MONDAY - 4 August

PLENARY SYMPOSIUM Monday, 10:30–12:30

Microbial Control - from Bench to Business

PLENARY SESSION. Monday, 10:30. **1**

Potentials for utilizing and controlling insect pathogens

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Insects are attacked by different invertebrate pathogens. Diverse strategies are used to deal with these pathogens. In this presentation, three examples are presented to show the utilization and control of insect pathogens in Guangdong Entomological Institute, China: (1) ***Ophiocordyceps sinensis* fungus as health food.** *O. sinensis* (Clavicipitaceae) (best known as *Cordyceps sinensis*) is one of the entomopathogenic fungi endemic on above 3000 m Tibetan Plateau. The fungus parasitizes larvae of moths (Lepidoptera) and fruiting bodies grow from the infected larvae. Regarded as "Himalayan Viagra", the fungus-insect complex is used to treat a variety of ailments including fatigue, impotence and cancer, and costs $60000–$75000 per kilogram. The growing worldwide demand and resource limitation drive the research to artificial cultivation of this fungus for commercial trade. (2) ***Photorhabdus* bacteria for insect control.** *Photorhabdus* bacteria associated with entomopathogenic *Heterorhabditis* nematodes produce oral protein toxins for killing insects. For sustainable termite control, the toxic genes are transformed into *Enterobacter cloacae*, one of the indigenous gut bacteria of the Formosan subterranean termite (*Coptotermes formosanus*), and the termites are fed with these genetically modified bacteria. (3) **Control of Chinese sacbrood virus (CSBV) by RNAi-mediated technology.** CSBV is the most serious virus of oriental honey bees *Apis cerana*. To protect the honey bees, RNAi technology is successfully used to control this harmful virus, by feeding second instar larvae of *A. cerana* with specific sequences of CSBV double-stranded RNA (dsRNA). The results from these examples show the research strategies in invertebrate pathology and potentials for implementing the research results in commercial purpose.

Key words: Invertebrate pathogens, *Ophiocordyceps sinensis*, *Photorhabdus* bacteria, CSBV

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PLENARY SESSION. Monday, 11:00. **2**

Story of an African firm: 10 years in the biopesticide business – lessons learned along the way

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In 2003, River Bioscience in South Africa became the first African company to successfully produce and commercialise an insect virus as a biopesticde. This was the *Cryptophlebia leucotreta granulovirus* (CrleGV). The outcome was instant success, mainly due to the good fortune of perfect timing. The target pest, the false codling moth (*Thaumatotibia leucotreta*), was a very serious one and there was a dearth of alternative products. River Bioscience originated as a spin-off company from grower-funded citrus research and for the first few years of existence, served that single agricultural sector as a one-product company: a high risk situation. Subsequently, the company expanded its product range into other viruses, including the *Helicoverpa armigera* nucleopolydrovirus (HearNPV) and the *Cydia pomonella* granulovirus (CpGV), entomopathogenic nematodes and a range of biorational products, such as Attract and Kill products for a range of fruit fly species. The success of the commercial venture can be attributed to a number of factors, including product quality and competitiveness, being market driven rather than product driven, starting small (hence not over capitalizing) and growing organically, a close association with research organisations and being owned by its major market – the citrus growers. However, all has not been moonlight and roses: many hard lessons have been learned. For example, simply having a good product is not sufficient – it is the way in which the product is marketed that determines how it sells relative to the competition, which has increased dramatically since the emergence of the company.

PLENARY SESSION. Monday, 11:30. **3**

A Roadmap to the Successful Development and Commercialization of Microbial Pest Control Products for Control of Arthropods

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Microbial pesticides have been developed for a hundred years, but many of these crop protection products have not been successful in the market. Therefore, there is a need for a model that facilitates the development and commercialization of these products. A model has been developed for a biocontrol product based on entomopathogenic bacteria, fungi, viruses and nematodes. The model aims to develop a rational and structured approach that will increase the chances of achieving success with microbial pest control products. The building blocks of the entire process are identified and essential aspects highlighted. This systematic roadmap with a strong focus on economics and market introduction will assist academic researchers and industrial developers of biopesticides in accomplishing their goal: the development of successful cost-effective biopesticides.

PLENARY SESSION. Monday, 12:00. **4**

BASF Functional Crop Care. Unlocking Agricultural Potential in Soil, Seed and Crop

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For many years BASF has been active in the area of biological pest control with its pheromone based mating disruption solutions and in 2012 it acquired the leading biologicals company Becker Underwood. With its broad range of seed,

soil and foliar products Becker Underwood was an excellent fit and has now been fully integrated into the company.
The presentation will outline the different key segments BASF is focusing on in the areas of soil, seed and foliar treatments. Furthermore it will focus on the main opportunities BASF sees in developing an integrated portfolio of biological and chemical products that are able to reliably cover a broad spectrum of farmer's needs. Beyond this we will look forward and outline how we expect the crop protection market to develop and what motivates BASF to invest into finding best possible solutions to meet these changing market demands.

SYMPOSIUM 1 (Nematodes) Monday, 14:00-16:00

Above and Belowground Interaction, Root-Shoot Interaction, Chemical Signaling

Symposium. Monday, 14:00. **5**

Small molecule signals in nematodes - common motifs and species specific modifications

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Chemical communication in nematodes via small molecule signals has been known since the 1960s. However, despite considerable efforts chemical structures have remained elusive for several decades. Recent research focusing on the model organism *Caenorhabditis elegans* has revealed a modular library of small molecule signals, the ascarosides, glycolipids of the dideoxysugar ascarylose linked to fatty acid derived side chains, that modulate nematode development and behavior. Furthermore, we have shown that production of ascaroside components is highly conserved among nematodes from different clades, life-styles and ecological niches.
Our ongoing research aims to comprehensively characterize ascaroside signaling in selected nematode species including bacteriovorus and entomopathogenic species. Identification of putative ascaroside signals is accomplished using our recently developed highly sensitive HPLC-MS/MS precursor ion screen that facilitates the detection of known and novel ascaroside components in crude nematode metabolome extracts. Novel ascarosides are subsequently isolated by SPE and HPLC and identified using a combination of HR-MS/MS and NMR techniques. We found that diverse nematode species share a large variety of common ascarosides and in addition also produce several highly species-specific derivatives. Chemical synthesis and subsequent functional characterization of these putative small molecule signals in different nematodes will reveal their importance in intra- and interspecific communication and help to decipher the evolution of ascaroside signaling in nematodes.

Symposium. Monday, 14:30. **6**

Olfactory Plasticity in Entomopathogenic Nematodes

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Many parasites, including entomopathogenic nematodes (EPNs), use host-emitted olfactory cues to locate hosts. However, how parasitic nematodes respond to host-emitted odors remains poorly understood. In particular, little is known about how parasitic nematodes integrate host odor cues with environmental cues such as temperature and intrinsic cues such as age to mediate context-appropriate host-seeking behaviors. To address this question, we are investigating the olfactory behavior of EPNs from the genera *Steinernema* and *Heterorhabditis*. We find that EPNs are attracted to the general host cue carbon dioxide under all conditions tested. However, responses to many odorants exhibit extreme olfactory plasticity as a function of IJ cultivation temperature and/or age. For example, in *Steinernema carpocapsae*, many odorants that are strongly attractive at lower temperatures are strongly repulsive at higher temperatures and vice versa. This temperature-dependent olfactory plasticity occurs in individual IJs and is reversible, since temperature-swapping IJs reverses their olfactory preferences. By contrast, other species appear to show primarily age-dependent changes in olfactory preferences, while still other species show little or no olfactory plasticity. Thus, the type and extent of olfactory plasticity varies among EPNs. In addition, we find that foraging strategy can also vary with temperature. For example, *Steinernema carpocapsae* behaves more like an ambusher at higher temperatures and more like a cruiser at lower temperatures. Some EPNs are found in geographical regions that undergo substantial seasonal temperature variation, and we hypothesize that plasticity of olfactory behavior and foraging strategy may enable EPNs to optimize host seeking under changing environmental conditions.

Symposium. Monday, 15:00. **7**

Multiple Consequences of Belowground Herbivore Induced Volatile Signals

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Plants can influence the behavior of and modify community composition of soil dwelling organisms through the exudation of organic molecules. Given the chemical complexity of the soil matrix, soil-dwelling organisms have evolved the ability to detect and respond to these cues for successful foraging. A key question is how specific these responses are and how they may evolve. Soil nematodes are a group of diverse functional and taxonomic types, which may reveal a variety of responses. Herbivore-induced volatile emissions benefit plant hosts by recruiting natural enemies of herbivorous insects. Such tritrophic interactions have been examined thoroughly in aboveground terrestrial environments. Recently, similar signals have been described in the subterranean environment, which may be of equal importance for indirect plant defense. Our work has shown that plant roots of citrus defend themselves against root herbivores by releasing an herbivore-induced plant volatile (HIPV), pregeijerene (1,5-dimethylcyclodeca-1,5,7-triene), that attracts naturally occurring entomopathogenic nematodes (EPNs) to larvae when applied in the field. However, the soil community is complex, containing a diversity of interspecies relationships that modulate food web assemblages. In a series of experiments we examine the specificity of this HIPV in the complex nematode community, including beneficial entomopathogenic nematodes, plant-parasitic nematodes, as well as, hyper-parasitic nematodes and nematophagous fungi. We provide the first evidence showing subterranean HIPVs behave much the