molecular links with environmental toxicants or environmental quality. Improving human health via environmental protection and phytochemical-based cure would ensure sustainable health.

### *Contents*

1. Introduction 2. Environmental toxicants and breast cancer: Putative role of pesticides in endocrine disruption 3. Aggregation of transthyretin (TTR) in plasma and potential of phyto-chemicals to inhibit TTR aggregation 4. Therapeutic potential of phyto-chemicals for controlling breast cancer via inhibiting interleukin-6-mediated STAT3-dependent pathway of carcinogenesis 7. Protein signature linking history of miscarriage and metabolic syndrome leading to cardiovascular disease, an emerging non-communicable disease 5. Mistletoe based phyto-therapy for cancer via regulating inflammatory pathway: A systematic review to unravel molecular targets 6. Evidence on phytochemical-based therapeutic potential of leafless mistletoe (*Viscum angulatum*) to control breast cancer 7. Variation in anti-oxidant and anti-cancer potential of leafless mistoe (*Viscum angulatum*) parasitic on different host tree species. Summary and conclusion. References. Appendices. Publications and conferences.

06. SHILPI

#### **Bioremediation of Nitramine Explosives (RDX & HMX) Using Native Microbes.**

Supervisor: Dr. Charu Dogra Rawat

Th 24472

#### *Abstract (Verified)*

In this report, aerobic biodegradation of Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), highly explosive chemicals by *Arthrobacter chlorophenolicus* strain S5-TSA-26, *Microbacterium esteraromaticum* strain SL1-DS-TSB-4, *Pelomonas aquatica* strain WS2-R2A-65 and *Planomicrobium flavidum* strain S5-TSA-19, isolates from explosive-contaminated soil and water, were investigated. The isolates S5-TSA-26, SL1-DS-TSB-4, WS2-R2A-65 and S5-TSA-19 degraded 87%, 89.9%, 86 % and 81.5 % of RDX and 90 %, 80 %, 78 % and 70% of HMX in 20 days during which time nitrite ions were produced. The release of nitrite was followed by the subsequent formation of metabolites, viz. Methylenedinitramine (MEDINA), CH<sub>4</sub>N<sub>4</sub>O<sub>4</sub> with MW 136 Da and N-methyl-N,N'-dinitromethanediamine, C<sub>2</sub>H<sub>6</sub>N<sub>4</sub>O<sub>4</sub> with MW 149, dinitroso derivative hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine (DNX) with MW 190

and trinitroso derivative hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX) with MW 174. Isolates S5-TSA-26, SL1-DS-TSB-4 and S5-TSA-19 follows both reduction and denitration for RDX degradation whereas isolate WS2-R2A-65 follows only denitration, while for HMX degradation all four isolates follows single path of denitration. Methylenedinitramine and N-methyl-N,N'-dinitromethanediamine were formed following denitration and reduction corresponds to the formation of nitroso products, DNX and TNX. All isolates under study remains unaffected by the toxic environment of RDX and HMX which is evident from the retention of shape and size of the bacteria in presence of nitramine explosives as depicted by SEM images. Apart from being the first report of RDX and HMX degradation by these isolates, this work also provides the evidence that the strains under study removed the nitramine contaminants by cometabolism. The bacterial isolates under study not only tolerated the high concentrations of RDX and HMX but successfully removed significant amount of them by cometabolism.

#### *Contents*

1. Introduction and objectives 2. Review of literature 3. Materials and methods 4. Results. Discussion. Summary and conclusions. References. Publications. Conference and seminar.

07. TOMAR (Manisha)  
**Acoustic Communication and Behavioral Ecology of Orthoptera (Suborder: Ens.**  
 Supervisor: Dr. Swati Diwakar  
Th 24473

#### *Abstract (Verified)*

I investigated seasonal calling activity, host plant association, site fidelity, sexual dimorphism, duetting and mating behavior in Indian wetas from Western Ghats for my PhD dissertation. Abundance of calling activity was greatest from October to December, and lowest calling activity was recorded from January to March. An isolated peak in the calling activity was recorded in the month of May. Vegetation sampling showed the dominance of Terminalia sp. in the study area however, resource selection function indicated that wetas showed no preference for any particular plant species. Out of 49 marked adults, 41 individuals were never re-sighted again. My study found that there was a significant difference between pronotum, abdomen length and body weight between males and females. My dissertation work also investigated duetting behavior of male and female of Gryllacropsis sp. and I found that the calling was initiated by males. I investigated the mating behavior of the Indian weta and summarized the findings in the form of an ethogram. Male wetas were reported to switch to courtship drumming at close distance from females. I investigated acoustic diversity of field crickets from different regions in India, and described their varied calling sites. A total of 36 calls were recorded. Of the 36 calls, 30 Call Types belonged to families Gryllidae, Phalangopsidae and Trigonidiidae. A variety of temporal patterns were recorded with 27 chirping calls and three species with trilling calls. The present study provided a quantitative description of acoustic signals of gryllids in India. I also compared pitfall trap sampling with the bioacoustics method. A total of six species were recorded from various sampling sites using acoustic sampling whereas only one Grylloid species was found from the 23 pitfalls over the entire sampling period. Pitfall sampling provided an estimate of abundance of other captured invertebrates in the study area.

## Contents

1. Introduction 2. Secret life of shy singers: Calling activity, habitat and behavioural ecology of *gryllacropsis* sp. (Orthoptera: Anostomatidae) 3. Acoustic inventory: Estimating the call diversity from different biogeographic regions, India (Infraorder: Gryllidea) 4. Bioacoustics or pitfall traps: Comparison of a modern and a traditional method to estimate species richness. Conclusions and future directions. References. Appendices. List of publications.