

Ecology of plant–animal interactions: pollination, seed dispersal and tritrophic interactions*

Plant–animal and plant–microbial interactions are major topics of current research both in India and abroad. They have tremendous direct practical applications in the areas of crop production and food security, crop protection, forest management and conservation. Our knowledge on the fundamental aspects of bioresources in India is poor, despite having a huge biodiversity protected in the three global biodiversity hotspots, indigenous and local community conserved sites and agro-ecosystems. We are yet to build comprehensive baseline data of the efficient pollinators of our crop plants, including plantation crops, although we have been cultivating them for centuries. We jump to topics such as DNA recombinant technologies and genetically modified crops, transgenic crops and so on to produce cultivars of our requirement that have both socio-ecological and economic implications. We forget the fact that a cross-pollinating bee is equally helping us maintain the genetic heterogeneity and diversity within a crop species through the production of quality seeds. If we do not have baseline information on the biotic interactions in our long-serving crops, one can imagine the knowledge gap regarding our wild plants. Plants have both suffered and survived from animals and microbes. At both the ends, insects as a community play a major role in the survival of plants. They extend essential services to plants, such as pollination, defence, seed dispersal, decomposition and nutrient cycling. At the other end, insects are the major herbivores and seed predators in tropical forests.

Recognizing the growing interest in this area, a comprehensive workshop was organized at the Central University of Kerala, Padannakad. It provided a unique platform for the exchange of scientific

ideas among active researchers of the country in the broad field of plant–animal interactions.

Inaugurating the meeting, K. R. Shivanna (ATREE, Bengaluru) stressed the need to generate baseline information on the natural history of the plant–animal interactions in our crop and wild plant species to understand the strength of the interactions per se and to value their service in the oriental tropical forest and agricultural systems. Since it is an interdisciplinary subject, he stressed the importance of collaboration among the plant biologists, ecologists, entomologists and microbiologists for a desirable outcome from research on this topic. In a pollination or tri-trophic interaction study, an entomologist can solve many issues in the field itself, he pointed out.

P. A. Sinu (Central University of Kerala) providing an overview of the workshop, emphasized the need for a coordinated research project to study the pollinator fauna of several plantation and vegetable crops. Since pollination is a most dynamic process, data should be generated at spatial and temporal scales for effective management of either a crop or wild plant species. He hoped that a national-level participation in the workshop itself was sufficient to create a network for monitoring the pollinator fauna across India.

Shivanna explained the complete series of sequential events in the pistil after the pollen is deposited there, which includes the continuous chemical dialogue between the pollen grain and the saprophytic tissues in the pistil before they discharge the male gametes in the embryo sac for fertilization, in his masterly class on pollen–pistil interaction. He was concerned about the current post-graduate syllabus used to teach plant science in various universities and colleges in India that has replaced these basic topics by advanced fields such as biotechnology and genomics. In his second lecture, Shivanna explained the adaptations of weeds for their success in any harsh environment; pollination in most of them does not need a pollinator, dispersal of seeds is through external attach-

ment to animals or by wind and the seeds are highly dormant.

Shashidhar Viraktamath (University of Agricultural Sciences, Dharwad) and D. G. Naik (Agharkar Research Institute, Pune) stressed the significance of bee attractants and repellants as tools to maintain the pollinator fauna in crop plants. They stressed that 55 out of 160 m ha of agricultural land has entomophilous crops and one-third of the food production comes from pollination. Since the queen mandibular pheromones of seven *Apis* species are remarkably similar to each other, the bee attractants based on bee pheromone can maintain the bees for more time on a given crop. Since the bee-pheromone-based lures are expensive and to a certain extent prohibitive for Indian farmers, Naik stressed the need to integrate it with the plant-based lures. He said that the leaf extracts of *Fagara budrunga* and *Swertia densifolia* are good bee attractants. He also gave hands-on training regarding pheromone extraction from the pheromone glands of *Apis dorsata*.

Sinu explained that since the bees constitute the majority of the pollinators, an understanding of their foraging behaviour and fidelity helps us to take necessary measures at habitat level for facilitating the right pollinator species in a given crop system. Citing his research in *Amomum subulatum*, Sinu mentioned that the managed honey bees are not necessarily an efficient pollinator for all plant species; rather, they can be good robbers of pollen. Rigorous examination of stigma after the visitation by a given ‘visitor’ species ceased can determine its efficiency as a pollinator.

Joysree Cranham and Pratibha Yadav (Indian Institute of Science, Bengaluru) explained plant–animal interaction as an example of co-evolution by taking the cases of fig–fig wasp and ant–ant plant (*Humboldtia* sp.) interactions. V. V. Belavadi (University of Agricultural Sciences, Bengaluru) in his lecture on the pollination system in *Elettaria cardamomum* in Mudigere area of Karnataka said that cardamom is pollinated well by the rock bees among a number of visitor

*A report on national-level workshop on ‘Ecology of plant–animal interactions: concepts and practices’ held at Riverside Transit Campus of the Central University of Kerala, Padannakad during 20–28 May 2014 and was supported by the Central University of Kerala and British Ecological Society, London.

species and managing honey-bee colonies in the plantations can substantially increase the productivity of small cardamom.

Rajesh Tandon (Delhi University) discussed the ecological and evolutionary consequences of nectar robbing and the mechanism by which plants circumvent and minimize the adverse effects of nectar robbing on their fitness. He also gave a hands-on training on the plant-pollinator network analysis in the R platform.

Plants are able to activate defence mechanisms against various forms of insect attacks. Insects release various elicitors along with other components that induce defensive response in plants. The defence mechanisms could be direct or indirect. In indirect mechanism the plants 'call' for help from other organisms, such as predators and parasitoids by releasing some volatiles or other chemicals. Sujatha Deshpande (St Xaviers College, Mumbai) unravelled the chemical interaction taking place in the tri-trophic interaction.

Giby Kuriakose (Sacred Heart College, Cochin) gave an outline on the diversity

of pollination syndromes seen in the plant kingdom. Taking the case of orchid pollination system, he explained deception as a pollination mechanism. Solomon Raju (Andhra University) stressed the relevance of studying the reproductive biology of several endemic plant species seen in the Eastern Ghats of India, a forgotten landscape. He explained the dispersal modes and seed predation systems in the plants of the Eastern Ghats.

Lectures were devoted to plant-microbial interactions also in the workshop. N. M. Sudheep and Jasmine Shah (Central University of Kerala) emphasized that many insect-plant interactions are facilitated by the above and below-ground endophytic fungi and other microbes. They are growth promoters and help in the germination of several hard seeds because of their enzymatic action.

The workshop had several field and laboratory-oriented practical experiments. Participants were trained in the basics of bee systematics, the pollination experiments, pollination efficiency of visitors, pollen-pistil interactions, acetolysis as a tool to study the pollen structure and

architecture, collection methods of pollinators, dispersal and seed predation experiments, basics of transgenics, enzymatic action of endophytic symbiotic fungi and R statistical package.

Participants and resource persons were given an opportunity to visit and interact with farmers, particularly the precision and hitech farmers at the M.S. Swaminathan Research Foundation (MSSRF), Wayanad. The polyhouse vegetable growers are producing several exotic varieties of vegetables, but most of them are pollinator-dependent. Currently, the farmers are practising manual pollination. The interaction with the resource persons gave a framework for the way forward to enhance the pollinator fauna in polyhouses through participatory research. V. Sivan and C. S. Dhanya (MSSRF) gave a guided tour through the well-planned botanical garden of the Foundation.

Palatty Allesh Sinu, Centre for Ecology and Entomology, Department of Animal Science, Central University of Kerala, Padannakad 671 314, India.
e-mail: sinupa@gmail.com

MEETING REPORT

Reconstruction and rehabilitation of disaster-affected landscape of Kedar valley, Uttarakhand*

A workshop was held recently to get an overview of the relief and recovery actions undertaken by the Uttarakhand Government, to seek feedback from the affected people on the issues of reconstruction and development, employment, livelihood and income-generation activities,

and also to take stock of the ground realities in the disaster-affected areas of Kedar Valley, Uttarakhand. The workshop offered a platform for sharing experiences regarding the disaster, lessons for reconstruction, livelihood improvement and short- and long-term recovery for sustainable development, disaster mitigation, preparedness and management system for the future. It brought together around 180 participants comprising local people from 25 villages, representatives of the Government (both State and Central), NGOs and other stakeholders who had actively participated in relief and recovery efforts in the state.

The first technical session covered measures for reconstruction and restoration of disaster-affected areas. R. K.

Maikhuri (Convener of the workshop), while welcoming the dignitaries and participants, highlighted the major issues, concerns and challenges with regard to reconstruction, development and livelihood of the disaster-affected areas of Kedar valley. He mentioned that the region requires high priority for natural resources management and community-based action plans. Restoring ecological balance, undertaking bioengineering measures for treating the affected and vulnerable areas should form the basic strategies, he added. These issues are to be given serious thought for revival of traditional customs and agro-ecological land use, terrain and habitat restoration through planting of suitable multipurpose trees, input of science and technology interventions in integrated rural

*A report on the two-day regional workshop on 'Reconstruction, development and livelihood in disaster-affected areas of Kedar Valley' held at the Rural Technology Centre, Triyuginarayan, Rudraprayag District during 29-30 September 2014, jointly organized by the G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar (Garhwal) and the Department of Political Science, H.N.B. Garhwal University, Srinagar (Garhwal) and sponsored by the Indian Council of Social Science Research, New Delhi.