

biological, geochemical, geochronological and isotopic studies along these corridors, specifically targeting Archaean geodynamics and terrain assembly of the Dharwar Craton and Southern Granulite Terrain. Interested geoscientists can send their focused proposals aiming to solve the scientific questions on any of the

above-mentioned themes to PAMC-Geosciences, Ministry of Earth Sciences (MoES), Government of India (GoI) preferably by 25 January 2020. It is further proposed to prepare a consolidated project proposal with several verticals for possible funding by the MoES, GoI.

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## MEETING REPORT

### Current challenges in the management of forest insect pests and diseases\*

Insect pests and diseases can cause serious damage to natural/man-made forests. Many records on such losses have already been reported worldwide. Therefore, the solution should focus on keeping the pest/pathogen population at low levels, which will not interfere with the management objectives. A seminar on current challenges in the management of forest insect pests and diseases was held recently. Fifty-seven delegates, including eminent scientists, researchers, academicians from colleges and universities, farmers and personnel of the State Forest Departments (SFDs) participated in the event. The seminar aimed to share knowledge and ideas on the available techniques and technologies for the management of forest insect pests and diseases.

The welcome address focused on the need of biological control of insect pests and diseases in the forestry sector, as pesticides have a devastating impact on the non-target and beneficial insect fauna (parasitoids, predators and pollinators) and beneficial microbes. Over 90% of these pesticides enter into the aquatic environment, grazing areas and human settlements, causing environmental pollution and human health hazards. Other serious problems associated with pesticide use include development of pesticide resistance and resurgence of pest populations. Biological control of insect pests and diseases is an effective, environmentally safe and economically viable management system.

\*A report on the seminar on 'Current Challenges in the Management of Forest Insect Pests and Diseases', held at the Forest Research Institute, Dehradun on 27 June 2019.

The Forest Research Institute (FRI), Dehradun has developed a method for biological control of teak and poplar defoliators and Eucalyptus gall wasp, which has been successfully utilized in the management of these key insect pests. For instance, approximately 134,100 parasitoids of *Megastigmus* sp. were released in the gall-infested Eucalyptus nurseries, plantations and vegetative multiplication gardens (VMGs) in Punjab during 2013–2017, and by 2017 gall infestation in most of the districts of the state was found nil.

While highlighting the contribution of FRI in the management of important diseases and insect pests of forestry species, collaborative research was suggested on shisham, sal and kikar mortality, *Cylindrocladium* leaf blight of *Eucalyptus*, rust of poplar and gall-forming insects. Further, work on the biological control of invasive species needs to be taken up. Importantly, scientists should develop suitable methods for the management of key insect pests and diseases of important forestry species.

Ten presentations were made during the first technical session. In the keynote address, the relevance of survey of forest diseases and insect pests for their management was discussed. Forest diseases along with insect pests constitute the major deterrents of forest productivity, and instances of losses due to insect pests and diseases are affecting the developmental plans in many countries. In some countries like the Lao PDR, forest diseases and insect pests are not reported so far, but many likely exist and need to be explored. Therefore, continuous surveillance of all forested land for diseases and insect pests is necessary, because patho-

gens and insect pests do not recognize national boundaries. Disease and insect pest surveillance, an information-based activity involving the collection, analysis, and interpretation of large volumes of data originating from a variety of sources, is required to be used in several ways to evaluate the effectiveness of control and preventative health measures. Further, the climate change scenario is posing new challenges for scientists as it will probably alter the geographical and temporal distribution of insect pests and pathogens. As a result, new epidemics may occur in certain regions and others may cease to be economically important, especially if the host plant migrates into the new areas. Plant pathogens and insect pests are ubiquitous in natural and managed systems, being among the first to demonstrate the effects of climate change due to large population, ease of reproduction and dispersal, and the short time between generations. Forest disease and insect pest surveys are therefore strongly required with the following main objectives: (1) continuous census of forestry diseases and insect pests generally; (2) detect and even predict new outbreaks; (3) timely assessment of the actual and potential threat due to them; (4) appraise damage both qualitatively as well as on a quantitative basis; (5) diagnose the diseases and insect pests in order to evolve control measures and (6) identify economically important insect pest and disease problems that would help in assigning priorities for taking up intense research on them.

The next presentation was on the 'Development of lure and kill trapping system for the management of forest insect pests: a safe and effective technology'.

Herein, the discussion was on the role of semiochemicals, a form of 'chemical signals' that help mediate interactions between insects. The insects have a well-defined communication system which relies more on chemical communication in the form of pheromones for finding a mate and aggregation. Insects synthesize their own pheromone from the by-products of metabolic activity, especially from fatty acid metabolism and these reactions are catalysed by enzymes. The success relies on the reception by their conspecifics. The pheromone-based trapping systems are non-toxic, specific to the targeted species, low amount of chemical compound is needed, and chances of resistance development are less. Therefore, isolation, identification and synthesis of novel pheromone formulations can be exploited for better forest protection. The importance of pheromone content, size, colour and situation was highlighted while discussing various kinds of traps, such as ground trap, funnel water trap, pheromone uni-trap, and pheromone delta trap. The 'trap-tree operation' is the only feasible and effective method for attracting and collecting beetles of sal heartwood borer. Therefore, isolation of attractive components from sal tree, their synthesis and formulation are required. Further, the systematic chemistry of sal and synthesis of chemicals responsible for attracting beetles in the forests would open up a new avenue for sal borer control. The success story of Eucalyptus gall wasp (*Leptocybe invasa*) control using *Megastigmus* sp., where about 80–90% gall infestation was reduced after the release of parasitoids, has proved biological control to be a reliable option for insect pest management. During the third presentation, the following strategies for furthering work on biological control of insect pests were presented: (1) parasitoids of different groups (Hymenopterous and Dipterous), including egg, larval and pupal parasitoids are to be explored thoroughly; (2) techniques of mass multiplication of larval and pupal parasitoids need to be developed, and (3) laboratory efficacy of selected parasitoids should be tested against key insect pests of forest tree species.

In the next presentation, recent disease outbreaks of sal in Jharkhand and Uttar Pradesh due to *Inonotus shoreae* were discussed in detail. In case of shisham wilt, an effective disease management strategy is required for existing planta-

tions as well as for future plantations. Therefore, screening of germplasm in artificial epiphytotic conditions is required for the identification of resistant sources. Foliar application of *Trichoderma* is an effective means to minimize losses caused by *Cylindrocladium* leaf blight of *Eucalyptus*. In case of urban tree health assessment, it was suggested that wood decay fungi should be categorized in terms of their arboricultural significance, particularly the potential risk of tree death that they may cause. Further, the impact of climate change on forest pathogens is high, and there is a need to incorporate climate change-driven disease effects into future forestry planning. To mitigate the impacts of changing climate, understanding the factors that trigger the development of virulent pathogenic races and host susceptibility is essential.

During the fifth presentation on 'IPM: a practical approach for the management of forest insect pests', emphasis was given on the compatibility of different control measures for their judicious use in forest insect pest management. Neem-based biopesticides can be used to control common pests like white flies, aphids, scales, mealy bugs, spider mites, locusts, thrips, Japanese beetles, etc. Importantly, the egg parasitoids, larval parasitoids, pupal parasitoids and larval-pupal parasitoids represent a major component of the strategy to mitigate the risk associated with forest insect pests; therefore more comprehensive research programmes are critical to the long-term success of biological control. Extensive discussions were held on sal heartwood borer, defoliator of *Ailanthus excelsa*, poplar borer, teak leaf skeletonizer and their control measures.

The next presentation was on 'Faunal diversity w.s.r. to insect diversity in India'. The exploration, survey, inventorying and monitoring of faunal diversity in various states, ecosystems and protected areas of India were discussed. The traditional morphology-based or appearance-based insect classification has given way to modern classification systems based on evolutionary history and genetic data. Despite non-uniformity across states and taxa in the available information, certain trends are visible. These trends permit us to infer both gaps in our knowledge and survey the insect fauna of the various States and Union Territories. Habitat destruction, industrialization, use

of insecticides and herbicides in agriculture, the butterfly trade, etc. require attention for butterfly conservation. The 'Key insect pests of Western Himalayan Oaks' was discussed in the seventh presentation. *Rosalia* sp. and *Xylothechus* sp. are the potentially devastating insect pests of Western Himalayan oaks, and therefore need special attention. The next presentation was on the 'Screening of insect pests resistance against poplar defoliators in poplar clones', where the selection and utilization of poplar clones with high resistance against insect pests was discussed. Poplar clones that grow faster and have resistance to defoliators could be significant in terms of wood yield, plantation health and productivity.

The need to incorporate DNA microarrays, transcriptome analysis by next-generation sequencing (RNA-seq), and other modern tools in future research programmes was discussed in the next presentation on 'Recent advances in molecular pathology'. The study on biodiversity of *Trichoderma* sp. from Uttarakhand Himalaya and its exploration in disease management was discussed in detail. Clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated protein 9 (Cas9) is gaining importance as a targeted genome editing technology. The CRISPR/Cas9 system has been exploited for developing resistance against pathogens. Therefore, specialized training programmes on this emerging technology would benefit researchers and pave the way for its implementation in forest pathology. The Forest Pathology Discipline, Forest Protection Division of FRI, Dehradun houses the National Type Culture Collection (NTCC) with 988 fungal cultures belonging to 140 genera and 298 species of wood rooting fungi and forest pathogens. Some of these species have immense value in biotechnology such as bioremediation, enzyme production, and many have medicinal uses. The NTCC, recognized by the International Mycological Institute (Now CABI Bioscience), Kew, England, has fungal cultures since 1936. Apart from being reference material and providing authentic cultures to scientists, academicians, students, NGOs, etc. the taxonomic identification of fungal species based on microscopic characters is also done here. However, in recent years fungal taxonomy has seen a sea change on account of reliability on the employment of molecular tools for authentic

identification of fungal species. No new report of fungal species is entertained by international research journals based on morphological and microscopic traits, unless molecular characterization is done. Molecular characterization along with morphology authentically determines taxonomic identity. With the advent of molecular taxonomy and phylogeny, reclassification of fungal species began, thus challenging the older system of identification/classification. Given these facts, there exists a strong need for authenticating our NTCC accessions based on DNA sequence data.

During the tenth presentation on the 'Role of coccinellid beetles in biological control of forest insect pest', the success stories of coccinellids beetles in the biological control of a variety of insect pests were highlighted. Detailed discussion was held on the biological control of cottony cushion scale, *Icerya purchasi* Maskell (Margarodidae) by coccinellid beetle, *Rodolia cardinalis*; biological control of mealybugs by different species of coccinellids beetle, *Cryptolaemus montrouzieri*; biological control of Subabul Psyllid, *Heteropsylla cubana* Crawford (Psyllidae) by *Curinus coeruleus*, etc. Therefore, taxonomy of coccinellid beetles is important in terms of their distribution and seasonal variation, host specificity, uses and applications.

During the second technical session, the last presentation was on 'Insect pests

and diseases of trees of Haryana'. Wilt and dieback were identified as the most serious problems affecting *Dalbergia sissoo* in the state. Interestingly, clone no. FRI-DS-14, which is blend of high productivity, resistance to dieback, and an excellent bole form is under study. There is an urgent need to work on Eucalyptus gall wasp (*Leptocybe invasa*), little leaf, witches broom, *Cylindrocladium* leaf blight, gummosis, bark split and canker. In case of *Terminalia arjuna*, gall is a serious problem and no effective solution is currently available; therefore it needs special attention. Similarly, toon shoot borer (*Hypsipyla robusta*) causes serious losses. Further, >50% red cedar (*Cedrela toona*) trees are affected by phytoplasmas in Haryana and Uttarakhand. The nematodes of Indian forests affecting acacia, sal, teak, sandal, jamun, etc. were also discussed. In conclusion, it was suggested that we should focus on the conservation of indigenous natural enemies, generate awareness among all stakeholders, and organize workshops for forest managers to educate them about the disease and insect pest problems. Detailed discussions on various problems resulted in the following recommendations for strengthening research on forest diseases and insect pest problems:

1. Ecofriendly approaches for the management of forest insect pests and diseases should be promoted.

2. Regular surveillance and monitoring on seasonal appearance and population build-up of forest insect pests and diseases should be carried out for timely checking on outbreaks or epidemics.

3. Research work on key pathogens and insect pests of forests and their management should be carried out in programme mode.

4. Molecular characterization of fungi in the NTCC and important insects should be taken up.

5. Emphasis should be given to isolate and characterize novel pheromones for the management of key insect pests of Indian forests.

6. The role of climate change in pathological and entomological problems of forests should be examined.

7. Extension of the research findings on current developments regarding forest diseases and insect pest management should reach the stakeholders.

8. Species diversity of *Trichoderma* should be studied in the forest types of Uttarakhand Himalaya.

9. Molecular basis of host-pathogen interactions should be investigated.

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## MEETING REPORT

### Indian Academy of Sciences, Bengaluru – 85th annual meeting\*

The 85th annual meeting of the Indian Academy of Sciences (IASc) comprised of several talks, including inaugural lectures by fellows/associates, special lectures and symposiums.

The meeting commenced with a special lecture by Partha P. Majumder (President, IASc), who covered aspects of non-familial cancers, and the genes and genomic alterations that drive their

growth. He cited his work in identifying the drivers of oral cancer, the most common form of cancer among Indian males. He found that the genes associated with oral cancer in the Indian scenario are predominantly concerned with tumour-suppressors. Any alterations to these tumour-suppressor genes hinder their normal functioning of suppressing uncontrolled cell growth, one of the hallmarks of cancer. Identifying such drivers provides insights into tumour evolution, nature of alterations in genes and pathways in cancers and the complex alterations that result in the spread of

cancer. This understanding could also lead to improved handles on prediction, prevention and treatment of the disease, and enable learning of new processes in biological evolution.

The special lecture was followed by inaugural lectures by the elected fellows. Sandeep Kunnath (TIFR-CAM, Bengaluru) spoke about his research interests in studying inequalities that exist in mathematics, for example, Poincaré inequality, and Sobolev inequality, and provided a framework for understanding them. Tapas Maji (JNCASR, Bengaluru) gave a brief overview of his research on

\*A report on the 85th Annual Meeting of the Indian Academy of Sciences held at the University of Hyderabad, Hyderabad during 8–10 November 2019.