NEWS

Rosabelle Samuel delivered a lecture on Amplified Fragment Length Polymorphism (AFLP). While explaining the importance of AFLP studies, she talked about taxa and sampling methodology, protocols involved in AFLP and data analyses. Unlike RAPDs, AFLP data are highly reproducible. The AFLP technique produces large sets of polymorphic markers that may be used to analyse closely related taxa. She highlighted the importance of AFLP data in the study of polyploidy evolution. She also demonstrated protocols for cycle sequencing.

D. Yakandawala introduced the methodology of GenBank search. Her lecture was followed by a panel discussion which was jointly conducted by Rosabelle Samuel, Deepthi Yakandawala, Harshendra and Pandey. Sequence alignment using different software was demonstrated to the participants using computers.

On the fourth day, Deepthi Yakandawala delivered a talk on PAUP (Phylogenetic Analysis Using Parsimony). She gave a detailed account of cladistic analysis using both morphological and molecular data. She presented an overview of maximum parsimony, maximum likelihood, Bayesian inference and other methods of analysis and tree-building. This was followed by laboratory exercises on computers.

On the final day of the workshop, Rosabelle Samuel presented two talks, viz. ‘Genus Leontodon (Asteraceae) is biphyletic’ and ‘Molecular phylogeny of Ebanaceae’. The lectures were followed by interactive sessions. Participants were also given training on writing papers on molecular phylogenetics and data analysis. All the participants were provided with handouts related to extraction procedure, amplification, sequencing, sequence alignment and phylogenetic analysis. The workshop was interactive and deliberations were active and lively. The workshop was productive and provided several occasions for interaction between participants and resource persons.

In her valedictory lecture, Prema Jha (Vice-Chancellor, TMBU, Bhagalpur) emphasized the need for molecular systematic studies in developing countries and development of DNA banks of plants in India. She emphasized that the sequence data of Indian plants, when deposited in GenBank, can be retrieved when needed and can solve the problems of patents of Indian plants and products. In the valedictory session, the participants and resource persons shared their experiences.

The major outcome of the workshop was the practical training given to the participants and first-hand information on various aspects of molecular systematics. The workshop also provided an opportunity to the young and senior taxonomists to learn various techniques of extraction, amplification, sequencing, sequence alignment and phylogenetic analysis. Participants were of the view that several such workshops are needed to train young Indian taxonomists in cutting-edge technology.

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MEETING REPORT

Semiochemicals in crop protection*

Inaugurating the Annual meeting, M. S. Swaminathan (MSSRF, Chennai) highlighted the need to improve the economic viability of farming, protection and improvement of land, water, biodiversity and climate resources for sustainable advances in productivity, profitability and stability of major farming systems. Emphasizing the need to strengthen the areas of conservation and green agriculture, he visualized the need to strengthen strategic research with a focus on biotic and abiotic stresses, ensure environmental sustainability, biotechnology, biosecurity and biosafety research, monitoring and strengthening research in the areas of semiochemical technology, nanotechnology, space and information technology, renewable energy technologies, besides strengthening research on technology-delivery systems to accelerate progress in bridging the growing gap between scientific as well as field-level know-how. Strengthening the ecological foundation for sustainable agriculture, extension and anticipatory research is an immediate necessity, with the establishment of a few national centres of excellence in agriculture.

Briefly outlining the theme of the meeting, T. N. Ananthakrishnan (Chennai) highlighted that semiochemicals are increasingly being integrated with a range of methods producing new schemes, with the application of semiochemicals being increasingly utilized for pest monitoring, mass trapping, mating disruption and natural enemy attraction. A bewildering array of secondary plant substances has been identified through diverse biosynthetic pathways, so that increased interest is being evinced on the impact of chemical communication between crop plants and insects. Compared to what has come to be known as the ‘supermarket utopia of monoculture’, prone to insect outbreaks, the significance of polyculture has come to be appreciated, with newer technologies involving genetic modification and molecular marker associated selection.

Stressing the need for better appreciation of the third component to host plant resistance, apart from vertical and horizontal ones, the need for better understanding of the third trophic level involving parasite/predator attracting semiochemicals, besides diverse blends of volatiles emitted by insect-damaged plants attracting natural enemies, has been highlighted. A better understanding of odour receptors, odour-binding proteins and

*A report on the Seventh Annual Discussion Meeting on ‘Semiochemicals in Crop Protection: Ongoing Technologies’ convened by T. N. Ananthakrishnan on 2 December 2006 at Centre for Cooperation in Science and Technology Among Developing Societies, Chennai.
odour-degrading enzymes become relevant, so that integration of semiochemi-
cals with pest management has become a
necessary exercise with what has come to
be known as the ‘stimulo-deterrent diver-
sionary strategy’, enabling better appre-
ciation of the need to boost frontier
technologies in relation to Integrated
Pest Management (IPM).

In his keynote address on ‘Molecular
crosstalks in insect–plant interaction’, Anil
Kush (Vittal Mallaya Research Founda-
tion, Bangalore) indicated that plants have
evolved defensive strategies to counter-
act potential invaders. Recent advances in
plant defence signalling research have
revealed that plants are capable of differ-
entially activating inducible, broad-
spectrum defence mechanisms, depend-
ing on the type of invader encountered.
Plant biologists talk about ‘innate immu-
nity’ in plants, which is linked to im-
une responses in mammals and insects.
A shared characteristic of innate immu-
nity in animals is the recognition of infec-
tious, ‘nonself’ agents by a specific
receptor and activation kinases cascades,
which eventually results in localized and/or
systemic response.

Plant hormones like salicylic acid
(SA), jasmonic acid (JA) and ethylene
(ET) are major players in the network of
defence signalling pathways. Crosstalk in
SA-, JA- and ET-dependent signalling
pathways is thought to be involved in
fine-tuning the defence reaction, eventu-
ally leading to the activation of an opti-
mal mix of defence responses to resist
the intruder. Genetic engineering of the
biosynthetic pathways of these signalling
compounds and development of protec-
tive chemicals mimicking their mode of
action, provide useful tools for the devel-
one of new strategies for crop protec-
tion. The question whether manipulation
of defence signalling pathways, either
through genetic engineering or through
application of defence signal-mimicking
plant protectants, will boost the plant’s
immunity to potential invaders or be a
burden in crop protection strategies, needs
to be carefully addressed.

Highlighting the role of semiochemi-
cals in rice IPM, J. S. Bentur (Directorate
of Rice Research, Hyderabad) indicated that
among the semiochemicals, sex pher-
omones have been the most extensively
investigated in case of rice insect pests.
Chemical nature and composition of sex
pheromones are known for at least eight
species of pests attacking the crop in the
field apart from three species damaging
rice in storage. While lepidopteran pests
produce female sex pheromones that
attract males, stink bugs are reported to
have male sex pheromones that attract
females or both sexes, as in the case of
coleopteran rice pest Hispa. Being vola-
tile substances, chemically these are less
than 20 carbon aldehydes and alcohols
and normally composed of 2–3 distinct
components expressed in different blends.
More research is needed to identify the
chemical nature of these substances and
effectively use them in IPM. Alterna-
tively, plants can be genetically modified
to express efficiently these kairomones
for better and natural protection against
herbivorous insect pests.

Discussing the chemical and transcrip-
tional analysis of insect-induced volatile
signalling in tomato plants, R. S. An-
aduraj (Vittal Mallaya Research Founda-
tion), indicated that plant volatiles that
are copious in nature are responsible for
a plethora of interactions varying from
defensive to competitive and mutual.
Indirect defence in plants is mediated
en route volatile organic compounds, by
attracting natural predators and parasites
of herbivores. JA, ET and SA are signalling
molecules implicated in triggering def-
cence mechanisms after herbivore attack
and wounding. The molecular intricacies
of these hormones in eliciting a response
are yet to be elucidated. The above-
ground signalling in crop plants like
tomato as volatile functions can guide us
for designing better crop varieties and
crop protection strategies in many vege-
table crops.

Highlighting the importance of semio-
chemicals for enhancing the efficiency of
biocontrol agents, R. J. Rabindra (Project
Directorate of Biological Control, Banga-
lore) indicated that kairomones are used
by entomophages for host location, host
acceptance and oviposition. Scales of
moth insects contain compounds such as
tricosane, pentacosane and hexacosane
that evoke a behavioural response in sev-
eral insect predators and parasitoids.
A combination of trocosane impregnated
in a rubber septa with supplementary diet
and spray of acid hydrolysed l-
tryptophan was found to increase the
abundance of Chrysoperla carnea on cotton.
Similarly, tricosane-impregnated septa
along with supplementary diet increased
the parasitization efficiency of Trich-
gramma chilonis on cotton. Spraying of
kairomones on rice plants increased
parasitism on Conopodium medialis
by Apanteles cypri. Plants containing
genes for expressing increased levels of
production of wound hormones are being
tested under different levels for their
ability to increase attraction of entomo-
phages, which will be a boon for eco-
friendly pest management.

Speaking on the structure-dependent
activities of semiochemicals and their
impact in IPM, S. Mohankumar (Tamil
Nadu Agriculture University, Coimba-
tore) mentioned that insect receptor sys-
tems could detect messenger compounds
at extremely low concentrations, thus
indicating the sensitivity and specificity
to semiochemicals. Pheromones, the intras-
pecific chemical messengers, influence a
range of behaviours and biological proc-
eses in the receiving individual. Sex
pheromones (that attract a mate) and ag-
gregation pheromones (that call others to
a suitable food or nesting site) are the
important components in pest manage-
ment programmes. Allelochemicals, the
inter-specific chemical messengers (kai-
romones and allomones) given-off by
food sources (plants/animals) play a vital
role in pest management, especially in the
utilization of biocontrol agents. Mohan
Kumar highlighted the role of phero-
mones biosynthesis activating neuropep-
tide and pheromone-binding proteins
in lepidopteran pheromone biosynthesis,
besides the role of limonoids and alkaloids
having feeding deterrent, insect-repelle-
t and antithormone properties against in-
sect pests. The role of allelochemicals
and P450 enzymes was highlighted as
well as that of molecular forces deriving
insect–plant interactions.

Over the past ten years, there has been
tremendous success in the area of com-
putational protein design. De novo de-
sign of novel structures is particularly
important because the protein backbone
must be designed in addition to the
amino acid side chains. To address this
issue, researchers have developed a variety
of methods for generating protein-like
scaffolds and for optimizing the protein
backbone in conjunction with the amino
acid sequence.

Exploring semiochemicals for imple-
mentation in rice IPM, G. Ravi (Tamil
Nadu Rice Research Institute, Aduthura)
indicated that plant volatiles induced
modulation of orientation behaviour in
key rice pests such as hopper, leaf folder,
stem borer and ear head bug. Plant vola-
tiles are also known to serve as kairo-

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mone cues for natural enemies to move either towards the host, the potential host community or its micro-habitat. Info-
chemicals, mainly kairomones and syno-
mones from the infested rice plant help in the selection and discrimination of host insects by parasitoids. Concentration of chemical cues changes with variety, growth stage and host density. Salivary enzymes in BPH, especially Beta gluco-
sidase, play an important role in host-
induced volatile production in rice plant. The larval parasitoid Cotesia chilonis uses a combination of volatiles from plant, larva and/or frass for locating lar-
vae. Another closely related parasitoid, Cotesia ruficrus which prefers both striped borer and leaf folder, uses vola-
tiles of the larvae and their frass for dis-
criminating damaged rice plants.

Trehalose and amino acids such as leucine, phenylalanine, aspartic acid, ser-
ine, cystine, alanine, valine and threonine are the components identified in the frass material of the host larvae. Rice volatiles also play an important role in the foraging behaviour of the predatory Cymorothyia lividipennis in the rice ecosystem. C. lividipennis uses honeydew from rice hoppers as host-searching kairomone. Further, jasmonate signalling pathway plays an important role in induced plant defence against pests and pathogens.

Speaking on the role of insect neu-
ropeptides and application in pest man-
agement, A. Joseph Rajkumar (Kerala Agriculture University, Cardamom Research Station, Pampadumpara) indicated that genes of several neuropetides were cloned adopting biotechnological ap-
proaches, so as to disrupt vital endocrine functions directly on the target insect pest or by developing transgenic food plants. By understanding the amino acid sequence it is also possible to design and devise agonist, antagonists and even mimics of the neuropetides leading to endo-
crine-based biopesticides. A new peptide hormone-based bioinsecticide technol-
ogy, Trypsin Modulating Ostatic Factor developed from mosquitoes down-regu-
lates the expression of trypsin-like prote-
as, which are primarily insect digestive proteases. Neuropeptides are a diverse widespread class of signalling substances in the nervous system. Insect neuropep-
tides function as neurotransmitters, neu-
romodulators, and neurohormones and are therefore called ‘master regulators’ of development, behaviour, metabolism and reproduction. Remarkable advances in the field of neuropeptide research and the comparative approach paved way for the discovery of many novel peptide structures.

Discussing some aspects of advances in resistance dynamics, A. M. Ranjit (Kerala Agriculture University, Trichur) indicated that specific plant-quality characters, such as alkaloid content, trichome density, etc. influence the overall quality of a plant as a host for insects, and cause of variation in herbivore population dy-
amics. Changes in abiotic environment and consequent stress, can change plant quality and lead to outbreaks of herbi-
vores. Herbivore and pathogen damage can also cause induced resistance or suscep-
tibility in the plant and herbivore-induced changes in plant resistance might drive fluctuations in insect populations.

‘If genetic differences among plants give rise to different dynamics in the popula-
tions of insects that feed on them, then evolutionary changes in plant characters affecting herbivores (such as resistance characters) might lead to changes in long-term herbivore dynamics.’ Induced and constitutive plant resistance can have short and long-term effects on insect herbivore population dynamics. Studies have shown that models representing the hypothesis that the three resistance types – no resistance, constitutive resistance and induced resistance – differed in their ef-
efacts on the population dynamics of Mexi-
can bean beetles on soybean varieties, have been validated.

Indicating recent trends in pheromone technology for crop protection, S. Nar-
simhan (Asthagiri Herbal Research Foundation, Chennai) said that crop pro-
tection through pheromone technology is gaining importance in the present-day demand for safe, pesticide-free products. The technology in India is yet to take-off for sustained growth and application. The major impediments are: cost and lack of availability of pheromones; a well-defined protocol for the development of a suit-
able product and application methods; and involvement of many parameters in the field to capture the insects. In order to gain a quantum jump in the technology it is necessary to consider non-conven-
tional approaches, which involve an in-
depth study of the behaviour of the in-
sects to semiochemicals.

The impact of kairomones of the tea shot hole borer, Euwallacea formicatus was discussed by A. Babu (UPASI Tea Research Foundation, Valparai). He indi-
cated that in an attempt to confirm whether the volatile compounds emitted from par-
tially dried cut-stems Montana bipinnat-
ata was entirely different from those from green stems of the same plant, studies were carried out by analys-
ing the different volatile compounds. The main objective was to find the possible kairomones (if any) responsible for attraction of E. formicatus towards this jungle plant.

Discussion relating to exploiting chemi-
cal ecology for sustainable pest control against forest pest was made by S. Murug-
gesan (Institute of Forest Genetics and Tree Breeding, Coimbatore). He indi-
cated that major forest pests like Hyblaea puera and Eutectona machaeralis on teak cause severe damage, and several approaches exist for better management of insect pests in forestry. Among the many possible mechanisms that could be responsible for protecting trees from herbivores, is induced plant chemical de-
ence. Insect feeding induces changes in plant function in terms of biochemical, physiological and morphological aspects, which tend to alter plant growth. Damage to plant tissue due to insect feeding leads to translocation of the signal from the damaged site to other parts of a plant re-
sulting in induced resistance, the expres-
sion of which tends to vary with the age, season and growth habit. Induced de-
fences tend to be more effective against unpredictable herbivores than intrinsic defences (expression in the plant). Utili-
ization of induced defence management has the potential to increase total forest productivity, provided the factors that in-
fluence the induced responses in forest trees are understood. If induced defences are more effective against insect herbi-
vores, then the tree will have more en-
ergy to allocate for biomass production. Genotypes representing a range of in-
duced resistance types could be incorpo-
rated into forest plantations. A forest plantation, genetically diverse because of variations in induced resistance response, is likely to be more stable when faced with an uncertain array of insect pests. Induced resistance is a relatively new and excit-
ing aspect of complex interaction be-
 tween forest trees and their herbivores.

N. Bhaktavatsalaan (Project Directorate of Biological Control, Bangalore), speak-
ing on kairomones for increasing the effi-
ciency of Chrysopids and Trichogram-
matids, indicated that Chrysopids have long been considered as efficient natural
enemies mainly against aphids, neonate larvae of lepidopterans. Adults of Chrysopids were attracted to the honey dew secretions of homopterans. On chemical analysis, it was proved that l-tryptophan was an important compound responsible for this. Acid-hydrolysed l-tryptophan was found to act as an ovipositional attractant for the Chrysopids. Other methods of hydrolysis using weak acids or oxidation using amino acid oxidizers were not as effective as acid hydrolysis of l-tryptophan. Indole acetaldehyde, the likely end-product of l-tryptophan on acid hydrolysis, showed some attraction to Chrysopids. Larvae of Chrysopids use the scales of moths as kairomones. Unsaturated hydrocarbons like tricosane, pentacosane and hexacosane, the constituents of moth scales, were found to increase the searching behaviour of Chrysopid larvae. In field studies, combination of tricosane-impregnated septa along with supplementary food and spray of acid-hydrolysed l-tryptophan increased the abundance of Chrysopids on cotton.

Presiding over the concluding session of the meeting, T. M. Manjunath (Bangalore) posed a question as to whether pheromones are a monitoring device or a pest management practice. While semiochemicals are the domain of organic chemists, their application forms the domain of entomologists, thus making the collaboration of organic chemists and entomologists essential in order to achieve successful marketing of products. While mass trapping may not have such a major impact, mating disruption does, besides pest monitoring. Alexander Jesudasan (Madras Christian College, Chennai) re-emphasized the role of semiochemicals in plant protection and called for increased inputs in this area.

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