ISCE 2019 Annual Meeting
Atlanta, GA
June 2- 6, 2019
Poster Presentations

Adams S. A., Schulz S., and Gillespie R.

Chemical Species Recognition in an Adaptive Radiation of Hawaiian Spiders.

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The mechanisms by which reproductive isolation evolves and is maintained in adaptive radiations is central to fundamental processes such as reinforcement, sensory drive, and hybridization. Particularly important are situations where ecologically distinct incipient sister species co-occur geographically, resulting in frequent encounters between diverging species and necessitating finely tuned recognition mechanisms for species to maintain reproductive isolation. This is seen in adaptive radiations of Anolis lizards, cichlid fish, and Hawaiian Drosophila. In these systems however, much of the work has been done within the domain of human perception – visual and auditory cues. Chemical cues are one of the most ancient and widespread modalities of communication, yet their importance in species recognition and reproductive isolation remains to be studied in the context of adaptive radiations. This study focuses on the role of chemical species recognition cues in reproductive isolation and speciation within a well-studied adaptive radiation of Hawaiian Tetragnatha spiders in which ecologically distinct sister species co-occur, and visual and auditory cues appear to play little or no role in species recognition prior to mating.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 99

Agnihotri A., and Xu W.

Molecular study of *Helicoverpa armigera* odorant binding proteins to better understand the insect chemosensation

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Like many other organisms, insects also use multiple external stimuli to regulate behaviours such as feeding, egg laying, and mating. These activities are initiated and driven by specific chemosensory signals in terms of olfaction or gustation. Odorant-binding proteins (OBPs) are one of the crucial aspects of insect chemosensory system, which plays an essential role in transporting the hydrophobic volatile odorant molecules through the sensillum lymph and deliver these ligands to the olfactory receptors. In this work, we aim to study the molecular interaction and the physiological functions of Helicoverpa armigera OBPs and understand the biochemical mechanism of OBP functions in insect chemosensation. Based on the available genome and transcriptome data, we have shortlisted the OBP candidates showing high expression in the Antennae and Tarsus of H. armigera. The molecular cloning and in-vitro protein expression methodology have been used to obtain a high amount of candidate OBPs. Further, by applying the reverse chemical ecology approach, these proteins are functionally characterised based on their interaction with the host plant volatile ligands. In-silico protein-ligand interaction study has also been performed to understand the binding patterns and ligand affinity of these proteins with corresponding plant volatile ligands. This study improves our understanding of the chemosensory mechanism of insects and aims to enhance the scholarly knowledge of insect-plant interaction.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 61

Alborn H. T., Bruton R. G., and Beck J. J.

A Comparison of Three Solventless Volatile Collection Techniques for Analysis of Plant, Insect, and Microbe Semiochemicals

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Volatiles play an important role in inter-organismal communication by plants, insects, and microbes. To better understand and exploit these interactions, headspace volatiles are routinely collected and analyzed. Ideally, the ecological system studied should help guide the choice of collection and analysis technique (e.g., static vs. dynamic); however, often the choice is governed by availability or tradition. Within these constraints it is still necessary that each system detect and provide a realistic, in situ or in vitro volatile profile of the studied system. Using a defined blend of compounds to mimic a simple, natural bouquet we compare the strength and weaknesses of three solventless, techniques: SPME, SPDE (needle trap), and an in-house designed thermal desorption system. For comparison purposes, a small volume direct head space and an established chemical desorption method were used. We found that qualitative as well as quantitative differences could be correlated with adsorbent sampling capacity and structural bias, but to an even greater extent by factors such as gas phase equilibrium and sampling volumes. The discoveries were used to provide a general guidance for selection of techniques for natural and agricultural chemical communication applications.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 19

Alvarez Costa A., Gonzalez, P. V., Harburguer L. V., and Masuh H. M.

***Eucalyptus nitens* (Myrtaceae) essential oil as an alternative natural repellent against Aedes aegypti and Anopheles pseudopunctipennis (Diptera: Culicidae)**

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Anopheles pseudopunctipennis (Theobald) is the main vector for malaria in Latin-America. Aedes aegypti (L.) (Diptera: Culicidae) is the vector of dengue, yellow fever, Zika, and chikungunya. The use of repellents based on natural products is an alternative for personal protection against these diseases. We evaluated the repellence of the essential oil of E. nitens against Ae. aegypti and An. pseudopunctipennis. The essential oil was extracted and analyzed by GC-MS. The repellence of the essential oil, 1,8-cineole and DEET against both species of mosquitos was evaluated using the plaque repellency method, which consisted in analyzing the behavior of individual females of these mosquitoes exposed to a filter paper half impregnated with the tested compounds. We tested the repellence of the three treatments against Ae. aegypti by the arm-in-cage method. The main components of the essential oil were terpenes and β-triketones (flavesone, leptospermone, and isoleptospermone). A repellent activity to the essential oil and DEET against both species were found but no significant response to 1,8-cineole was detected. We detected the increased locomotor activity of Ae. aegypti exposed to the essential oil. The total protection time of the essential oil (97.50 min) against Ae. aegypti was significantly higher compared with 1,8-cineole (5.00 min) and similar compared with the DEET (196.67 min). The good repellent activity of E. nitens essential oil could be due to the cyclic β-triketones.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 67

Amorós M. E., Lagarde L., Do Carmo H., Heguaburu V., and González A.

Advances in the development of an attractant for *Diploschema rotundicolle* (Coleoptera: Cerambycidae)

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The citrus borer, Diploschema rotundicolle (Coleoptera: Cerambycidae), is a longhorn beetle native to South America and regarded as a serious citrus pest in Uruguay. High infestation levels cause an overall deterioration of the tree structure, resulting in important yield reduction. Currently, the only available management strategy is cultural control by trimming off infested branches, which is expensive in labor costs and mostly inefficient. Our work aims at the development of an effective trapping system that could eventually be used for management strategies of this pest. Our work on the chemical communication system of D. rotundicolle has shown that males produce large amounts of (3R)-3-hydroxy-2-hexanone and some minor compounds, including 2,3-hexanediol and 2,3-hexanedione. This a nocturnal beetle, and preliminary work has shown attraction to light traps. In this work a field trail was carried on, in which the pheromone and light stimulus were tested in cross-vane traps in a citrus grove, during the summer of 2018/19. Tested attractants included the racemic hydroxyketone, racemic hydroxyketone plus hexanediol, led light, led light plus the two pheromone compounds, and isopropanol as control. Preliminary results show higher catches in light traps with pheromone than in light traps alone, suggesting that light and chemical stimuli can be used in combination to enhance field trapping of D. rotundicolle.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 84

Arriola K., Meier L., Mongold-Dyers J., Hanks L. M., and Millar J.G.

Synthetic Strategy and Absolute Stereochemistry of a Novel Polyketide, the Likely Aggregation-Sex Pheromone of *Graphisurus fasciatus* (Coleoptera: Cerambycidae)

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The Cerambycidae constitute one of the most diverse and economically important beetle families. Exploiting insect semiochemistry as a strategy for integrated pest management has proven successful, and while the chemical ecology of longhorn beetles has progressed substantially within the past decade, our overall knowledge of cerambycid semiochemistry is still limited. The first polyketide cerambycid pheromone was only recently discovered, indicating the chemical space occupied by cerambycid semiochemicals is more diverse than initially thought. Herein, we describe the isolation and identification of a male-specific polyketide from the cerambycid Graphisurus fasciatus, which is a likely candidate for its aggregation-sex pheromone. The absolute configuration of this novel polyketide was identified through a modular synthetic approach, whereby multiple stereoisomers were synthesized in predicted biased ratios, allowing unequivocal structural elucidation of the natural stereoisomer from 16 possible stereoisomers.

Themed Session: Integrated Approaches for Structure Determination in Chemical Ecology

POSTER

Number: 39

Avila C., De Castro-Fernández P., Nestorowicz I., Moreno-Salazar C., and Angulo-Preckler C.

How will global change affect Antarctic chemical ecology?

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Future climate change scenarios predict an increase of 1.8-4ºC in sea surface temperature. Polar regions seem to be among the most vulnerable, given that polar species are in general stenothermal and less capable of enduring temperature shifts. Antarctica is a still unexplored area of our planet, where biological diversity and even more, chemical diversity remain vastly unknown. Our research group has been studying marine benthic ecosystems in different Antarctic areas, producing many interesting discoveries regarding both new species to science as well as new natural products. Since 1998, the Antarctic research projects ECOQUIM, ACTIQUIM, DISTANTCOM, and BLUEBIO aimed at gaining a better understanding of the diversity and structure of Antarctic benthic marine communities, both at biological and chemical levels. To do so, among other aspects, we studied the ecological activity of marine natural products from benthic organisms by in situ chemical ecology experiments. In contrast to what happens in other regions of the planet, benthic Antarctic ecosystems are ruled by a strong environmental stability, only comparable to that observed in caves or abyssal regions, and thus the interactions between organisms become a very important factor in structuring these communities. Many of these interactions are regulated by natural products. How climate change may affect Antarctic marine chemical ecology is the subject of our most recent studies and we present here our preliminary results.

Themed Session: Anthropogenic Impacts on Chemical Cues, Signals and Chemoreception

POSTER

Number: 2

Bae M.

Chemical Warfare between Microbial Symbionts of Fungus-Growing Ants

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Recent chemical investigations into bacterial symbionts of fungus-growing ants has led to the identification of several secondary metabolites that play key roles in maintaining the health of this complex system.1,2 In a classic mutualism, bacterial symbionts provide bioactive small molecules, i.e. dentigerumycin, selvamicin, that combat both disease and predation within the nest.1-6 My work has focused on uncovering the chemical interactions occurring between the bacterial symbiont and fungal pathogen. I discovered the Pseudonocardia sp. strain, ICBG1122 producing the cyclic peptide antifungal agent, dentigerumycin, displayed potent and selective inhibitory activity against a strain of the pathogenic fungus that originated from the same nest as ICBG1122. In the newly developed trans-well system, which was designed to uncover molecular interactions between microbes,7 new analogs of conocandin from pathogen fungus were highly-induced only when exposed to dentigerumycin. Conocandin B and C showed highly-potent inhibitory activity against Pseudonocardia sp. ICBG1122. Based on the further bioinformatic studies for mutants of S. aureus,7 we hypothesize that conocandins are targeting the FabH in Pseudonocardia sp. and thus preventing the Psuedoncardia from generating branched chained fatty acids. From this study we have gained interesting insights into the complex interactions occurring between fungus-growing ants, cultivar fungus, symbiotic bacteria, and pathogenic fungus.

Themed Session: Chemical Communication of Social Insect Associates: Espionage, Weaponry and Stealth

POSTER

Number: 30

Balakrishnan P., Damodaram K. J. P., Parepally S. K., Murugan T. R. L., and Subbaraya U.

Role of host plant volatiles in adult attraction and auto dissemination of entomopathogenic fungi, with Banana fruit scarring beetle, *Nodostoma virdepenne* (Jac.)

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Adult leaf and fruit scarring beetles (Nodostoma virdepenne (Jac.), Chrysomelidae: Coleoptera) exclusively feed on banana leaf as well as developing fruits causing both qualitative and quantitative losses. The management practices till to date are being dominated by chemical insecticides as suitable eco-friendly management measures are lacking. Therefore, an attempt was made to study the scope of the host plant volatiles (= kairomones) mediated attraction for the successful trapping of adult beetles and subsequent contamination with entomopathogen, Beauveria bassiana for developing potent autodissemination technology. As the beetles are monophagous and prefer to feed on the newly emerging leaf, flag leaf, flower bract, leaf mid rib and developing fingers, preliminary studies using these plant parts as bait in conventional trap along with B. bassiana (1x109 CFU/g) conclusively established the attraction of beetles to the trap and subsequent mortality to the tune of 100%. Further attempts to isolate and identify the host plant volatiles that can be synergistically used in the traps revealed the presence of butyl 3-hydroxybutanoate, 2,7-dimethyl-1-octanol, 2-pentanol, 3-chloro-4-methyl-, (R*,R*)-(±)-, 2,6,10-trimethyltetradecane, 3,7,11-trimethyl-1-dodecanol, 4-Acetyl-m-xylene, benzyl oleate, 2-hexadecanol, 2,6,10-Trimethylhexadecane, propanoic acid, 2-(3-acetoxy-4,4,14-trimethylandrost-8-en-17-yl)-, 1,2-benzenedicarboxylic acid, bis(2-methylpropyl) ester, 14-hydroxy-14-methyl.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 3

Balaraman P., and Plettner E.

Ecological Role of Cytochrome P450cam (CYP101A1) in the Chemotaxis of *Pseudomonas Putida* (ATCC 17453) Towards Camphor

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The camphor-degrading P. putida (ATCC 17453) is an aerobic soil bacterium, which can use camphor as its sole carbon and energy source. The genes responsible for the catabolic degradation of camphor are encoded on the extra-chromosomal CAM plasmid. A monooxygenase, cytochrome P450cam, mediated hydroxylation of camphor to 5-exo-hydroxycamphor is the first committed step in the camphor degradation pathway. Under low O2 levels, P450cam catalyzes an unusual reduction reduction to produce borneol form camphor. Borneol has been previously demonstrated by us to downregulate the expression of P450cam. To evaluate the role of P450cam and the consequences of borneol based down-regulation of P450cam under low O2 conditions, we performed chemotaxis assays with camphor induced and non-induced P. putida strain ATCC 17453 using camphor, borneol, oxidized camphor metabolites and known bacterial attractants (D)-glucose, (D) - and (L)-glutamic acid. In addition, we have used 1-phenylimidazole, a P450cam inhibitor, to explore if P450cam plays a role in the chemotactic ability of P. putida towards camphor. We demonstrated that camphor, a chemoattractant, became toxic and chemorepellent when P450cam was inhibited. We have also demonstrated the effect of borneol on chemotaxis and found that the bacteria chemotaxed away from camphor in the presence of borneol. This is the first report describing chemotactic ability of P. putida ATCC 17453 and the crucial role of P450cam in this process.

Themed Session: Microbe-Driven Chemical Communication across Ecosystems and Hosts

POSTER

Number: 60

Beránková K., Schlyter F., and Jirošová A.

Design of the new monoterpenyl dispensers with required release rate

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The bark beetle Ips typographus is the most aggressive, tree-killing pest of conifer forests. During the last 25 years, its outbreaks have increased rapidly in the middle Europe as a result of climate changes. Therefore, it is very important to find new alternative defense measures close to nature with the possible use in management. One of them is the search for chemicals from its ecological niche and testing their biological activity. The promising candidates to expose the repellent effect for Ips typographus are oxygenated monoterpenes, compounds with provable electroantennographic activity and specific sensilla located on Ips typographus antenna. Its behavioral activity will be tested in large-scale field experiment in bark beetle pheromone traps. Here, we report the new design development of eight oxygenated monoterpenes dispensers and optimization its release rate in dependency on time. We create dispensers with required release rate of 0.1, 1 and 10 mg per day. The lowest level corresponds to the natural rate of evaporation of these substances from natural sources. The highest rate of evaporation is a potential repellent dose. The release rates of dispensers were estimated by weighting per time unit under the constant condition. The terpinene-4-ol, estragole and carvone were chose for developing of the prediction methodology for creation of the dispensers with the required release rate.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 68

Body M., Appel H. M., Grant, T. N. L., Gray, D. J., and Schultz, J.C.

Gall induction by Phylloxera on grape leaves – An integrative approach

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Galls are highly specialized structures arising from atypical development of plant tissue induced by another organism. Many different kinds of organisms can induce galls on plants, including viruses, fungi, bacteria, nematodes, mites and insects. However, gall-inducing insects produce the most diverse galls in nature, ranging from simple stem swellings to complex structures that are ornamented with bright colors and spines. An insect-induced gall is a modified growth of plant tissue induced by a reaction to the presence and activity of an insect. The insect induces a differentiation of tissues with features and functions of an ectopic organ. These structures are thought to provide adaptive advantages to gall-inducers by providing protection to the galling insect from natural enemies and environmental stresses, and also an adequate nutrition. Gall formation is a complex and close interaction between the gall-inducing insect and its host-plant resulting from molecular cross-talk between two independent genomes. Many have noted that galls often resemble flowers or fruit, but the mechanism at the origin of gall induction is still unknown. In this study, we (i) characterized how the gall-inducing insect Daktulosphaira vitifoliae reshapes the leaf morphology of the grapevine Vitis riparia during gall induction and development, and (ii) investigated whether galling insects hijack plant flowering pathways to induce galls. We used an integrative approach that included using microscopy.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 58

Böttner L., Niephaus E., Prüfer D., Gronover C. S., and Huber M.

Ecological functions of natural rubber biosynthesis in Russian dandelion

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Natural rubber, a cis-1,4-polyisoprene with more than 10,000 isoprene units, is one of the economically most important plant polymers. Although its phylogenetically widespread distribution and likely convergent evolution suggests important adaptive functions for plants, the ecological roles of these compounds remain unknown. We investigated the effects of natural rubber on herbivore resistance and root microbial colonization during the interaction of the high-rubber producer Taraxacum kok-saghyz with its soil-dwelling enemy, the common cockchafer (Melolontha melolontha). In a choice experiment addition of ecologically relevant 1,4-cis-polyisoprene concentrations to diet deterred M. melolontha feeding. In a non-choice setup M. melolotha larvae gained less weight on artificial diet supplemented with 1,4-cis-polyisoprene compared to diet with solvent control. Moreover, transgenic T. kok-saghyz plants deficient in natural rubber biosynthesis suffered stronger reduction in above ground biomass accumulation under M. melolonhta attack compared to control plants. These experiments provide the first line of evidence that natural rubber protects plants from herbivore attack. Whether natural rubber additionally restricts the colonization of microorganisms under root herbivory will be addressed in future microbiome analyses.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 26

Brzozowski L., and Mazourek M.

Role of cucurbitacins in insect preference in *Cucurbita pepo*.

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Cucurbitacins are intensely bitter and toxic terpenoids of the Cucurbitaceae family that have been implicated in mediating herbivore preference. While many herbivores are dissuaded by the presence of cucurbitacins in plant tissue, some beetles (Coleoptera: Chyrsomelidae) have evolved specialized metabolism to sequester cucurbitacins for their own defenses. However, it is yet unclear whether this relationship is maintained between Cucurbita pepo crops (i.e. zucchini, summer squash), and an agricultural pest, the cucurbit-specialized striped cucumber beetle (Acalymma vittatum). Of the specialized beetles, A. vittatum is relatively insensitive to cucurbitacins, and C. pepo crops have relatively low levels of cucurbitacins. We thus developed a genetic mapping population to address two objectives: (1) determining the genetic basis of cucurbitacin production in C. pepo, and (2) establishing the role of cucurbitacins in A. vittatum preference through a selection experiment. Overall, we identified one major effect locus controlling cotyledon cucurbitacin production. We also demonstrated that A. vittatum leaf damage and cotyledon cucurbitacin production is independently regulated. There is ongoing work to fine map the locus, and explore the generality of this result in other Cucurbitaceae crops.

Themed Session: Biosynthesis of Secondary Metabolites in Chemical Ecology

POSTER

Number: 15

Būda V., Aleknavičius D., Apšegaitė V., Radžiutė S., Blažytė-Čereškienė L., Servienė E., and Butkienė R.

Is buckthorn and fruit fly interaction mediated by yeasts?

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Sea buckthorn fly, Rhagoletis batava L., is the most important pest of sea buckthorn (Hippophae rhamnoides Hering) (SB) berries. Females lay their eggs into the berries and after maggot eclosion those cause significant damage. The yield and its quality decreases causing economic loses for farmers sometimes up to 100% (e.g. Shalkevich et al., 2014). Demand of SB berries is increasing, for wide use in food, cosmetics and medicine industry, thus ecologically friendly methods for pest control are needed. Data on chemoecology of the pest could be useful looking for new biocontrol methods. To identify volatile organic compounds (VOCs) present both in emissions of SB berries as well as in several yeast species occurring on the berries which elicit EAG responses both in females and males of buckthorn fly, was the aim of the present report. Among yeast species which occur on SB berries, Pichia kudriavzevii was identified and VOCs were collected by SPME and analyzed. Among 35 VOCs identified by GC-MS method, 10 were recorded as EAG-active. Those were 8 esters and 2 alcohols: ethyl acetate, ethyl propionate, ethyl butanoate, 2-methylbutyl-/3-methylbutyl acetates, 3-methylbut-1-yl propionate, 3-methylbutan-1-ol, ethyl hexanoate, ethyl octanoate, 2-phenylethyl acetate, and 2-phenyl ethanol. Both laboratory and field behavioural tests of the EAG-active VOCs are in progress. The study was supported by Research Council of Lithuania grant No. DOTSUT-12 (09.3.3-LMT-K-712-01-0099).

Themed Session: Insect-Microbe Chemical Communication

POSTER

Number: 38

Buellesbach J.[1], Gadau J.[1], Tsutsui, N.[2], Schmitt, T.[3], and Niehuis, O.[4]

From wasps to ants: What unifying elements can be found in phylogenetically and functionally diverse cuticular hydrocarbon profiles hinting at a commonly evolved chemical language?

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As the earliest and most wide-spread form of communication, chemical signaling has permeated through all known taxa of life. Insects, in particular, have exploited chemical signaling as their primary mode of communication. Cuticular hydrocarbons (CHC), the dominant fraction of the insects' epicuticle, form the basis for a wide array of different chemical signaling systems while primarily functioning as desiccation barrier. However, how exactly information is coded, preserved and communicated in the vastly diverse CHC profiles found in different insect taxa remains largely unassessed. My main goal is to decipher the signaling properties of CHC profiles in different representative Hymenopteran model organisms where CHC provide the main cues for interaction systems as diverse as sexual attractiveness and species recognition for solitary taxa (e.g. the jewel wasp Nasonia vitripennis) as well as nestmate and colony recognition for eusocial taxa (e.g. the Argentine ant Linepithema humile). Integrating genetic, chemical and behavioral methods, intriguing similarities in the key CHC signaling compounds begin to emerge despite the high diversity in information content. This strongly suggests that the main signaling properties in CHC profiles are evolutionary conserved traversing vast phylogenetic boundaries, delivering the first hints at elements of a unified, common "chemical language".

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 20

Cepeda M. R.[1], Fisher C. L.[2], Lane T. W.[2], and Kubanek J.[1]

Natural Products to Protect Algal Biofuel Ponds

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Microalgae are known to benefit from bacterial communities through nutrient exchange whereby algae provide organic carbon to bacteria in return for vitamins and minerals. Preliminary studies suggest that microalgae in open biofuel ponds could also benefit from specific bacteria consortia that chemically defend them from rotifer predation, thus preventing biofuel pond crashes, but the mechanism of action is unknown. These studies indicate that aquatic bacteria consortia potentially produce protective molecules that deter predators and understanding the chemical ecology of these systems would lead to a cost-efficient way of minimizing algal predation in open algal biofuel ponds. The microalga Microchloropsis salina, the rotifer Brachionus plicatilis, and co-occurring communities of aquatic bacteria are a model system for understanding how bacteria consortia mediate microalgal-predator interactions. This project consists of three main aims where the first is to determine whether the protective molecule(s) are small organic metabolites, biomacromolecules, or intracellular bacterial toxins. 1H NMR and mass spectrometry-based metabolomics are used to obtain chemical profiles of bacteria consortia in order to identify putative defenses against rotifer predation. The method developed for identifying protective molecules in this system could further be applied to other microalgal open outdoor systems to target predators that prey on additional commercially valuable microalgae species.

Themed Session: Other

POSTER

Number: 104

ISCE 2019 Annual Meeting
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Poster Presentations

Chhetri B. K.[1,2], Lavoie S.[2,3,4], Sweeney-Jones, A. M.[1,2], Mojib N., Polavarapu P. L.[5], and Kubanek J.[1,2,3,6]

Spectroscopic and computational approaches for determining the three-dimensional structure of the antifungal diterpene glycoside, peyssonnoside A

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Secondary metabolites play vital roles in ecosystems where they are used by organisms for interspecific, intraspecific, and environmental interactions. Their ecological functions typically manifest themselves by binding to specific protein receptors. Consequently, the three-dimensional structures of secondary metabolites are critical; related organic molecules with slight structural differences often exhibit completely different biological effects. Two diterpene glycosides, peyssonnosides A–B, sharing an unprecedented carbon skeleton were isolated from the marine red alga Peyssonnelia sp. The strong antifungal activity of peyssonnoside A against the marine fungus Dendryphiella salina (IC50 = 0.14 μM) along with a high natural abundance (0.42% of dry weight) suggests that it acts as an antimicrobial defense. The structures were deduced by extensive NMR and mass spectral analysis. A unique application of quantitative rotating frame Overhauser effect spectroscopy (ROESY) NMR spectroscopy was employed to determine the absolute configuration of the aglycone of peyssonnoside A, wherein the known configuration of the molecule's sulfated β-D-glucose moiety was used as an internal probe. The absolute configuration was confirmed by comparison of experimental optical rotatory dispersion (ORD) with values predicted with density functional theory (DFT) calculations. These combined approaches enabled elucidation of the full 3-D structure of an ecologically important marine natural product.

Themed Session: Integrated Approaches for Structure Determination in Chemical Ecology

POSTER

Number: 40

Clavijo-McCormick A., Nakano M., Trewick S., and Morgan-Richards M.

Mate choice and sexual communication in the New Zealand stick insect *Clitarchus hookeri*.

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New Zealand has a unique natural heritage, including multiple native and endemic species of arthropods. Understanding their reproductive behaviour may provide valuable information for their conservation, and that of their habitats. The New Zealand stick insect Clitarchus hookeri is particularly interesting in this regard, since it has both sexual and asexual (parthenogenetic - female only) populations distributed throughout the country. This work aimed to explore the morphological and chemical traits associated with sex (male vs. female), and different reproductive strategies for females (sexual vs. parthenogenetic) across populations; and to test the ability of males to discriminate between sexual and parthenogenetic females for their pre- and post-copulatory choices. We found clear morphological and chemical traits distinguishing males from females, namely differences in body mass, leg length, antennal length, and volatile organic compound emissions during the peak mating hours. However, sexual and parthenogenetic females overlapped in their morphology and chemical traits. Concurrently, males failed to discriminate between sexual and parthenogenetic females both in pre- and post-copulatory choices preferring females with lighter body weight irrespective of their reproductive mode. This study suggests that parthenogenetic females still retain traits linked to sexual reproduction in spite of their potential costs.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 85

Cofer T. M., Jones A. C., Seidl-Adams I., and Tumlinson J. H.

Phylogenetic analysis of the mechanisms for altering green leave volatile (GLV) emissions in herbivorous Lepidoptera

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Green leaf volatiles (GLVs) are six-carbon aldehydes, alcohols, and their esters that are produced by nearly all plants upon damage. GLVs function as within- and between-plant signaling molecules, and can serve as foraging cues for insect herbivores and their natural enemies. Our research, and that of others, show that GLV emissions are decreased, and that their emission profile may be modified, when insect oral secretions are applied to damaged leaves. To date, three mechanisms have been identified by which insect herbivores alter GLV emissions: 1) an isomerase that converts the GLV (Z)-3-hexenal to (E)-2-hexenal, 2) a hydroperoxide dehydratase that modifies the substrate required for GLV biosynthesis, and 3) a small, heat-stable molecule that appears to bind (Z)-3-hexenal, thus preventing its release. Here, we apply a phylogenetic analysis to these mechanisms to determine their evolutionary relationships across common lepidopteran families. We show that the small molecule occurs in nearly all families surveyed, while genes encoding the hydroperoxide dehydratase are present in only three. Similarly, we find that the (Z)-3 to (E)-2 isomerase is restricted to only two closely related families. These results suggest that Lepidoptera have evolved multiple strategies to alter GLV emissions. However, rather than being redundant, these strategies act at specific steps in the GLV biosynthetic pathway, undoubtedly with downstream effects on both the insect and its host plant.

Themed Session: Chemically-Mediated Consumer-Prey Interactions

POSTER

Number: 32

Colazza S.[1], Guarino S.[1], Arif M. A.[1], Millar J. G.[2], Arriola K.[2], and Peri E.[1]

Novel diterpenes from *Brassica oleracea* var botrytis seedlings mediate host location by the stink bug *Bagrada hilaris*

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Bagrada hilaris Burmeister, the painted bug, is a pest of various vegetable crops of the Brassicaceae family, being particularly damaging to young seedlings. In this study, the role of volatile organic compounds (VOCs) emitted by seedlings of three Brassica species on host location by B. hilaris was evaluated. Volatiles from B. oleracea seedlings were collected and bioassayed with B. hilaris individuals, using electroantennographic and behavioral techniques. When crude extracts of the VOCs from B. oleracea seedlings and liquid chromatography fractions thereof were bioassayed, B. hilaris individuals were attracted to the crude extract, and to the non-polar fraction containing hydrocarbons, whereas there were no responses to the more polar fractions. GC-MS analysis indicated that the main constituent of the non-polar fraction is a diterpene hydrocarbon, with trace amounts of several other diterpene hydrocarbons. These results suggest that this diterpene, alone or in combination with one or more of the minor compounds, is a key mediator in this insect-plant interaction. The main diterpene has a molecular weight 272 Da with chemical formula C20H32 and is a compound new to science. It was isolated in microgram quantities by a combination of liquid and preparative gas chromatography, and identified by a combination of microchemical tests and mass and NMR spectral data.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 4

Colazza S.[2], Salerno G.[1], Frati F.[1], Conti E.[1], Peri E.[2], and Cusumano A.[3]

The emission of oviposition-induced plant volatiles exploited by an egg parasitoid depends on the mating status of an herbivorous stink bug female

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Plants respond to insect egg deposition with emission of oviposition-induced plant volatiles (OIPVs) which can recruit egg parasitoids of the attacking herbivore. The elicitor responsible for OIPV emission is not known in the case of plants induced by stink bug oviposition. In this work we conducted behavioural and biochemical investigations to localize the source of the elicitor that attracts egg parasitoids and elucidate the role of host mating in elicitation of plant responses. We used as model study organisms a tritrophic system consisting of the egg parasitoid Trissolcus basalis (Wollaston), the stink bug host Nezara viridula (L.) and the plant Vicia faba L. We found that egg parasitoid attraction to plant volatiles is induced by extracts coming from the dilated portion of the stink bug spermathecal complex. However, attraction only occurs if extracts are obtained from mated females. Parasitoid were not attracted when extracts coming from the accessory glands of male hosts were applied. SDS-PAGE electrophoresis correlated with olfactometer observations as the protein profile of the dilated portion of the spermathecal complex is affected by the stink bug mating status. This finding suggests that post–copulatory physiological changes in this reproductive structure trigger OIPV emission and egg parasitoid attraction. This study lays the basis for the chemical characterization of the elicitor responsible for OIPV emission.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 5

Coll Aráoz M. V.[1,2], Hill J.[1], Fernandez, P. C.[3,4], Albarracín E. L.[1], and Virla E.G[1,5]

Dalbulus maidis and Peregrinus maidis, both phloem feeding hopper species, induce different volatile profiles in maize. Consequences for a natural enemy

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Upon herbivory several biosynthetic pathways are activated and the response of a single plant species to different species of herbivores and even different instars of the same herbivore may be specific (Gouinguene et al, 2003). Natural enemies exploit these herbivory induced volatile profiles to find their preferred hosts, sometimes involving complex context-dependent analysis of chemical cues (De Moraes et al 1998). Dalbulus maidis (DeLong) (Hemiptera: Cicadellidae) and Peregrinus maidis (Ashmead) (Hemiptera: Delphacidae) are phloem feeding hopper species associated with maize that serve as vectors of several maize stunting and viral diseases. Both hopper species damage maize plants by removing sap and also because females lay their endophytic eggs in the nerves of the blade, cutting holes into the plant tissue with their ovipositor. Dalbulus maidis is a specialist herbivore that has a long history of coevolution with the genus Zea like maize (Zea mays L.) and its wild relatives, the teosintes (Zea spp.). Unlike D. maidis, P. maidis apparently adapted to maize as a host in post-Columbian times and it is a polyphagous insect, most frequently associated with Sorghum spp., but has also been found on Panicum spp. and other grasses. The eggs of both hopper species are parasitized by the wasp Anagrus virlai Triapitsyn (Hymenoptera: Mymaridae). However, parasitism on P. maidis seems to be occasional and Hill et al. (2019) demonstrated that A. virlai preferred odours from plants ind.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 86

Crisan C., Chandrashekar H., Hill S., Lieberman R., and Hammer B. K.

A Type Six Secretion System gene cluster found in V. cholerae environmental strains encodes a novel toxin

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Vibrio cholerae, the waterborne etiological agent responsible for fatal cholera disease, employs a Type VI Secretion System (T6SS) to compete against other bacterial and eukaryotic cells. The T6SS is a harpoon-like macromolecular apparatus that can puncture adjacent cells to deliver toxic proteins and confer a competitive advantage to V. cholerae in environmental and host habitats. Regulatory and structural T6SS proteins are found on a large gene cluster in V. cholerae strains, while additional components and toxins are located on auxiliary gene clusters. Previously, we identified a novel T6SS auxiliary gene cluster (Aux 4) in several V. cholerae strains of environmental origin and predicted a novel toxic protein encoded within the cluster (Tve4, Type VI Vibrio Effector 4). No conserved motifs or catalytic sites indicative of function were identified in the amino acid sequence of Tve4. Tve4 induced toxicity in E. coli when expressed in the periplasm but not in the cytoplasm. A patient-derived V. cholerae reference strain encoding the Aux 4 cluster outcompeted the parental strain lacking the Aux 4 cluster in a T6SS- and Tve4-dependent manner. Confocal microscopy revealed that Tve4 can induce lysis of target cells and suggests this novel toxin possesses bactericidal activity. We are currently working to understand the regulation of the Aux 4 cluster in the native strain and to determine the biochemical function of the Tve4 protein.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 62

Demko A. M.[1], Klau L. J.[1], Muskat M.[1], and Jensen P. R[1.2].

Linking sediment characteristics with microbial communities and their metabolites

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Bacteria are a vital component of the earth's ecosystem and exhibit an extraordinary amount of diversity relative to the rest of life. These microbes play an integral role in the food web and nutrient cycling, are symbiotically associated with countless organisms, and can be both a source of disease and/or an agent of mitigation through the natural products they produce. Previous research has found correlations between the microbial communities in marine sediments with various environmental characteristics, but few studies have explored those connections using next-generation sequencing or considered the role of spatial variability in community dynamics. Furthermore, the use of environmental metabolomics as a method to assess the secondary metabolite profiles of marine sediments can give us insight into the role these compounds are playing in structuring and maintaining the microbial community. Thus, the goal for this project was to utilize next-generation sequencing in conjunction with environmental metabolomics and sediment characteristics to study the microbial community of tropical marine sediments across varying spatial scales. Ultimately, we hope to gain insight into sediment microbial community dynamics and the role secondary metabolites play in shaping these complex marine ecosystems.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 48

Dowell J., and Mason C.

An evolutionarily relevant definition of 'Eavesdropping' and 'Communication'

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Current hypotheses surrounding the evolution of emission and perception of volatile organic compounds (VOCs) as a communication mechanism among plants lies in their importance as internal signals. VOCs released from damaged organs induce resistance in undamaged organs of the same individual faster than vascular signaling and independent of anatomy. Earlier work shows the reduction in efficacy of VOC induced resistance as genetic and physical distance of populations increase, although the pattern of decay is not supported at the interspecies level. As evidence supports the occurrence of interspecies VOC-mediated induction, variable responses not explainable by shared evolutionary history pose a critically missing mechanism for describing the transition of the phenomenon from communication to 'eavesdropping'. As evolutionary theory necessitates fitness consequences for 'true communication', it is important to disentangle chemically mediated induction events from reciprocal self-recognition (communication) among individuals from unidirectional signal interpretation (eavesdropping). Here we present several theoretical models hypothesized to lead to communication or eavesdropping, while presenting a series of experiments to disentangle this question in a phylogenetically informed manner using the annual clade of Helianthus.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 21

Du Y., and Chen J.

Attraction and olfactory responses to ylang ylang oil in red imported fire ant, *Solenopsis invicta*

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Ylang ylang oil is an essential oil extracted from the fragrant yellow flowers of the tree Cananga odorata. The red imported fire ant, Solenopsis invicta Buren, is one of the most successful invasive ants in the world. Intriguingly, the electrophysiological study (electroantenno-graph, EAG) revealed that ylang ylang oil elicited extremely high EAG response in S. invicta male alates, intermediate high EAG response in S. invicta worker and female alates. In addition, strong and significant EAG response can be detected in other 12 widespread insect species beside S. invicta. Subsequently, gas chromatography-mass spectrometry (GC-MS) coupled with EAG determined that benzyl acetate (BA), prenyl acetate (PA), benzaldehyde were key compounds in ylang ylang oil, which are responsible for the extremely high EAG response in S.invicta male alates. Furthermore, behavior (digging assay and two choices) assays indicated ylang ylang oil, PA and BA could be potential attractants for S. invicta. The additional EAG responses to over 30 acetates in S. invicta worker, female and male alates demonstrated that large diversity of EAG tuning responses ranges in structural different acetates. Our findings could be particularly interesting not only to increase the knowledge of the S. invicta olfactory system but also to better develop the sustainable fire ant control strategies based on manipulating chemosensory communication.

Session/symposium: Natural Product Application in Insect Pest Control

POSTER

Number: 69

Fischer, A., de Sa, S. M., Varney, J., Gries R., and Gries G.

Female false black widow spiders adjust their web architecture and pheromone deposition on it in response to conspecific female presence

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Females of cob-web spiders such as the false black widow Steatoda grossa can alter the architecture of their webs in relation to external cues to upturn prey-capture, safety, or mating opportunities. Here, we tested the hypothesis that female S. grossa respond to mate competition in that they change the architecture of their web and the amount of pheromone they deposit on it in response to the number density of webs in the microhabitat. In each of seven replicates of experiment 1, three females (low-number density) were allowed to build their webs in the same room for two days. Following a 12-day intermission, the same three females were then be allowed to build a new web for two days together with 27 other females (high-number density) present in the same room. The design of experiment 2 was similar except that females first build their webs in the high-number density setting and then in the low-number density setting. The females' web architecture in low- and high-number density settings were measured and all webs were extracted individually to quantify the amount of pheromone present. Our data support the hypothesis that females change their web architecture, and the amount of pheromone they deposit on it, in response to the number density of webs in the microhabitat.

Session/symposium: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 87

Fisher C. L.[1], Reese K. L.[2], Cepeda M. R.[3], Jaryenneh J. J.[1], Kubanek J.[3], and Lane T. W.[1]

The Good, the Bad, and the Algae: Chemical Analysis of Microalgal Cultures

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Open ponds are likely to succumb to unpredictable, devastating crashes as a result of algal biomass loss by one or several deleterious species. We are interested in identifying signature chemicals and natural products to aid in early pond crash detection, define the mechanism of protection from algal grazers, and discover novel high value products to support algal biotechnology and biofuel economy. We have surveyed the production of algal volatile organic compounds by microalgae in the presence and absence of the algal grazers. So far, we have determined some putative carotenoid breakdown products to be volatile biomarker signals for grazing of Microchloropsis salina by the marine rotifer Brachionus plicatilis. Additionally, we are performing chemical analysis of M. salina with various marine bacterial communities to (1) identify the mechanism of protection of some specific bacterial communities from grazing by B. plicatilis and (2) discover novel antimicrobial natural products for antibiotic resistance efforts. From our recent screen of 75 chemical extracts of diverse algal-bacterial origin, we found 25 extracts to have antimicrobial properties against bacteria and/or fungi. We will be performing chemical analysis to identify the active natural products in these extracts. Through these diverse, concerted efforts, our work in identifying novel volatile biomarkers and antimicrobial natural products will support and enhance national energy security and biosecurity efforts.

Themed Session: The Chemical Ecology of Stress, Warning Signs and Fear

POSTER

Number: 100

Galassi F. G., Picollo M.I., and Gonzalez A. P.

Aggregation in the head lice (Pediculus humanus capitis): response to and chemical analysis of volatiles and no volatiles from their own faeces.

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The head louse Pediculus humanus capitis (De Geer) (Phthiraptera: Pediculidae) is a cosmopolitan human ectoparasite that causes pediculosis, one of the most common parasitic arthropod conditions in humans. The mechanisms and / or chemicals involved in the lice aggregation are still unknown. In this study, we evaluated the response of head lice to faeces extracts and volatiles that emanate from their faeces. In addition, we identified the volatiles components of the faeces and the extracts. The volatiles were collected by means of Solid Phase microextraction (SPME) and the extracts obtained were chemically analyzed by GC-MS. The faeces were extracted in three different solvents with increasing polarity (Hexane, dichloromethane and methanol) and analysed by HPLC-MS. Twenty-nine volatiles were identified in the faeces, with the main compounds being the aldehydes (hexanal, nonanal, decanal). Head lice were highly attracted by the blend own faeces volatiles, as well as by the methanol extract with feces (the higher polarity solvent). Only two purines, uric acid and guanine, were found in the HPLC-MS analysis of faeces extracted in methanol. The results of this study indicate that lice can use volatiles and non-volatiles chemical signals that generate aggregation behaviours.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 88

Geedi R.[1], Ranger C. M.[1], Canas L.[2], Reding M. E.[1] and Castrillo L.[3]

Microbial Volatile Emissions Mediate Attraction of a Generalist Herbivore to a Fatal Fungus

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Some insect herbivores use microbial volatile organic compounds (MVOCs) to detect and avoid entomopathogenic fungi, but MVOCs can also function as attractants. Attracting insect hosts would be beneficial to Beauveria bassiana since it requires direct contact for infection and has no other active mechanisms of dispersal. We conducted a series of experiments to assess host-pathogen interactions between the generalist insect herbivore Myzus persicae and B. bassiana. The specific objectives were to assess M. persicae behavioral responses to B. bassiana, and identify MVOCs from B. bassiana. A variety of behavioral bioassays determined M. persicae were preferentially attracted within 10-15 minutes to cultures and dry conidia of B. bassiana. Mortality risk of M. persicae also dramatically increased from their attraction to B. bassiana. Solid phase microextraction-gas chromatography-mass spectrometry (SPME-GC-MS) identified MVOCs emitted by cultures and conidia of B. bassiana. Forthcoming olfactometer studies will assess the behavioral responses of M. persicae to these MVOCs as individual compounds and blends. Characterizing and enhancing the attraction of M. persicae to B. bassiana could improve the efficacy of biopesticide and mycoinsecticide tactics as part of IPM programs. Key words: Beauveria bassiana, Myzus persicae, virulence, host-pathogen interactions, microbial volatile organic compounds, entomopathogen.

Themed Session: Insect-Microbe Chemical Communication

POSTER

Number: 36

Gerdt J.[1], Brancucci N.[2], De Niz M.[2], Marti M.[2], and Clardy J.[1]

The Chemical Ecology of Stress, Warning Signs and Fear

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The malaria-causing protozoan Plasmodium falciparum infects hundreds of millions of people annually. It is transmitted by mosquito vectors, and senses chemical cues from the human and mosquito hosts in order to finely regulate its life cycle. One of the parasite's key life cycle transitions occurs in an infected human: asexual Plasmodium cells mature into sexual gametocytes. Gametocytes are incapable of multiplying further within the human, but instead are the transmissible form that can be taken up by a new mosquito vector. Therefore, each Plasmodium cell's gametocytogenesis "decision" determines whether that individual will remain in the human host for another cycle of multiplication, or leave the body to infect a new host. We hypothesized that Plasmodium senses chemical cues in its human host to determine whether or not it should commit to its transmissible gametocyte form. Indeed, using an in vitro gametocytogenesis assay and activity-guided fractionation, we found that human serum lysophosphatidylcholines (lysoPCs) inhibit gametocytogenesis. Metabolomics studies revealed that Plasmodium depletes lysoPCs from both in vitro culture and within hosts in vivo. Therefore, we conclude that asexual blood stage Plasmodium senses its chemical environment in the human host; after it senses depleted levels of lysoPC, the parasite converts to the transmissible gametocyte stage. This finding can be leveraged to identify molecular targets against the transmission of malaria.

Themed Session: Secondary Metabolites and other small Molecules as the Language in Microbiome Interactions

POSTER

Number: 79

Gonzalez P. V., Rodriguez M., Costa A.A., Masuh H., and Harburguer L.

δ- Dodecalactone a natural origin substance as a candidate mosquito repellent for *Aedes aegypti* (Diptera: Culicidae).

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Aedes aegypti is the main vector of arboviral diseases. The first line of defense that is possible to constitute between mosquitoes and humans is the use of repellents. N,N-diethyl-3-methylbenzamide (DEET) is a synthetic insect repellent used worldwide. δ-dodecalactone is an aliphatic lactone widely found in vegetable tissues. This study evaluate the repellent effect on Ae. aegypti females of δ-dodecalactone alone and in combination with DEET through different behavioral bioassays. A petri dish with a filter paper divided into a treated zone (different concentrations of δ-dodecalactone alone and in combination with DEET) and a control zone. The individual behavior of the females was analyzed with the Ethovision XT video tracking software, which allowed the automated tracking and quantification of the behavior. We calculate behavioral variables and the repellency index. A decrease in the activity variables was observed for those concentrations that showed a repellent effect with δ-dodecalactone alone and in combination with DEET. Bioassays on pigeons were conducted with a section of skin impregnated with the effective concentrations of δ-dodecalactone. We obtained 100% feed inhibition (FI) with δ-dodecalactone alone and in combination with DEET during the 120 min of the assay. Also 100% FI was obtained with 7% δ-dodecalactone (same as commercial use dose for DEET). The results showed an effective repellent effect of the δ-dodecalactone alone and in combination with DEET.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 70

Goodwin R. J. A.

The impacts of microplastic ingestion on the physiology of a marine worm, *Nereis diversicolor*

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Since the industrial revolution humans have placed a heavy reliance upon synthetic materials to facilitate modern life. This extensive utilization has caused exponential growth of the world's plastics production from 1.7 million tonnes during the 1950s, to over 5 million tonnes in 2018. There is a growing concern that plastics pose an increased threat to marine life. It is estimated that 10% of plastic waste will enter the world's oceans. Plastics that enter the ocean are subject to mechanical and chemical processes that progressively degrade them into smaller fragments called microplastics. Microplastic is found in the stomachs of many marine animals, readily accumulates in body tissues and microplastic toxicity is expected to have negative fitness costs. The present study aims to identify how microplastic exposure and/or ingestion impacts key fitness traits, in Nereis Diversicolor, sampled in the Humber estuary (N=1200), FTIR analysis will be performed to identify microplastic content of body tissues and deduce a geographical origin. The effects of microplastics toxicity on overall fitness will be tested by exposing N. Diversicolor (N=500) to similar types of microplastic found in the Humber, using a series of behavioral assays. The overall goal of the study is to highlight fitness costs associated with microplastic toxicity and is expected to inform the impact of feeding responses associated with microplastic toxicity, which may cause ramifications on plastic production.

Themed Session: The Chemical Ecology of Stress, Warning Signs and Fear

POSTER

Number: 101

Guo X., Miao C., Li W., Zhao M., Wang X., and Dong S.

Ovipositional choice response of *Helicoverpa assulta* mated females to volatiles derived from different tobacco species

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Mated females of the oriental tobacco budworm, Helicoverpa assulta (Guenée) (Lepidoptera: Noctuidae), showed much stronger ovipositional preference to Nicotiana rustica than to N. tabacum. This result was confirmed in the comparison of solvent extracts. A total of 37 components was detected in the headspaces of the two Nicotiana species during different stages (vegetative stage and flowering stage) by gas chromatography-mass spectrometry (GC-MS). Among these, nicotine, nonanal, (E)-3-hexen-1-ol, and D-limonene, were major components. However, when synthetic volatile blends mixed in corresponding natural ratios of different species at different stages were compared, a mixed result were obtained. When volatile blends derived from tobacco vegetative stage were compared, H. assulta preferred N. rustica to N. tabacum; the rank was reversed when those derived from tobacco flowering stage were compared. Further testing on the ovipositional choice response to individual volatiles indicates that nonanal and nicotine showed oviposition-stimulating effect on H. assulta, while benzaldehyde showed significant oviposition-deterring effect on H. assulta. Keywords: elicoverpa assulta; Tobacco, Nicotiana rustica; Nicotiana tabacum; Volatile; Oviposition #.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 6

Hansen B., Collins A., El-Hifnawi L., and Traxler M.

The Root Nodule Microbiome: A Model System for Microbial Chemical Ecology

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Microbiomes and their complex network of chemically-driven interactions are inherently difficult to decipher. Synthetic communities attempt to deconstruct these interactions, however, they are limited in their ecological relevance. With a model system reflecting the natural environment, we can assess community interactions in the context of ecological theory without encountering these limitations. Our candidate for such a system is the root nodule of alfalfa and its simplified accessory community. The nodule is a symbiotic structure that forms on the roots of leguminous plants and provides a niche for Rhizobia and a small accessory community. After growing alfalfa in a variety of soils, harvesting nodules in a time-course framework, and profiling the community using 16S sequencing, we developed a plant-mediated method of selection to arrive at a 5-member community capable of producing antimicrobial compounds in vitro. To understand the role of antibiotics in structuring this community, we grew plants in gnotobiotic conditions and aimed to detect production in planta using analytical chemistry, while also characterizing the impact a single strain has on community structure. Taken together, these data suggest that the antibiotics they produce may be influencing the accessory community profile. Once this community is fully characterized, we envision this experimental model to serve as an approach to address the role antibiotics play in mediating interactions within a microbiome.

Themed Session: Secondary Metabolites and other small Molecules as the Language in Microbiome Interactions

POSTER

Number: 80

Hansen L.[1], Xu T.[1], Hao D.[2], and Teale S.[1]

Host Olfactory Percepts of *Anoplophora glabripennis* and *Anoplophora chinensis*

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The Asian and Citrus Longhorned Beetles (Anoplophora glabripennis and Anoplophora chinensis) are East Asian Cerambycids whose outbreak and invasive tendencies have made them an international pest control focus. Both species are broadly polyphagous, infesting a variety of common trees including Acer, Salix, and Populus species. The host range of Citrus Longhorned Beetle also includes economically valuable fruit trees such as Citrus and Prunus species. We investigated the comparison of host and nonhost headspace volatiles as a method to determine the host percepts of the two pests and improve monitoring lures. Static headspace aerations were collected from seven species of hardwoods. The quantities of Asian Longhorned Beetle antennally active volatiles in hosts and nonhost samples were then compared using multivariate statistical methods to determine host indicative compounds for both species. Monitoring lures containing a subset of Asian Longhorned Beetle host indicative compounds were evaluated in Bengbu, China alone and in combination with 4-(n-heptyloxy)butan-1-ol and 4-(n-heptyloxy)butanal, pheromone components that have previously been reported to significantly attract both species. Host indicative compounds were not significantly attractive by themselves and did not synergize attraction to the pheromone components.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 89

Hardege J.D., Schirrmacher P., Roggatz C., Benoit D. M., and Bartels-Hardege H.

Impacts of ocean acidification on chemically-mediated behaviours – from signalling cue to behavioural response

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Ocean acidification, also named the 'evil twin of climate change', is a growing threat to life in our oceans. Besides global warming, climate change leads to a rapidly increasing absorption of atmospheric carbon dioxide. The disturbed ocean carbon chemistry and a decreasing pH level pose a major threat to chemical-ecological processes. Here we give an overview of how this acidification can impact chemically-mediated behaviours. We thereby look at the effect of ocean acidification at different levels from the signalling cues themselves via the reception of cues to the actual behavioural and physiological responses. Our research highlights that a wide range of behaviours are affected by pH shifts relevant for climate change scenarios. Foraging, mating, brood-care and settlement of marine invertebrates are altered at one or more of the investigated levels. As all these interactions are fundamental to a functioning ecosystem, we urgently need to develop a more detailed understanding of the mechanisms by which ocean acidification impacts marine life to be able to predict and model such future impacts.

Themed Session: Language of Life under Climate Change

POSTER

Number: 44

Hoffman-Campo C. B., Magalhães S. P., Da Graça J. P., Zeraik M. L., and Nunes E., Gazzoni D. L.

Volatile compounds of soybean flowers (Glycine max l.Merrill) by microextraction at the solid phase combined with gas chromatography coupled to mass spectrometry (SPME-GC-MS)

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Bees are currently observed in soybean (Glycine max L. Merrill) field, even if this plant is considered cleistogamic and self-pollinated. However their effect on the pollination of soybean plants remains unsolved. Volatile organic compounds (VOCs) released by flowers are one of main plant attractants for pollinators, and the aim of this studies was optimizing a method to VOCs collecting and making possible the metabolite analyses exclusively released by floral tissue. Optimization of the static headspace (HS) and solid phase microextraction (SPME) techniques were performed and gas chromatography (GC) coupled to mass spectrometry (GC-MS) was used to analyze VOCs produced by soybean flowers. Three SPME fibers with different polarities as polydimethylsiloxane (PDMS), polydimethylsiloxane/divinylbenzene (PDMS/DVB) and divinylbenzene/carboxene/ polydimethylsiloxane (DVB/CAR/ PDMS) were tested with flowers of 'BRS 399' and 'DONMARIO 6563'. In general, the SPME technique plus PDMS/DVB fiber showed a greater amount of VOCs in both cultivars. After using SPME plus PDMS/DVB fiber, 45 VOCs were detected from `DONMARIO 6563`. A few flowers VOCs here were previously reported in other soybean structures and the method developed has an innovative contribution. The identification of VOCs released exclusively by soybean flowers, and this achievement potentially will allow further studies for better understanding of the interaction between soybean flowers and pollinators.

Themed Session: Chemical Communication of Social Insect Associates: Espionage, Weaponry and Stealth

POSTER

Number: 28

Hoffman-Campo C. B., Parpinelli R., Alves J., Vagner T., Nunes E. O., and Gazzoni D. L.

Carbohydrates profile on nectar of soybean flowers

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Although the soybean is considered a self-pollinating crop, pollinators like honey bee (Apis mellifera) are observed foraging on soybeans fields. Several studies have been performed, but still there is no consensus among scientists about the role of pollinators found on soybean crop, and several questions remain unanswered, mainly regarding soybean yield increase. This study aimed to evaluate the adequacy of the soybean nectar sugar profile as a floral reward to pollinators. A chromatographic analytical multi-detection method for 8 different sugars (fructose, glucose, saccharose, maltose, erlose, melezitose, raffinose and stachyose) was developed, by using HPLC with refractive index detector. The operational conditions were: mobile phase (ACN/H2O – 75:25, v/v), flow (1.4 mL.min-1), oven (T=35°C), column (µBondapackTM) and pre-column with the same conditions. Calibration curve, limits of detection and quantification were established. Nectar samples were collected from flowers (purple and white) of soybean grown on field and greenhouse, and analysed by the methodology described above. The sugar profile mainly varied in a quantitative basis. The ratio fructose/glucose of the samples was ± 1.17, and sugars like erlose, melezitose, raffinose and stachyose were not detected, but they might show up as we expand the study using a broader soybean genetic array, as there are evidences that both the sugar profile and the amount of sugar on soybean nectar are genetically controlled.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 22

Hoffman-Campo C. B., Cotrim G., Aquino M., Gazzoni D. L., Oliveira Junior A., and Nunes E. O.

Metabolomics fingerprint on soybean leaves in response to variation of the potassium amount on soil fertilization

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Metabolomics studies were performed to evaluate the effect of potassium (K) on the secondary metabolites profile on the tissue of soybean leaves. A field experiment was settled using four rates of K (0, 40, 80 and 160 kg.ha-1 K2O) applied on the soil. Soybean leaves were collected at V6 stage and extracted with MeOH/H2O (80:20 v/v). Aliquots of leaf extracts were analyzed by UPLC-QTof-MSE, ionization for ESI, in negative mode. The raw data were analyzed by MarkerLynx XS 4.1 (Waters) to identify potential chemical markers influenced by the treatments. Principal component analysis (PCA) was performed and metabolites were discriminated by multiple orthogonal partial least-squares discriminant analysis (OPLS-DA). The total number of detected ions (m/z) after data processing were 1458, and 13 metabolites belonging to the linolenic acid, cutin, suberine, wax, phenylpropanoids mainly flavonoids and terpenoids metabolism. Most of detected compounds are related to plant defense mechanisms, thus further studies should be performed, regarding the role of K on soybean resistance to stresses caused by pathogens and insect-pests.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 49

Ibarra Bouzada L., Concha I. M., García M., Perusset A., Cecere C., León J. R., and Guerenstein P.

Olfactory responses in the brain of triatomines, hematophagous insects vectors of Chagas disease

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Chagas disease is an important vector-borne neglected tropical disease. The prevention of vector-borne transmission of Chagas disease in endemic areas relies on suppressing house infestations by triatomine bugs. Triatoma infestans is the main vector species in the southern cone countries of South America. We aim at developing an efficient host-based odor blend attractant to be used as a lure in a trap to monitor triatomines. In insects, odorants are detected by olfactory receptor cells (ORCs) mainly on the antenna. Insect ORCs project to the antennal lobe (AL) in the brain. The AL is the first information-processing center of the olfactory system. Odor mixtures are more attractive than single odorants. In order to understand how information about potentially attractive odor mixtures is processed in the triatomine brain it is necessary to study the responses of AL neurons to single odorants and their mixtures. Using a multichannel recording technique we recorded the activity of neurons in the AL of T. infestans nymphs upon stimulation with synthetic and natural odorants. Responses to a number of synthetic and natural odorants or their mixtures were obtained. Synthetic odors included (+)a-pinene, valeric acid, 1-octen-3-ol, nonanal, isobutyric acid, isobutylamine, ammonia, indole, benzyl alcohol, acetophenone, pyruvic acid, L(+)lactic acid, 3-methyl 1-butanol, and propionaldehide;(some of them not previously known to be detected by triatomines).

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 90

Johnson T., Kula R. R., and Hanks L. M.

Identification of natural enemies by proxy: deployment of aggregation-sex pheromones of longhorned beetles (Coleoptera: Cerambycidae) facilitates the discovery and identification of their parasitoids

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The use of pheromones is critical for the location of mates for many species of beetles in the family Cerambycidae. Parasitoids are known to use pheromones of their hosts as kairomones to locate opportunities for oviposition. We conducted a field study to test the hypotheses: species of parasitoids would be attracted to pheromones of their host species, but not those of other cerambycid species, as well as that attraction to pheromones can be used to predict host relationships. Bioassays were conducted in a wooded area in east-central Illinois, USA during June - August 2016 using transparent sticky traps. We baited traps with one of the following pheromones of cerambycids diluted in isopropyl alcohol: anti-2,3-hexanediol, syn-2,3-hexanediol, anti-2,3-octanediol, syn-2,3-octanediol, or isopropyl alcohol (solvent control). We found a significant treatment effect for Wroughtonia sp. (probably ferruginea), with the greatest number of individuals captured only on traps baited with syn-2,3-hexanediol. Wroughtonia ferruginea has been reported as a parasitoid of the cerambycid Neoclytus acuminatus which produces syn-2,3-hexanediol as its pheromone. This result constitutes support for both of our hypotheses. Because N. a. acuminatus has become invasive in Europe, W. ferruginea may be a candidate for biological control of N. acuminatus in these locations. Further research on the host-specificity and behavior of W. ferruginea should be conducted to determine if this is viable.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 71

Jones T. H., Curry C. J., Wolfin M. S., and Baker T. C.

The structure and synthesis of two EAD active ketols from the mushroom fly *Megaselia halterata*

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The phorid mushroom fly, Megaselia halterata (Wood) is a pest of commercial mushroom production. The adult flies spend the majority of their time mushroom houses laying their eggs in compost, and the larvae feed on and destroy growing mycelium. Although 3,6-dimethyl-2,4-heptanedione was identified in 1982 as a female specific (sex?) pheromone of M. halterata, we have recently observed two other EAD active components in the whole-body extracts of M. halterata whose structures were established by unambiguous synthesis as the diastereomers of 2-hydroxy-3,6-dimethylheptan-4-one. The relative stereochemistry of each isomer was determined by comparison of their 13C nmr spectra to the published spectra of simpler analogs. Bioassays are ongoing to confirm the behavioral activity of these EAD active compounds.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 91

Joubert J., Hammerbacher A., Hurley B., and Schroder M.

Host preference of Gonipterus sp. 2 and chemical analysis of susceptible and resistant Eucalyptus species

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The Eucalyptus snout beetle (Gonipterus sp.2) is a re-emerging pest of eucalypt plantations around the world. Gonipterus prefers to feed on specific Eucalyptus species. However, the mechanisms underlying this preference is poorly understood with multiple studies showing different levels of resistance for the same species. Since the chemical cues behind this selective feeding behaviour are largely unknown, we conducted a series of feeding preference trials in the laboratory. This allowed us to rank several of the Eucalyptus species present in South Africa by their relative level of resistance to feeding. Different genotypes of 3 Eucalyptus species showing different levels of resistance were selected for analysis using both gas chromatography as well as liquid chromatography coupled to mass spectrometry. We discovered several compounds that either correlated strongly positively or negatively with insect feeding preference. Furthermore, we developed an artificial diet for Gonipterus which can be used in future to study the physiological effects of the compounds we identified.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 72

Karthi S., and Senthil-Nathan S.

Comparative efficacy of two mycotoxins from *Beauveria bassiana* (Bals.) Vuill. and *Metarhizium anisopliae* (Metchnikoff) Sorokin against *Spodoptera litura* Fab. and their non-target activity against the earthworm, *Eudrilus eugeniae* Kinb.

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Entomopathogenic fungi are feasible and effective against the agricultural pest. In the current research we intensive on bioactive comparison of two widely accepted entmopathogens against the destructive pest Spodoptera litura (Fab.) through the assessment of larval tolerance and regulation of antioxidants and non-target impact on the soil dweller worm, E. eugeniae, in evaluation to commercial pesticides. The entomopathogenic fungus exposure resulted in the modification of the levels of detoxification enzymes as well as significant increases in catalase and superoxide dismutase activity after exposure of entomopathogenic fungus. Bioassay results showed that B. bassiana and M. anisopliae displayed larval mortality against third and fourth instars. Correspondingly, sub-lethal dosage of B. bassiana showed slightly higher alterations in the development as compared to M. anisopliae. Gut-histology revealed that mycotoxins dosage (4×105) showed significant changes in the midgut tissues as compared to control

larvae. The non-target screening through artificial soil assay on beneficial worm E. eugeniae, with mycotoxins B. bassiana (5×108 conidia/ml/kg) and M. anisopliae (5×108 conidia/ml/kg) showed less toxicity as compared to Monocrotophos (10 ppm/kg). Current results suggest that the fungal mycotoxins of M. anisopliae and B. bassiana significantly reduce the development of lepidopteran pests, while having only lesser impact on beneficial earthworms.

Themed Session: Secondary Metabolites and other small Molecules as the Language in Microbiome Interactions

POSTER

Number: 81

Kinnby A., White J., Toth G., and Pavia H.,

Ocean acidification affects the growth and chemical defense of a habitat forming seaweed and the condition of a snail grazer

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Ocean acidification driven by anthropogenic climate change is projected to cause a drop in pH of 0.4 units by the year 2100. Previous studies have shown that seaweeds grown under such conditions developed tissue damage, and that calcified herbivores struggle to maintain shell density. It is not clear how these changes might impact interactions between algae and herbivores, e.g. through changes in respiration and growth rates, or defense production. We cultured Fucus vesiculosus for 30 days in the projected future pCO2 (1100 ppm) with genetically identical controls in ambient pCO2 (400 ppm). After this, we conducted grazing experiments using Littorina littorea, acclimated to the relevant pCO2 treatment. We found increased growth in algae exposed to high CO2-levels, and a lower phlorotannin content. The grazers had a significantly higher condition index but consumed less when exposed to elevated pCO2.

The implications of changing abiotic factors on individual species are relatively well understood, but predicting changes to interspecies relationships is more challenging. Our results demonstrate some of the changes in algae, grazers, and their interaction, with likely consequences for algae, grazers, and their predators. The changes in surface area and phlorotannin content in F. vesiculosus suggest increased vulnerability to mechanical damage. This could have effects on coastal ecosystems by reducing both the habitat available to small animals and the food available for grazers.

Themed Session: Language of Life under Climate Change

POSTER

Number: 45

Kofsky J., and Song B.

Identification of novel SCN resistance strategies in wild soybean

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The domestication process of crop plants often involves selection for agronomic traits against the plant's intrinsic resistance strategies. Thus, domestication processes decrease genetic variation, making crop plant varieties more susceptible to pests than their wild relatives. Domestication of the wild soybean (Glycine soja) accounts for a major loss is genetic diversity. The G. soja gene pool is indisputably more diverse than the cultivated soybean (Glycine max) due to a primary loss of nucleotides in domestication and continued loss due to selection and modern breeding practices. Therefore, we dissect the diversity contained in the wild soybean population, which has been going through differential stress from varying environments, as a naturally adapted source of resistance. In this study, resistance to Soybean Cyst

Nematodes (SCN) is investigated in a newly identified SCN resistant ecotype. In order to investigate the global gene expression changes, we compare RNA seq-based transcriptomes of the novel SCN-resistant wild soybean ecotype vs. other resistant and susceptible genotypes. All accessions were inoculated with SCN HG type 2.5.7. This project identified candidate genes and associated pathways involved in SCN resistance and advances the long-term goal to develop SCN resistant soybean cultivars, which has crucial significance to agriculture and environmental sustainability.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 23

La Forgia D., Jaffuel G., Herrera R. C., Turlings T. C. J., and Verheggen F.

The lure of hidden death: Attractive volatile organic compounds to attract wireworms towards entomopathogenic nematodes

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Most of the research on the interactions between insect herbivores and plants focus on the aboveground parts, but there is a growing interest in belowground plant-insect interactions. Like most soil dwelling pests, wireworms use Volatile Organic Compounds (VOCs) released from the rhizosphere to locate a suitable host. It has been proposed that specific VOCs can be used in attract-and-kill strategies with

biological alternatives to pesticides. In order to develop such an attract-and-kill strategy, we aimed to (1) identify VOCs from maize roots that are particularly attractive to wireworms and (2) select an entomopathogenic nematode (EPN) that readily infects and kills wireworms. Field observations have revealed considerable differences between two maize varieties in infestation levels by wireworms. We identified the VOCs from their roots and found that the less susceptible variety released a more complex VOC blend than the other. Two VOCs, hexanal and β-caryophyllene, were found in the VOC profiles of maize and potatoes, and were tested for attractiveness in olfactometer assays. We are also testing the combination of these compounds in alginate beads containing EPN for attractiveness and biocidal effects under laboratory conditions. Using VOCs as attractants and EPN as biological agents represent a promising alternative to pesticides that remains to be evaluated in the field.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 7

Liu F., Kong X., Zhang S., and Zhang Z.

Identification and Syntheses of the Sex Pheromone of *Micromelalopha troglodyta* from China

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Micromelalopha troglodyta (Graeser) is one of serious defoliators of poplars in China. The gas chromatography-electroantennographic detection (GC-EAD) results indicated that male moth antenna was detected to elicit sensitive reaction to one component of the sex gland extract of the virgin female

moth; Based on gas chromatography-mass spectrometry (GC-MS) data of the extract and the additive derivative of 4-methyl-1,2,4-triazoline-3,5-dione (MTAD), 13,15-octadecadienal has been identified as the main active component of sex pheromone of this insect; But the configuration of these double bonds have not been determined, due to lacking of standard compounds. This project is to stereoselective synthesize four geometric isomers of 13,15-octadecadienal [(13Z, 15Z), (13Z, 15E), (13E, 15Z) and (13E, 15E)-octadecadienal], using the C12+C3+C3 strategy. With biological activity test to identify the composition information of the active component. The above study provides a reference for the use of sex pheromone to monitor the population and control of this pest.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 92

Liu Y., and Wang G.

Patterns in the distribution and functional conservation of olfactory receptors among lepidopterans underscore the flexibility of OR repertoires

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Odorant receptor (ORs) play a central role in olfactory system, and functionally characterizing OR repertoires is an essential step for studying olfactory mechanisms of certain insects, yet there have only been a few reports outside Drosophila melanogaster. Here, we report our comprehensive profiling of the receptor functions of the entire OR repertoire of the cotton bollworm Helicoverpa armigera using our highly flexible and sensitive analytical platform. Our in vitro screen with a large diversity of 67 plant volatiles as triggers revealed robust responses of HarmORs as 28 of the 44 ORs responded to the triggers. Further, our functional comparison with S. littoralis revealed that tuning reactivity of ORs can differ substantially, only a small number of ORs function conservatively. One of the functional conserved ORs-HamOR42 was predicted to be essential for sensing of phenylacetaldehyde, this is confirmed by follow-up in vivo studies through CRISPR/Cas9 combined with electrophysiological and behavioral experiments. Our research provides a reference for further studies of olfactory mechanisms in Lepidoptera and opens the door for genetic-based manipulation of OR-mediated insect behaviors.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 66

Lortzing V., Valsamakis G., Fuchs B., Fatouros N., Kunze R., and Hilker M.

Prepared by timing: The dynamics of plant anti-herbivore defense primed by insect egg deposition

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Plants can take insect egg deposition as “warning” of impending larval herbivory and then reinforce their feeding-inducible defenses. Pieris brassicae larvae perform worse on egg-deposited Arabidopsis thaliana plants than on egg-free ones. This priming effect depends on salicylic acid-(SA-) mediated signaling and enhanced expression of defense-related genes.We addressed the questions: (i) How long must the egg stimulus persist on a leaf until the plant displays a “primed response” and (ii) does egg deposition accelerate the feeding-induced defense response? The questions were addressed by measuring the larval performance and A. thaliana gene expression at one to six days after egg deposition and by determining the kinetics of phytohormone levels after the onset of larval feeding. Our results show that A. thaliana reaches its fully primed state when having “experienced” P. brassicae eggs for five days, i.e. one day before larvae hatch. The transcript levels of “primeable” marker genes correlated with the power of the priming effect of previously egg-laden plants on larvae (readout: reduction of larval weight). Furthermore, our phytohormone data suggest that the plant´s response to egg deposition accelerates the subsequently feeding-induced defense response of A. thaliana against P. brassicae. We conclude that the plant invests in “full priming” shortly before larvae will hatch, and then seems to speed up its defense against the actual threat, the feeding larvae.

Themed Session: The Chemical Ecology of Stress, Warning Signs and Fear

POSTER

Number: 102

Maleki A. F., Seidl-Adams I., and Tumlinson J. H.

Stomatal aperture determines the uptake and transport of green leaf alcohols in maize

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It is well known that exposure to the Green Leaf Volatile (GLV) (Z)-3-hexen-1-ol (Z3HOL) induces maize plants to mount a faster and stronger defense response to subsequent herbivory. Little is known about the uptake and the transport of Z3HOL inside the plant. Since stomata are known as the major pathways for the exchange of airborne molecules with the surrounding environment, we investigated the question of how the closure of stomata affects the delivery of GLV signals in maize seedlings. Since GLV alcohol is converted to (Z)-3-hexenyl acetate (Z3HAC) in maize, we used the emitted amount of Z3HAC from exposed plants as an indicator for Z3HOL delivery. Also, we used (E)-3-hexen-1-ol, which is not made by plants but is structurally similar to Z3HOL, to differentiate between externally provided GLV, and internally induced GLV biosynthesis. As expected, closure of stomata not only reduced the uptake of GLV alcohols but also decreased their transport rate. Environmental conditions, which close the stomata and thus reduce xylem flow rate, i.e. drought, could decrease transport of GLV inside the plant and consequently induction and priming of defenses. Additionally, we found that cut seedlings supplied with Z3HOL induced sesquiterpene biosynthesis in a dose-dependent manner, but in the dark or under ABA treatments, no induction of sesquiterpenes was recorded. The role of Z3HOL transport through the xylem in the induction of other systemic defense responses remains to be shown.

Themed Session: Language of Life under Climate Change

POSTER

Number: 46

Martin C., Vanderplanck M., Boullis A., Francis F., and Verheggen F.

Forensic chemical ecology: how do necrophagous insects perceive and impact the smell of a cadaver?

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After death, corpses undergo a complex decaying process, during which volatile organic compounds (VOCs) are released. Necrophagous insects use these VOCs to find their feeding and oviposition sites. The impact of the presence of necrophagous insects on a cadaver on the cadaveric VOC profile, remains to be tested. In this study, dead rats were left to decompose under four modalities: (i) without necrophagous insects, (ii) in presence of Lucilia sericata, (iii) in presence of D. frischii and (iv) in presence of both Lucilia sericata and D. frischii. VOCs released during the different decaying stages (fresh, bloated, active, advanced and dry remains) were sampled with thermodesorption tubes (Tenax Ta®) and analysed by GC-MS. Solvent-eluted SuperQ® filters were also used to collect cadaveric VOCs to be used during subsequent behavioural trials. All rats went through the five decomposition stages with the exception of rats decomposing without insects. The volatile profiles differed among decaying stages, but were not affected by the presence of insects. During a multiple-choice bioassay, blowflies were exposed to the four above-mentioned blends of odours, and were shown to prefer the odour of a corpse where conspecific larvae were present. Two-dimensional gas chromatography coupled with high resolution mass spectrometer analysis should be performed in the future to reveal indicator compounds of the presence of necrophagous insects.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 93

Martini X., and Stelinski L.

Development of a push-pull system for the redbay ambrosia beetle *Xyleborus glabratus*, vector of the laurel wilt pathogen

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Laurel wilt is a vascular disease that has caused extensive mortality of trees and shrubs in the Lauraceae family, which include species such as Redbay, Persea borbonia and avocado P. americana. Laurel wilt is caused by the fungus Raffaelea lauricola that is vectored by the exotic redbay ambrosia beetle, Xyleborus glabratus. We discovered that levels of methyl salicylate (MeSA) significantly increased in redbay three days post inoculation with R. lauricola, and that X. glabratus was significantly repelled by MeSA in olfactometer bioassays. We decided to test MeSA in field condition, as well as verbenone, an anti-aggregation pheromone that has been found to repel a wide diversity of bark beetles. During the experiment conducted on cut redbay bolts, we observed a decrease in terms of arrivals to the bolts as well as number of boring holes found in the bolts at the end of the study for both MeSA and verbenone treatments. However, on subsequent experiments conducted on whole trees on a larger scale only verbenone significantly repelled redbay ambrosia beetles. In a final step, we included verbenone in a push-pull system in forest and avocado grove settings. In redbay, the attractant used was α-copaene while ethanol was used in avocado orchards. In both situations, we were able to significantly reduce the number of beetles attacking redbay and avocado. In redbay, we were able to reduce beetle populations by nine fold as compared with untreated controls.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 73

Matsunaga T., Goldman-Huertas B., Karageorgi M., Suzuki H., and Whiteman N. K.

Evolution of olfactory receptors tuned to mustard oils in a leaf-mining drosophilid fly

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Insects are equipped with an array of chemoreceptors that play a major role in their adaptive behaviors. Trophic shifts often coincide with chemoreceptor expansions through receptor duplication events. When a gene duplication event gives birth to a new Or gene, purifying selection is relaxed for one of the gene copies. Thus the second copy of this receptor could reshape the response curve to increase sensitivity to olfactory cues in the new environment. However, the adaptive significance of this consequence has not been largely demonstrated. In the drosophilid clade Scaptomyza, the herbivorous S. flava evolved from microbe-feeding ancestors. In S. flava, Or67b was triplicated into three paralogs (SflaOr67b1-3), and they show signatures of positive selection. The closely related microbe-feeding S. pallida and D. melanogaster, on the other hand, have only one copy of the Or67b ortholog. The ortholog of Or67b in D. melanogaster (DmelOr67b) responds to several ligands, including green leaf volatiles (GLVs). This suggests that the SflaOr67b1-3 could also be involved in the detection of GLVs, which are the only volatiles S. flava responds to in its host plant. We use SflaOr67b1-3 as a model system to test whether the response curves of the SflaOr67b1-3 have been reshaped. We utilized empty neuron system to characterize the odorant response curves of SflaOr67b1-3 and Or67b in S. pallida (SpalOr67b). We round that DmelOr67b and SpalOr67b, but not SflaOr67b1-3, are activated by simila.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 27

Maynard L. D., and Whitehead S. R.

Ecological patterns and significance of secondary metabolites in a Neotropical shrub, *Piper sancti-felicis*

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Rooted in place, plants often rely on secondary metabolites to mediate interactions with other organisms. Both attraction of mutualists and defense against antagonists are thought to be mediated by secondary metabolites. Piper is one of the largest genera of flowering plants, containing about 1,000 species. This study describes the secondary metabolites occurring in the infructescences of Piper sancti-felicis and their functional significance in ecological interactions. We focus on one group of compounds: alkenylphenols. We had three specific objectives: 1) to elucidate the structures of the major alkenylphenol compounds present in the infructescences of P. sancti-felicis; 2) to describe the natural variation in alkenylphenol composition throughout infructescence development and across individual plants; and 3) to test the ecological significance of the alkenylphenols in fruit defense against fungi. Results suggest that alkenlyphenol concentration in infructescences significantly differed among individual plants, developmental stages, and individual compounds. Alkenylphenol concentration was higher in unripe infructescences compared to inflorescences with high interspecific variation. Results from the microdilution bioassays revealed that as alkenylphenol concentration increases, absorbance decreases. This is the first study to describe alkenylphenols in P. sancti-felicis and their ecological function as defensive secondary metabolites, possessing anti-fungal properties.

Themed Session: Secondary Metabolites and other small Molecules as the Language in Microbiome Interactions

POSTER

Number: 82

Meents A. K., Chen S., Reichelt M., Lu H., Bartram S., Yeh K., and Mithöfer A.

A single volatile induced systemic herbivore resistance in leaves of sweet potato (*Ipomoea batatas*)

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Plants perceive and respond to volatile signals in their environment. Often, neither the perception mechanisms nor the nature of these signals is known. Upon herbivory, blends of volatile organic compounds (VOCs) are released from infested tissues to attract predators of higher trophic levels and /or initiate systemic defense reaction in leaf-to-leaf and plant-plant communication. We show in leaves of the crop Ipomoea batatas (sweet potato) that herbivory-induced jasmonate phytohormones accumulate locally but the defense-related Sporamin polypeptide, a protease (trypsin) inhibitor, accumulates systemically. Among various herbivory-induced VOCs, one abundant compound was identified as (E)-4,8–dimethyl–nonatriene (DMNT). This homoterpene is sufficient for an airborne systemic induction of defensive Sporamin protease inhibitor activity in neighboring sweet potato plants. This induction is jasmonate independent and does not need any further priming-related challenge. Responsiveness to and strongly induced emission of DMNT is restricted to a herbivory-resistant cultivar (Tainong 57) while a susceptible cultivar, Tainong 66, neither emitted significantly higher levels of DMNT nor showed reaction to this VOC. This result is consistent with the finding that Spodoptera larvae feeding on DMNT-exposed cultivars gain significantly less weight on Tainong 57 compared to Tainong 66. Our results indicate a highly specific, single volatile-mediated plant-plant communication in sweet potato.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 8

Mevers E., Pishchany G., Su L., Kolter R., Ajo-Franklin C., and Clardy J.

Bacterial-derived electron shuttle

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Shewanella oneidensis MR-1 is a facultative anaerobic γ-proteobacterium that has the ability to utilize a diverse suite of terminal electron acceptors, including insoluble solid metal oxides. The mechanisms underlying how MR-1 indirectly shuttles electrons to these solid substrates are poorly understood. In 2000 chemical analyses of MR-1's spent supernatant revealed that MR-1 excretes a small labile molecule that has the ability to recover anaerobic respiration of mutants on solid substrates, but the active metabolite was never identified. Revisiting this lack of identity with specialized resin, HR-LCMS analysis, and total synthesis, led to its identification as 2-amino-3-carboxy-naphthoquinone (ACNQ). ACNQ potently recovers anaerobic respiration in a mutant strain (ΔmenC: menaquinone mutant) on solid substrates (EC50 of 25 nM) and can significantly increase current generation in Mtr-expressing E. coli strains. ACNQ is derived non-enzymatically from a primary metabolite, 1,4-dihydroxy-2-naphthoic acid (DHNA) and is produced by all other anaerobic bacteria (facultative and obligate) investigated. In summary, the discovery of ACNQ provides a better understanding as to how MR-1 shuttles electrons to insoluble terminal electron acceptors. This discovery has several potential applications, including medical uses like treatment of mitochondrial disease and bioenergy.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 63

Mitchell R. F., Jenson A., Scully E. D., and Oppert B.

An emerging model of odorant receptor evolution in insect pests of stored products

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Odorant receptors (ORs) are the primary mechanism by which insects detect volatile compounds, and presumably are among the first genes affected by ecological shifts in insect populations. Thus, we are documenting the evolution of ORs in the context of stored product pests, which are thought to have originally fed on isolated and unpredictable seed heads and rodent stores before transitioning to human granaries over the last several millennia. Previous genomic annotation of the model beetle (and grain pest) Tribolium castaneum suggested an extensive but contracting OR suite, attributed to relaxed selection on olfaction in a stable anthropogenic environment. Here, we test this hypothesis by genomic annotation of ORs from additional stored product pests, including the lesser grain borer (Rhyzopertha dominica; Coleoptera: Bostrichidae), mealworm (Tenebrio molitor; Coleoptera: Tenebrionidae), khapra beetle (Trogoderma granarium; Coleoptera: Dermestidae), and Indianmeal moth (Plodia interpunctella; Lepidoptera: Pyralidae). Initial results support the hypothesis that stored product pests are experiencing a reduction in chemosensory breadth.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 64

Mittal N., and Song B.

Accumulation of iso-flavonoids and phenolic acid conjugates in response to soybean cyst nematode in wild soybean (*Glycine soja*)

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Plants produce a wide range of biologically active metabolites to protect themselves against attacking pests. Elucidating the key metabolites and associated pathways underlying defense responses is critical in understanding the molecular mechanisms of plant chemical defense. Non-targeted metabolomics analysis has emerged as a useful strategy to increase our understanding of the resistance-related (RR) metabolites and pathways in plant-pathogen interactions. In this study, we performed a non-targeted metabolomic analysis to determine and compare the roles of key metabolites and pathways in response to infection by the soybean cyst nematode (SCN, Heterodera glycines) in wild soybean (Glycine soja). SCN is the most devastating pest causing significant losses in soybean yield. A comparison of the metabolic profiles among SCN-resistant (S54) and susceptible (S67) genotypes showed clear differences, mirroring the effects of isoflavonoids (daidzein, daidzin, malonyl daidzin, formononetin, and iso-formononetin), as well as phenolic acids and phenolic acids-derived hydroxyl and methylated glucoside esters, in defense. To the best of our knowledge, these findings uncover the first metabolomics-based network for defending against SCN HG type 1.2.5.7 (SCN-2). The results of the present research can facilitate the future metabolic engineering to develop novel and diverse soybean cultivars with enhanced SCN resistance and/or improved nutraceutical value.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 50

Yuki Miyake, Erina Ohno, Tatsuya Hojp, Miyoshi Yamashita, Akihiro Bana, Takeshi Kinsho

Synthesis of Tomato leafminer, Tuta absoluta, sex pheromone and its application in field mating disruption

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The Tomato leafminer (TLM), Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae), is the most serious pest of tomato in many countries. This pest, native in South America, invaded into Spain in 2006 and is now widespread in Europe, Africa and Asia. Its infestation makes crops unmarketable.Insecticide application against TLM has been used, however, it is sometimes ineffective because of rapidly developing resistance. Pheromone-based mating disruption (MD) to control this serious pest has been strongly desired.Female produced sex pheromone of TLM consists of two components, (3E,8Z,11Z)-tetradeca-3,8,11-trienyl acetate and (3E,8Z)-tetradeca-3,8-dienyl acetate. We have established an economical and safe production method of TLM sex pheromone using a key C-5 building block. Coupling reaction of the C-5 and C-9 building blocks enables industrial production of both active ingredients.Field MD trials using tube-type dispensers (ISONET®-T) have been conducted in several European countries including Italy and Spain. MD efficacy was demonstrated through suppression of the male trap capture and reduction of the damage. We will explain one of the sustainable insect management strategies for TLM.Keywords: Tomato leaf miner, Tuta absoluta, mating disruption, ISONET®-T

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 74

Victoria Moris, Katharina Christmann, Thomas Schmitt, Oliver Niehuis,

Looking back in time: study of old pinned museum samples of Odynerus spinipes females (Insecta: Hymenoptera: Vespidae) reveals the geographic structure of the two chemotypes across the species' distributional range.

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The mason wasp Odynerus spinipes presents an extraordinary case of intrasexual CHC profile dimorphism. O. spinipes females are able to express one of two different CHC profiles (chemotypes) that differ qualitatively from each other. Females with different chemotypes seem to differ exclusively in this trait and keep their chemotype during their entire lifespan. The frequency of the two chemotypes in natural populations of O. spinipes has never been investigated. In order to determine whether both chemotypes are present in similar ratios in all geographic regions, we studied the CHCs of specimens stored in museum collections and collected from across the species' distributional range. Specifically, we analyzed via GC-MS the CHC extracts of a total of 1,210 specimens of the species. Intriguingly, we were capable in reliably identifying the chemotypes of most samples, some collected 200 years ago. While we find both chemotypes in samples from Europe and from the Far East (the presumed geographic origin of the species), we discovered significant geographic structure in the frequency of the two chemotypes. The geographic structure in the chemotype frequencies could indicate differential selection regimes and/or different dispersal routs during the colonization of Europe by this Euro-Siberian faunal element. The present results pave the route for disentangling these factors in future studies by providing information where to best collect samples for population genetic analyses.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 94

Mohammad Munir Mostafiz, Aijun Zhang, Kyeong-Yeoll Lee

Naturally-occurring compound methyl benzoate against the sweet potato whitefly, Bemisia tabaci MED (Q biotype), one of the most important vectors for plant viruses

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Methyl benzoate (MB) is a plant-derived volatile organic compound with insecticidal properties, but such activity has not been evaluated against the sweetpotato whitefly Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae), a major crop pest. In this study, we tested methyl benzoate control efficacy on B. tabaci infecting tomato plants in a greenhouse, specifically measuring contact and fumigant toxicity, as well as repellent activity. For direct spray applications of 0% (control), 0.1%, 0.25%, 0.5%, 1%, 2% MB onto tomato leaves infested with adults of B. tabaci (< 5-d-old), 2% MB showed the highest corrected mortality (100%) at 24 h post-treatment. For residual toxicity in which the same MB solutions were sprayed onto tomato leaves and allowed to dry for 2 h before <5-d-old adults were released, the 2% MB also showed the highest corrected mortality (100%) at 48 h post-treatment. The lethal median concentration (LC50) for eggs, fourth-instar nymphs, and adults were 0.3%, 0.2%, and 0.2%, respectively. In pot culture experiments, 1% MB concentration was found more effective at killing nymphs and preventing adult eclosion than all other concentrations, and gave 100 percent population reduction compared with the control. MB repelled adult whiteflies and caused 96.5% fumigant toxicity within 10 h post-treatment. Our results suggest that MB has strong potential as an environmentally friendly biopesticide for control of B. tabaci but field trials and further greenhouse studies need.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 75

Raimondas Mozūraitis, Dominykas Aleknavičius, Sandra Radžiūtė, Laima Blažytė-Čereškienė, Elena Servienė, Vincas Būda

Effect of the volatiles released by yeasts related to sea buckthorn Hippophae rhamnoides berries on behaviour of Rhagoletis batava flies.

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Yeast released volatiles are used by insects as olfactory cues for finding feeding and oviposition sites. Those olfactory cues have a large impact regulating insect behaviour and fitness consequently drawing increased attention in integrated pest management programmes. The yeast strain SB-16-15 was isolated from spontaneous fermentation of Hippophae rhamnoides berries and identified as Pichia kudriavzevii. Thirty-nine volatiles were sampled and identified from the headspace of P. kudriavzevii yeasts by solid phase micro extraction, gas chromatography and mass spectrometry techniques. Ten of those volatiles elicited antenna responses of Rhagoletis batava flies one of the most serious pest of H. rhamnoides berries. In the two-choice experiments, R. batava flies preferred the mixture comprised of nine synthetic compounds analogous to EAD active volatiles released by yeasts compare to the solvent control. Female flies were significantly attracted to the mixture at the concentration 0,1 µl/ml and showed no preference to the mixture at the concentration1 µl/ml versus control while males reacted positively to the synthetic blend at the concentration 1 µl/ml. Herein, for the first time, behaviour modifying effect of H. rhamnoides berry related yeast volatiles was shown revealing the application potential of those allelochemicals in pest management programs of R. batava flies.

Themed Session: Insect-Microbe Chemical Communication

POSTER

Number: 37

Michael Ng, Siu Lung Ng, Tobias Hoffmann, Brian K. Hammer

Novel Regulation of Type VI Secretion System in Environmental Vibrio cholera

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The waterborne bacterial pathogen Vibrio cholerae resides within dense multispecies microbiomes in aquatic environments and in the human gut where is causes cholera disease. Like other bacteria, V. cholerae competes for resources in these habitats using a Type VI Secretion System (T6SS) weapon that can lyse competitors by piercing neighboring bacteria and delivering toxic cargo. Based on studies with strains of V. cholerae derived from patients, it was proposed that triggering of the T6SS in V. cholerae requires one of two signaling factors 1) QstR, which is activated by external quorum sensing molecules and chitin, or 2) TfoY, which is activated by internal second messenger molecules. We sequenced several dozen strains of V. cholerae from environmental sources, identified the T6SS genes in each, and documented that most engaged in T6SS-dependent killing of target E. coli cells in laboratory condition in the absence of chitin. For many environmental strains tested, deletion of both the qstR and tfoY genes revealed that neither is required for T6SS-dependent target cell killing. From these results, we predict that a novel signaling factor(s) participates in T6-mediated aggression in V. cholerae. Genetic analysis, including mutagenesis, is being conducted to identify such a factor, which will broaden our understanding of how bacteria coordinate competitive behaviors in response to chemical signals.

Themed Session: Secondary Metabolites and other small Molecules as the Language in Microbiome Interactions

POSTER

Number: 83

Linh Nguyen, Roberto Brenes

Metabolic detoxification of the metabolite emodin produced by the common buckthorn (Rhamnus cathartica) by the Green frog Lithobates clamitans (Ranidae)

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The secondary metabolite emodin, present in the invasive common buckthorn (Rhamnus cathartica), has been related to morbidity and mortality of amphibian larvae. However, the effect of the metabolite in older tadpoles with fully liver and kidney function has been unknown whether the compound could be metabolized by amphibians as seen in higher vertebrate groups such as mammals. To demonstrate the relationship between organ function and survival, Green frog (Lithobates clamitans) tadpoles of different developmental stages were exposed to synthetic emodin at different concentrations of 0.5 ppm, 1 ppm, and 2.5 ppm to determine if older tadpoles with higher levels of liver function can neutralize the metabolite. During the experiment, tadpoles were monitored daily for signs of morbidity or mortality and all animals were necropsied and the liver and kidney removed for histopathology. Preliminary results showed differences in time of mortality among size classes ($F_{3,19}=189.5$, $P<0.05$), as well as a strong relationship between size and time of death with small animals dying at a faster rate than older individuals

(Pearson=0.483, P<0.05). Higher concentration showed relatively faster mortality (Pearson=0.321, P<0.05) and most of the surviving individuals presented visually the effects in liver and kidney. Signs of metabolic detoxification, like hepatocellular swelling and other hepatic injuries, are still assessed thorough histopathology analysis.

Themed Session: Biosynthesis of Secondary Metabolites in Chemical Ecology

POSTER 18

Vincensius Surya Putera Oetama, Stefan Pentzold, Yannick Pauchet, Wilhelm Boland
Chlorophyll detoxification? Learning from Spodoptera littoralis

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Chlorophyll (Chl) is the green pigment which is found ubiquitously in plants, algae, and bacteria. It is classified as a natural product that is needed in the photosynthesis. The degradation pathway and enzymes involved in Chl degradation are known in plants during leaf senescence. However, the mechanisms in chewing insects are not known. The previous study has shown the detected Chl catabolites were similar as in the plants. In the present study, the suspected liable protein – Chlorophyllide binding protein (CHBP) – has been identified using transcriptome and proteome analysis from regurgitate of S. littoralis. The gene functional analysis using RNAinterference has shown the importance of the gene and indicating a metabolic change detected in the feces. We also found a lower survival rate in larvae injected with gene specific dsRNA, where gene expression was decreased up to 80%. Heterologous expressed CHBP in

insect cells was used for ligand assay and revealed that not only chlorophyllide, but also Chl could be bind to CHBP. Photo toxicity assay in the expressed and non-expressed CHBP insect cells showed the higher susceptibility in the expressed CHBP insect cells. These findings lead to the understanding this mechanism as a Chl detoxification. Moreover, the alteration of gut's condition compare to feces' yielded new finding of several catabolic compounds. Putting together pieces of the puzzle hopefully will bring the understanding of the Chl degradation mechanism.

Themed Session: Integrated Approaches for Structure Determination in Chemical Ecology

POSTER

Number: 41

Taylor Paret, Melanie JA. Body, Elizabeth S. Haswell, Reginald B. Cocroft, Heidi M. Appel
To hear without an ear: Mechanosensation in plants

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Plants respond to herbivory by increasing the production of chemical defenses. Early defense signaling depends on the plant's ability to quickly detect the attack and activate the appropriate signaling cascades. Response cascades begin with the perturbation in plant plasma membrane potential and change in the calcium concentration, eventually leading to the increase of plant chemical defenses. The plant can recognize wounding, insect oral secretions, and insect feeding vibrations to identify the "attacker", and

thereby respond accordingly. Mechanosensitive conductance Small (MscS) channels are located between the cell wall and the plasma membrane in higher plants. MscS channels in plants respond to many of the same stimuli as the Mechanosenstive (MS) channels in animals. These channels can respond to unique stimuli, including cell wall damage and plant-pathogen interactions. Recently, our lab has shown that plants respond to insect herbivory vibrations by priming the production of chemical defenses that will deter insect feeding. By playing recordings of feeding vibrations produced by the White Cabbage caterpillar Pieris rapae back to the plant Arabidopsis thaliana, we can prime the production of chemical defenses in the absence of the insect. In this study, we will use A. thaliana wildtype plants, and MSL mutants with different combinations of nonfunctional MSL channels. Plants receive either caterpillar feeding vibrations or a silent sham.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 59

Sulav Paudel, Edwin Rajotte, Gary Felton

Temperature regulates the activity of herbivore salivary defense elicitor, Glucose Oxidase

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Interactive effect of temperature and herbivore salivary defense elicitors is largely unknown. Using experimental warming and a combination of biochemical and herbivory bioassays, we evaluated the effect of elevated temperature on the activity of Glucose Oxidase, salivary defense elicitors of Helicoverpa zea

and subsequent effect on plant defensive enzymes. The activity GOX in caterpillar was regulated by temperature and the activity decreased at a warmer temperature. This was surprising as the temperature within physiological limits is predicted to increase enzymatic rates in insects. Further, induction of defensive enzymes was reduced when insects from warmer temperature fed on plants as compared to caterpillars grown at low temperature. Subsequently, a low level of defensive enzymes was correlated with reduced herbivore growth in the bioassay.

Themed Session: Language of Life under Climate Change
POSTER

Number: 47

Cynthia Perkovich, David Ward

Oak tree differentiation of defense and reallocation strategies in response to herbivore pressures

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Plant strategies against herbivory may involve defending themselves by producing plant secondary metabolites (PSM), regrowing to negate injuries from tissue loss (tolerance), or reallocating resources to better defend or protect themselves from further damage. We investigated the strategies of oak plants to minimize herbivory by investment in tannins and reallocation of non-structural carbohydrates. Oak species may differentially invest in defenses and reallocation depending on the intensity and location of herbivore feeding. We simulated the effects of herbivory by removing 25% or 75% of oak tissue, removing either the apical or lateral meristems. The investment in defenses may act as a selective pressure driving herbivore diversity and behavior. Using 12 oak species from different parts of a well-supported phylogeny, we applied five treatments of simulated herbivory, varying in intensity and location. The 12 species were chosen to represent a broad array of geographical and phylogenetic diversity. Using an untransformed statistical analysis, we found that oak species invest differentially in defensive mechanisms. We will also present a more thorough phylogenetic comparative analysis of the data to determine if differences in defense and reallocation strategies are a result of adaptation to herbivory or if defense and reallocation strategies are associated with particular oak lineages.

Themed Session: Biosynthesis of Secondary Metabolites in Chemical Ecology

POSTER

Number: 16

Rita de Cassia Pessotti, Matthew Traxler

Investigating the semi-social beetle Odontotaenius disjunctus as a model for actinomycete chemical ecology

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Some insects harbor in their bodies and colonies microbes, e.g. actinomycetes that are capable of producing diverse specialized metabolites. However, in many cases the ecological role of these compounds remains an open question. We are currently investigating Odontotaenius disjunctus, a Passalidae semi-social beetle, as a model for studying chemical ecology in insect-microbe association. These beetles live in decaying logs across the Eastern US. We subjected frass from 22 colonies across 11 US states to metabolomic analysis. We found that the metabolome of frass material is surprisingly uniform across large geographic distances. Interestingly, the antibiotic actinomycin was detected in multiple colonies. An actinomycin producer, Streptomyces padanus, was isolated from 86% of the colonies. This species also produce the antifungal filipin, which was also detected in some frass samples. When tested together, Actinomycin D and Filipin III showed synergistic effect against the entomopathogenic fungus Metarhizium anisopliae. These results indicate that O. disjuctus and its associated microbiome is a potential system to investigate the chemical ecology of natural products in the context of insect-microbes associations. Beyond this, the prevalence of Streptomyces padanus from the same environment across large geographic distances provides a unique opportunity to study the evolution of microbial specialized metabolism in the context of symbioses.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 51

Kelsey Poulson, Kyle Mayers, Helen Fredricks, Benjamin Van Mooy, Elizabeth Harvey
What makes algae tasty: combining lipidomics and grazing assays to explore chemical drivers of palatability

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Marine phytoplankton are responsible for half of global primary productivity, yet 70% of this productivity can be lost daily due to protist grazing, demonstrating major top-down control on the abundance and composition of phytoplankton communities. However, protist grazing is modulated by the interplay among morphological (e.g., calcification), chemical, and behavioral characteristics of prey. To gain a more comprehensive view of what influences grazing on the bloom-forming coocolithophore Emiliania huxleyi, we performed a series of grazing assays on multiple E. huxleyi strains that vary in levels of calcification. In these assays, both ingestion and growth rates of the grazer, Oxyrrhis marina, were variable, even among calcified strains of E. huxleyi, suggesting additional drivers of prey quality. In order to identify these drivers, we assessed the lipid make up of four different E. huxleyi strains using mass spectrometry-based lipidomics and found that the lipidomes of these strains are statistically distinguishable using partial least squares discriminant analysis. Additionally, E. huxleyi lipidomes mapped onto calcification state: those strains displaying a greater degree of calcification also displayed a more similar lipidome. Thus, lipids specific to certain E. huxleyi strains are targets for future investigation as indices of prey value. These results highlight the importance of biochemical composition in mediating predator-prey dynamics among the plankton.

Themed Session: Chemical Indices of Quality and Health Guiding Foraging, Host- and Mate-Choice

POSTER

Number: 31

Melany Puglisi, Skylar Carlson, Stanley Budzynski, Jason Kwan

Role of Caulerpin and Other Metabolites in Formation of the Microbiome of Caulerpa spp.

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Thirteen strains of Vibrio, including known pathogens to benthic marine organisms, have been isolated from the surface of Caulerpa cylindracea in the Atlantic Mediterranean. High densities of microbial populations on the surface of the algae suggest an algal-bacterial association that may increase the fitness of C. cylindracea. The objective of this study was to explore the role of metabolites from Caulerpa spp. in the formation of the algal microbiome. A panel of 38 strains of surface-associated bacteria (SAB) isolated from Caulerpa spp. were used to screen the solvent partitions of common species of Caulerpa spp. from the Florida Keys. Minimal growth inhibition (8.4%) and growth inhibition (6.6 %) was observed. Subsequent bioassay-guided isolaton of the active extract from C. sertularioides against Vibrio sp. from the surface of C. mexicana yielded caulerpin and two derivatives that significantly promoted the growth of Vibrio sp. below natural concentration (1.8 ug/mL). Settlement assays conducted in the laboratory showed that caulerpin induced settlement of Vibrio sp. from the seawater. In addition, 30% of the unidentified SAB tested were induced to settle when exposed to the H2O partitions from C. racemosa, C. sertularioides and C. cupressiodes and CHCl3 partitions from C. sertularioides and C. cupressiodes. Caulperin and other metabolites may play a role in the chemical mediation of Caulerpa microbiome.

Themed Session: Other

POSTER

Number: 105

Haili Qiao, Pengfei Lu, Sai Liu, Changqing Xu, Jun Chen

Volatiles from Aquilaria sinensis damaged by Heortia vitessoides larvae deter the conspecific gravid adults and attract its predator Cantheconidea concinna

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The effects of induced plant responses on herbivores are categorised as direct, by reducing herbivore development, or indirect, by affecting the performance of natural enemies. Here, we investigated a tritrophic system, which included the herbivore Heortia vitessoides, its host plant Aquilaria sinensis, and its predator Cantheconidea concinna. Herbivore-damaged A. sinensis plants released significantly greater amounts of volatiles than undamaged and mechanically damaged plants, with an obvious temporal trend. One day after initial herbivore damage, A. sinensis plants released large amounts of volatile compounds. Volatile compounds release gradually decreased over the next 3 d. The composition and relative concentrations of the electroantennographic detection (EAD)-active compounds, emitted after herbivore damage, varied significantly over the 4-d measurement period. In wind tunnel bioassays, mated H. vitessoides females showed a preference for undamaged plants over herbivore and mechanically damaged A. sinensis plants. In Y-tube bioassays, C. concinna preferred odours from herbivore-damaged plants to those from undamaged plants, especially after the early stages of insect attack. Our results indicate that the herbivore-induced compounds produced in response to attack by H. vitessoides larvae on A. sinensis plants could be used by both the herbivores themselves and their natural enemies to locate suitable host plants and prey, respectively.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 95

Navneet Rai

Molecular characterization and phylogenetic analysis of Culicinae mosquitoes (Diptera: Culicidae) collected from Northwest India

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Characterization of Culicine mosquitoes collected from Northwest India has been done using both morphology and molecular based taxonomy by COI gene. A ~500bp sequences of mitochondrial Cytochrome Oxidase I (COI) gene were analyzed to construct molecular database and to establish the phylogenetic relationship among 14 Culicinae mosquito species. The sequences were found to be A+T rich and in substitution the rate of transitions was higher than the rate of transversions. Conspecifics showed <2% divergence (range = 0% to 0.9%), whereas interspecific divergence was >2% with K2P (range = 6.4% to 18.2%). Sequence divergence was much higher among species in different genera ranging from 11.0% to 21.3%. Species from the two mosquito tribes (Aedini and Culicini) mostly clustered with other members of their tribe in Neighbor-Joining tree. The tree also showed a separation of species of the sitiens-Group from pipiens-Group.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 25

Lana Resende de Almeida, Ana Maria Obino Mastella, Marina Amaral Alves, Rafael Garrett, Maria João Ramos Pereira

What does metabolomics say about Neotropical Mustelids (Mammalia, Carnivora)?

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Chemical signs act on a wide range of intra and interspecific interactions. In mammals they consist of a complex mixture of volatile and non-volatile compounds. The latter are associated with territorial marking and resource use due to their continuous signaling capacity. Chemical profiles from non-invasive biological material, such as feces, have great potential to contribute to ecological knowledge, mostly for species showing elusive behavior or low population densities. Using Neotropical Mustelidae as model we developed a non-invasive methodology for species identification, as well as to investigate the chemical diversity of non-volatile components in fecal samples. We collected ca. 70 fecal samples from captive individuals of four mustelids occurring in Brazil: Lontra longicaudis, Eira barbara, Galictis cuja and Galictis vittata; these were analyzed by liquid chromatography coupled to high-resolution mass spectrometry. Multivariate data analysis (PCA, PLS-DA and HCA) successfully discriminated the three genera, revealing a chemical similarity between the species of Galictis. We identified over 100 compounds in the fecal samples, including bile acids and food components. Our results suggest that chemical profiles from non-invasive fecal sampling allow species-specific identification within the Mustelidae and potentially within the Carnivora, allowing fast confirmation of the presence of rare or elusive species, contributing for better supported wildlife management plans.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 52

Lora Richards, Casey Philbin, Matt Paulsen

Intraspecific phytochemical variation in Ceanothus velutinus along an elevational gradient and the associated herbivores

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Phytochemical diversity is an emerging focus of research on plant functional diversity. Recently, we have set forth on quantifying the "phytochemical landscape" (Hunter 2016), to understand how spatial and temporal variation in phytochemistry across multiple scales can affect the diversity of multitrophic interactions associated with Ceanothus velutinus (Rhamaceae). We set up two elevational transects on the eastern slope of the Sierra Nevada mountains near Reno, NV covering an elevational range of 1600m to 2500m. Along these transects we established temporary 10m plots and recorded plant diversity and lepidopteran herbivore diversity as well as collected Ceanothus leaves for chemical analysis. We visited the plot and collected data monthly from the beginning of summer through fall. Using an untargeted metabolomics approach we analyzed 500 leaf samples using LC-MS to quantify the how phytochemistry varied along the elevational gradient and seasonally. We linked this variation to herbivore community, and phenology. By identifying the contributions of phytochemical variation on herbivore communities across the landscape, we can begin to understand the role of phenotypic variation and in the maintenance interaction diversity

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 53

Ursula Röse, Andrea L. Call, Katharina H.C. Röse, Emma Tobin, Kristin M. Burkholder
Antimicrobial properties of three red and brown marine macroalgal species

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Macroalgae are very abundant in the intertidal zones of the coast of Maine despite considerable herbivore pressure. This implies that they may contain defense mechanisms that protect them against herbivore and microbial attack. We investigated three macroalgal species for their antimicrobial activity on an array of WHO priority pathogens. The brown alga Fucus vesiculosus, and red algae species Chondrus crispus and Ahnfeltia plicata were collected from the intertidal zone of the Gulf of Maine. Algae were extracted with solvents of different polarity including methanol, dichloromethane and pentane and their antimicrobial activity was investigated against four gram positive pathogens (methicillin-sensitive Staphylococcus aureus strain Newman (MSSA), methicillin-resistant Staphylococcus aureus (MRSA) strain USA300, Bacillus cereus, Listeria monocytogenes) as well as five gram negative pathogens (Pseudomonas aeruginosa, Proteus mirabilis, Salmonella Typhimurium, Klebsiella pneumoniae, Escherichia coli). Antimicrobial activity was tested in a disc diffusion assay followed by a Minimum Inhibitory Concentration assay. All three algal species tested showed antimicrobial activity against several human pathogens. Of the three solvents tested, extractions with methanol, showed the highest antimicrobial activity. Of nine human pathogens tested, S. aureus (MSSA) and S. aureus (MRSA), P. mirabilis, S. Typhimurium, and K. pneumonia were inhibited by algal extracts.

Themed Session: Biosynthesis of Secondary Metabolites in Chemical Ecology

POSTER

Number: 17

Carmen Rossini, Anna Paula Burgueño, María Eugenia Amorós, José Buenahora, Andrés González
Oviposition cues for the Asian citrus psyllid, Diaphorina citri (Hemiptera: Liviidae)

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The Asian citrus psyllid (ACP) is the vector of Huanglongbing, the most destructive citrus disease. Preliminary work has shown that ACP prefers to oviposit on Duncan grapefruit and Sweet Orange. Rough, Eureka and Cravo lemons showed variable results, whereas Citron was not preferred. Searching for biomarkers that may serve as kairomones for ACP females, the volatile organic compounds (VOCs) and the CDCl3 and D2O extracts from shoots of the mentioned varieties (N = 6/species) were analyzed by GCMS and NMR respectively. All processed data were submitted to multivariate analyses (MetaboAnalyst4.0). For the D2O extracts, the chemical profiles of Sweet orange and Duncan grapefruit were grouped; being different from the profiles of Citron while the Eureka, Cravo and Rough lemons exhibited intermediate profiles. These results correlated to the oviposition preference (PLS model, permutation test: P = 0.048). Correlation was traced to chemical shifts in the NMR spectra corresponding to compounds with aromatic and sugars moieties in their structures. We are currently working to determine the identity of these compounds. Among the 81 VOCs characterized, limonene and a mixture of limonene, (E)-β-ocimene, Methyl N-methylanthranilate, β-elemene and β-caryophyllene exhibited different ACP capture ratios than the control in 2-choices cage experiments (GLM, P <0.05). These results suggest that the ACP could use a combination of volatile and non-volatile cues to choose its oviposition plants.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 54

Jordano Salamanca, Escuela de Ciencias Agrícolas, Pecuarias y del Medio Ambiente, Vanessa Garzón-Tovar, Escuela de Ciencias Agrícolas, Cesar Rodriguez-Saona, Cristina Mendoza

Herbivore-induced plant volatiles to attract natural enemies in agroecosystems: Are 2 better than 1?

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Herbivore-induced plant volatiles (HIPVs) are emitted by many plants after herbivore feeding and oviposition damage. Both methyl salicylate (MeSA) and benzaldehyde (BEN) are HIPVs known to attract natural enemies in agroecosystems. In this study, we hypothesized that combinations of these HIPVs are better at attracting natural enemies (predators and parasitoids) than each HIPV alone. For this, we conducted field experiments with MeSA-, BEN-, or MeSA+BEN- baited sticky traps in coffee farms in the region of Sumapaz, Colombia. Treatments were: (a) MeSA; (b) BEN; (c) MeSA + BEN; and (d) control (-MeSA -BEN), replicated three times in four different farms in a randomized complete block design. Every fifteen days sticky traps were collected and the number of natural enemies (predators and parasitoids) counted, for a total of four months. Insect predators of the family Syrphidae were attracted to BEN alone. Anthocoridae were attracted to BEN alone, the predatory thrips Franklinothrips vespiformis (Thysanoptera: Aeolothripidae) to MeSA alone, and both to the combo MeSA+BEN. MeSA in combination with BEN also attracted more Chrysopidae than the others treatments. For parasitoids, Megaspilids were attracted to MeSA alone. On the other hand, Aphelinidae and Mymaridae showed an attraction to BEN and MeSA alone. This study shows the potential of combining multiple HIPVs to increase natural enemy attraction for enhanced conservation biological control in an agroecosystem.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 9

Mariana Sanchez, Arnubio Valencia, Joe Louis, Blair Siegfried, Ana Maria Velez

Evaluating CO2 Receptor Genes Through Parental RNAi as Potential Targets for Western Corn Rootworm Management

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The western corn rootworm (WCR) is an insect considered the most significant pest of corn in the United States Corn Belt, where the yield reduction and management cost exceed more than 1 billion dollars every year. Given that WCR has evolved resistance to different management strategies, the need of developing novel and efficient tools has increased. The RNA interference (RNAi) is the newest tools developed for WCR management. However, current target genes are highly conserved housekeeping genes, which generates concerns in effects on non-target organisms. Therefore, we are exploring gustatory receptor genes which are associated with WCR biology, and have been reported as species-specific genes. Three gustatory receptor genes (gr) have been identified in WCR and are believed to be involved in CO2 detection, the primary host-finding cue used by neonates in the soil. In the current study, a parental RNAi (pRNAi) approach was used to evaluate those genes. Herein, WCR adult females were treated with dsRNA for gr genes (gr1, gr2, and gr3) ten days after mating, observing gene knockdown in adults, eggs, and larvae for gr1 and gr2. Phenotypic analysis in larvae also showed behavioral disruption of finding CO2 cues after knocking-down the gr2 gene through pRNAi. These results demonstrated for the first time the effectiveness of parental RNAi in a non-development-related gene. Additionally, this research is pioneering in the study of rootworms genes involved in cues perception.

Themed Session: Chemical Biology Approaches for Interactions among Organisms

POSTER

Number: 24

Antonio Santana, Kelly Silva, Dannielle Costa, Chryslane Silva, Gilson Chia, Henrique Goulart, Antônio Santana

Chemical composition of the extract of the anterior wing of Eupalamides cyparissias Fabricius (Lepdoptera: Castniidae) and its role in chemical ecology

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Eupalamides cyparissias is a pest for the Arecaceae family, represented by the economically relevant cultures of palm oil and coconut. The main damage caused by the insect is the formation of galleries in the plant strain. The control of this Lepidoptera is difficult and is based on the mechanical harvesting of caterpillars, pupae and adult insects to reduce the incidence of adults in the field and thus curtail any new generation. As it is an endophytic insect, the use of insecticides to control the caterpillar is inefficient and therefore more efficient control methods are urgently required. The use of semiochemicals (pheromones) for pest control appears as a viable alternative that does not affect the product and does not affect the environment. The present work aims to identifying the chemical profile of extracts obtainedfrom the anterior wing of E. cyarissias, of 24-hour old males and females. They were obtained by extraction with HPLC-grade hexane, during 20 min. The extracts were analyzed by gas chromatography coupled with flame ionization detector and mass spectrometry. The Kovats index was calculated, as usual, using the same stationary phase of the analyzed samples.The chemical profiles analyzed in both extracts ranged from linear hydrocarbons to esters, alcohols and terpenes, in addition to a specific male compound. These results is bringing the opportunity to have a pheromone for monitoring and control of E. cyarissias.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 10

Fredrik Schlyter, Annette, Johansson, Hjortsberga, Prague, Alnarp

Detection dogs trained to recognize spruce bark beetle pheromones outperform human experts in locating spruces recently attacked

EXTEMIT-K, Faculty of Forestry and Wood Science, CULS, Prague, Czech Republic & Chemical Ecology, SLU, Alnarp, Sweden

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For forest protection, the rapid detection of bark beetle infestations is required to successfully implement a management strategy that relies on sanitation felling of recently infested trees within 2 −3 weeks of attack. However, human detection generally requires close inspection (≤ 1m) of trees, and is therefore time-consuming, costly, and not always practical. Detection dogs trained to recognize synthetic pheromone compounds from spruce bark beetles has been shown to detect naturally infested spruce trees. In this study we compared detection dog teams to human experts in finding recent natural attacks. In a first trial several new dog-handler teams were trained to recognize trees attacked by spruce bark beetles. These teams were tried in several field plots and ware compared with a trained forest inspector in the same areas. In a second, larger scale trial an insect expert from the Swedish Forestry Agency did a first inspection in a wildfire damaged area and the same area was in following spring inspected by detection dog teams. In both trials dog-handler teams were more efficient than trained human experts in finding early bark beetle infestations both in infestations found in the area and particularly in time spent. In a parallel poster of EXTEMIT-K, location of experimentally induced attacks (i.e. positions known) were tested in a similar way -check it out to see what happened!

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 11

Gerald Schneider, Lauren Maynard, Susan Whitehead

Frugivory and the dispersal of phytochemistry: the divergent secondary metabolomes of fruit and leaves in bat-dispersed Neotropical Piper plants

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Over 50% of angiosperm species depend on frugivorous animals to disperse their seeds. Yet, while a wealth of phytochemistry has been found in fruits, patterns of ecological and evolutionary interplay between fruit phytochemicals and seed dispersers remain largely opaque. Metabolomic techniques have enabled the elucidation of these patterns through comparisons across multiple species and plant tissues. Using this approach, we investigated the components and scales of phytochemical diversity distinguishing fruit from leaves across 12 co-occurring bat-dispersed species in the genus Piper. Further, we investigated the relationship between phytochemical diversity and bat diet. Across species, our metabolomic comparisons indicated divergence between fruit and leaves at the levels of both chemical composition (all $p<1x10-5$) and structural complexity (all $p<1x10-5$). This trend was most pronounced at the scale of interspecific β-diversity, with unripe and ripe fruit pulp more divergent than leaves in both structural (both $p<1x10-5$) and compositional (unripe $p=0.007$; ripe $p=0.013$) comparisons. Next, we found that Piper species' occurrence in field-collected bat fecal samples was positively correlated with the structural complexity of ripe pulp across 6 of 7 species ($R2=0.89$, $p=0.003$). This suggests that selective pressures on phytochemistry in fruits are fundamentally different from those in leaves, with seed disperser interactions potentially driving phytochemical diversification.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 55

Stefan Schulz, Christian Schlawis, Stefan Schulz

Structure elucidation without NMR - A combined approach using GC/MS, GC/IR, DFT calculations and synthesis

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Structure elucidation of minor amounts of compounds in complex mixtures, a problem often encountered in Chemical Ecology, is difficult. Usually GC/MS is used for this purpose for volatile or lipophilic compounds. Additional information is obtained from high-resolution MS data or micro reactions. Finally, a structural proposal is formulated that has to be verified by synthesis. If the synthetic compound does not match the natural one, this process has to be repeated with the next proposal, culminating in substantial synthetic effort. We present here orthogonal techniques that reduces the required synthetic effort to a minimum. Direct disposition GC/IR allows the analysis of material in amounts as low as 10 ng, with a chromatographic resolution similar to that of a GC/MS system. The IR data give information on functional groups, but IR cam be of more use. A third analytical dimension can be added by DFT calculations of IR spectra. Instead of synthesizing a set of compounds, the respective simulated IR spectra allows selection of the most likely candidate structure, thus drastically reducing required synthetic effort. We will present this approach in the identification of unique salinilactones produced by marine Salinispora bacteria. Salinilactones are unprecedented cyclopropabutanolides that show toxicity in brine shrimp assays and are structurally related to the A-factor, a signaling compound in some actinomycetes. The use and the limitation of our approach is presented.

Themed Session: Integrated Approaches for Structure Determination in Chemical Ecology

POSTER

Number: 42

Jacqueline Serrano, l Peter J. Landolt, J. Steven McElfresh, Jocelyn G. Millar

Progress with the identification of pheromones from North American click beetles (Coleoptera: Elateridae)

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The click beetles (Coleoptera: Elateridae) comprise a large family with ~10,000 identified species, a number of which are important agricultural pests. To date, relatively few click beetle pheromones or pheromone candidates have been identified, and most of these are from one subfamily. Furthermore, most known or suspected pheromones have been identified from species native to Europe and Asia, where they are used to monitor and manage a number of pest species. Identification of pheromones for North American species would be immediately useful because of the current resurgence of a number of species as pests of major crops such as corn, wheat, and potatoes. We hypothesized that the known pheromones of Asian and European species might be conserved within closely related taxa, and thus also used by North American congeners. We synthesized and field tested a library of known elaterid pheromones and analogs, which resulted in the identification of neryl hexanoate and neryl octanoate as pheromones or likely pheromones for four species in the genera Idolus and Dalopius. In addition, several novel pheromone structures have been identified from other North American species in the genera Melanotus and Cardiophorus, with these structures often bearing little similarity to any previously identified click beetle pheromones. Although elaterid pheromone research is in its infancy, structural patterns are beginning to emerge within related taxonomic groups.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 96

Jacqueline Serrano, J. Steven McElfresh, Yunfan Zou, Jocelyn G. Millar

Identification of Aggregation-Sex Pheromone Components for a "Living Fossil", the False Click Beetle, Palaeoxenus dohrni Horn (Coleoptera: Eucnemidae)

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Insect pheromones have rarely been exploited in surveys or studies of rare and endangered species, despite their potential as powerful, highly selective attractants for target species. Here, we report the identification, synthesis, and field bioassays of male-produced aggregation-sex pheromone components for a rare false click beetle species, Dohrn's elegant eucnemid beetle, Palaeoxenus dohrni Horn. This species is endemic to the mountain ranges in southern California, USA and is the only extant species in its genus and subfamily. Analyses of extracts of headspace volatiles collected from adult beetles revealed several male-specific compounds. Two of these compounds, identified as (E)-2-nonen-4-one and (R)-2-nonanol, elicited electroantennographic responses from antennae of both sexes. In field bioassays, a blend of the two compounds attracted both sexes, whereas the individual compounds were not attractive. The identification of an attractant pheromone should provide a useful tool for determining the range and estimating population densities of this iconic species.

Themed Session: Other

POSTER

Number: 107

Salina Som, Denis S. Willett, Hans T. Alborn
Moisture effects on belowground volatile diffusion and degradation

United States Department of Agriculture, Agriculture Research Service, Center for Medical, Agricultural, and Veterinary Entomology (USDA ARS, CMAVE)

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Above ground herbivory can induce release of plant volatiles that attract natural enemies of the herbivores. Similarly, roots can release herbivore induced volatiles that attract beneficial organisms such as entomopathogenic nematodes belowground. Unlike their aboveground counterparts, belowground volatile signals interact with solids, liquids, and gases as they move through soil pore spaces. These interactions influence belowground signaling, can create non-linear diffusion profiles, and result in surface adsorbtion and degradation of volatiles in space and time. By examining diffusion and degradation in sand-filled microcosms, we found that the diffusion profiles of E-β-caryophyllene, d-limonene, pregeijerene, α-pinene, germacrene-d, and linalool were affected by moisture and pH. Furthermore, the common plant volatile linalool was non-diffusive below ground. In addition, we discovered a novel pathway for the degradation of linalool into rapidly diffusing belowground signals. These findings suggest areas for future exploration and highlight the importance of abiotic factors when

studying belowground semiochemically-based interactions such as attraction of beneficial entomopathogenic nematodes to plant roots infested by host insects.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 12

Maria Sousa

Antennal morphology of a bark beetle predator M. signaticornis

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The long legged flies (Dolichopodidae) is one of the largest families of Diptera, where most of the species are predators and play an important ecological role as natural enemies of a wide variety of organisms. Many species from Medetera genus, for example, are known to prey on Scolytidae brood at early developmental stages and have been indicated for the biological control of bark beetle pests such as Ips typographus. The fly females identify a tree under bark beetle attack from a distance. After landing they 'scan' the surface searching for bark beetle galleries. The females oviposit their eggs at the entrances of bark beetle galleries and the eclosed larvae mine through the bark and into the bark beetle larval galleries, where they predate on the bark beetle brood during their development. Although, the importance of these predators have long time ago been identified, little information is available regarding Medetera host-prey location and it is still not clear how the different Medetera spp locate infested trees or how they locate

their prey underneath the bark. Antennae and maxillary palps are the main olfactory organs known in Diptera. The aim of this project is to use scanning electron microscopy (SEM) to study the antennal morphology of M. signaticornis, which is one of the most important Ips typographus predator found in Sweden.

Themed Session: Chemically-Mediated Consumer-Prey Interactions

POSTER

Number: 33

Lindsay Spiers

Feeding preferences of herbivorous fish and sea urchins: potential implications for the recovery of degraded reefs

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The long legged flies (Dolichopodidae) is one of the largest families of Diptera, where most of the species are predators and play an important ecological role as natural enemies of a wide variety of organisms. Many species from Medetera genus, for example, are known to prey on Scolytidae brood at early developmental stages and have been indicated for the biological control of bark beetle pests such as Ips typographus. The fly females identify a tree under bark beetle attack from a distance. After landing they 'scan' the surface searching for bark beetle galleries. The females oviposit their eggs at the entrances of bark beetle galleries and the eclosed larvae mine through the bark and into the bark beetle larval galleries,

where they predate on the bark beetle brood during their development. Although, the importance of these predators have long time ago been identified, little information is available regarding Medetera host-prey location and it is still not clear how the different Medetera spp locate infested trees or how they locate their prey underneath the bark. Antennae and maxillary palps are the main olfactory organs known in Diptera. The aim of this project is to use scanning electron microscopy (SEM) to study the antennal morphology of M. signaticornis, which is one of the most important Ips typographus predator found in Sweden.

Themed Session: Chemically-Mediated Consumer-Prey Interactions

POSTER

Number: 34

Sprayberry, J., Kass, S., Roma, N., and Domardsky, A.,

How much is too much? Scent-pollution and odor-recognition in bumblebees.

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Bumblebees often forage in anthropogenically-modified sensory landscapes. We know that floral-odor signals are used by foraging bumblebees, and have a basic understanding of how olfactory systems encode complex odor blends. However, our understanding is not nuanced enough to predict how perception of learned odors is influenced by scent pollution. Previous studies indicate that foraging can be negatively impacted by anthropogenic modulation of odors. This study investigates the extent of odor contamination that will result in behavioral disruption. Using an associative-learning paradigm

bumblebees are trained to associate an odor with a food reward, then offered a choice between the associative odor (AO) and a contrasting odor (CO). Contrasting odors range from novel scents (a simple task) to blends of the AO with a novel scent (a harder task). Experimental odors are complex blends of odorants; blending novel odors with the AO increases the amount of structural overlap between the AO and CO, allowing us to test the amount of odor contamination that the bumblebee olfactory-processing system can tolerate before the AO is no longer recognized. This hypothetically indicates the level of odor pollution that is likely to disrupt odor-driven foraging behavior. Defining a 'level' of pollution is non-trivial; this project also presents a novel method of representing complex odor blends in a multidimensional computational space, which allows us to quantify scent-contamination.

Themed Session: Anthropogenic Impacts on Chemical Cues, Signals and Chemoreception

POSTER

Number: 1

Svatoš, A., Kaftan, F., Manezes, R., and Gajdošová, S.

Untargeted metabolomics of simulated herbivory: Mass spectrometric imaging and metabolic profiling of Arabidopsis thaliana show reallocation of metabolites upon mechanical wounding.

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Question on metabolic reaction of plants to herbivory stress is still largely unanswered. Recent reports indicates reallocation of primary metabolites to young tissue and towards roots associated with regulation of biosynthetic pathways [1,2]. Biological experiments are typically supported by targeted metabolomics because nontargeted metabolomics did not provided suitable tools for a large scale identification of

metabolites and rather provides set of features may be representing interesting metabolites.Current development in metabolomics data dereplication and novel instrumentation with fast scanning capacity opens possibility for a large scale identification of metabolites. Three weeks old A. thaliana were mechanically wounded and 1-7 leaves, apical meristem, cotyledon and roots extracted and analyzed on Q-Exactive HFX coupled to UPLC chromatographic separation. MS and DDA-measured MS/MS spectra were uploaded to GNPS [3] and Sirius [4] programs for metabolite identification. Several hundreds of metabolites were identified. Glucosinolates, principal defensive compounds of Brassicales order, show significant reallocation toward meristem and roots as upon mechanical wounding.1. S. Zhou, Y-R Lou, V. Tzin, G. Jander. Plant Physiology,169: 1488–1498, 2015.2. S. Gómez, A. D. Steinbrenner, S. Osorio, M. Schueller, R. A.Ferrieri, A. R. Fernie & C. M. Orians. Entomologia Experimentalis et Applicata 144: 101–111, 2012.3. Wang, M., et al. Nature Biotechnology 34.8 (2016): 828-

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 56

Sweeney-Jones, A.M., and Kubanek J.

Early Identification of Known Molecules in Complex Mixtures Derived from Marine Organisms that Exhibit Pharmacological Activity

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For the chemist seeking to discover novel secondary metabolites, identifying known compounds early is essential to avoid re-isolating molecules. Natural product chemists often examine literature for taxonomic groups of interest to find known secondary metabolites. In cases where the organism is well-studied, the probability of isolating known compounds is high. Methods such as 1H NMR spectroscopy and LC/MS are useful for drawing comparisons between complex mixtures and data reported in literature for pure compounds. Additionally, MS/MS data can be used to build molecular networks comparing molecules in the mixtures to known compounds included in the Global Natural Products Social Molecular Networking website. Marine varieties of the chemically rich phylum Cyanobacteria have nearly 800 secondary metabolites reported. A cyanobacterium Moorea bouillonii attracted our attention for its potent antimalarial activity. Due to the high probability of identifying known chemistry, the methods described above were applied throughout the purification process. The natural products ulongamide A and lyngbyabellin A, which are cytotoxic against cancer cell lines, as well as a novel analog of lyngbyapeptin A were tentatively identified in the extract. These compounds were subsequently purified to confirm their novel antimalarial activity. Employing these methods expedited the identification of known molecules and consequently minimized the resources required for structure determination.

Themed Session: Integrated Approaches for Structure Determination in Chemical Ecology

POSTER

Number: 43

Tosh, C.R., Conboy, N.J.A, McDaniel, T., et al.

French marigolds protect tomato plants from glasshouse whiteflies through the emission of airborne limonene

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Gardeners in temperate regions often claim that planting marigolds next to tomato plants protects the tomatoes from the glasshouse whitefly (Trialeurodes vaporariorum Westwood). Here we present two large-scale glasshouse trials corresponding to the two main ways growers are likely to use marigolds to control whiteflies. In the first, marigolds are grown next to tomato throughout the growing period. Here the association with marigolds significantly slows whitefly population development. Adding whitefly-attractive 'pull' plants around the perimeter of plots has little effect, but reducing the proportion of marigolds and introducing other non-hosts of whiteflies (basil, nasturtium and Chinese cabbage) also reduces whitefly populations on tomato. The second experiment assesses the efficacy of marigolds when used as an 'emergency' measure. Here we allow whitefly populations to build to a high density on unprotected tomatoes then introduce marigolds. Limonene is a major chemical component of French marigolds and whiteflies dislike the odor of this compound so limonene dispensers are added as an additional treatment. "Emergency" marigold companion planting yielded minimal reductions in whitefly performance, but the use of limonene dispensers was more effective. Companion planting short vine tomatoes with French marigolds throughout the growing season will slow development of whitefly populations. The use of limonene dispensers placed near to tomato plants also shows promise.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 13

Traczyk, E., Funderburk J., McAuslane, H., and Martini, X.

Predatory Search Behaviors of a Minute Pirate Bug, Orius insidiosus (Hemiptera: Anthocoridae), in Response to Thrips Contact Cues

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The western flower thrips are an economically destructive pest within agroecosystems worldwide through the transmission of numerous Tospoviruses, often resulting in fruit loss or downgrading. Natural enemies of the flower thrips, such as the minute pirate bug, Orius insidiosus, have been shown to successfully suppress and control western flower thrips populations better than calendar insecticide applications, and prefer western flower thrips over related species. Additionally, contact cues, such as western flower thrips alarm pheromone, have been shown to alter the foraging behaviors of Orius predators, acting as kairomones that result in arrestment behavior. The implementation of other potential contact cues, such as shed cuticle and fecal material, in exploiting Orius behavior has yet to be studied. The following experiments explored the inducing effects of western flower thrips tracks on Orius predatory search behaviors. Using motion-tracking software, Y-tube and arena bioassays, and mass spectrometry, the behavior-inducement and profile of thrips tracks were studied to determine if chemical compounds in the tracks served as arrestants and whether those compounds could be utilized to exploit Orius predatory search behaviors. Initial data show that thrips tracks alone result in arrestment behavior of O. insidiosus in arena and Y-tube trials. Analysis of chemical components and biosynthesis are necessary to determine the practicality of field and greenhouse implementation.

Themed Session: Chemically-Mediated Consumer-Prey Interactions

POSTER

Number: 35

Uefune, M., Abe, J., Urano, S. Nagasak, K, and Takabayashi, J.

The use of plant volatiles that attract the parasitoid wasp Cotesia vestalis for the biological control of diamondback moth larvae

Faculty of Agriculture, Meijo University, Nagoya, Japan; Western Region Agricultural Research Center, NARC, Fukuyama, Japan; Peco IPM Pilot Co., Ltd., Minami-kumamoto, Japan; Agricultural Research Center, NARC, Tsukuba, Japan; Center for Ecological Research, Kyoto University, Otsu, Japan

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Plants infested by herbivorous arthropods release volatiles called herbivory-induced plant volatiles (HIPVs). We have been studying ecological functions of HIPVs in a tritrophic system of crucifer plants, diamondback moth (DBM) (Plutella xylostella) larvae and their parasitoid wasps Cotesia vestalis. One of the ecological functions of HIPVs from crucifer plants infested by DBM larvae is to attract C. vestalis females. α-pinene, sabinene, n-heptanal and (Z)-3-hexenyl acetate detected in the headspace of cabbage plants infested by DBM larvae are involved in the attraction. We also showed that the synthetic blend of the four compounds attracted C. vestalis females under both laboratory and field conditions. Further, the blend enhances the host-searching efficacy of C. vestalis on plants: the wasps show longer residence time and searching time on plants with the synthetic blend than they do on those without the blend. The number of encounter/oviposition by the wasps on plants with the blend is also higher. Based on these data, we conducted field experiments using the synthetic blend to control DBM in commercial greenhouses, and in open agricultural fields. The results of the field experiments will be discussed.

Themed Session: Application and Manipulation of Plant Volatiles for Crop Protection

POSTER

Number: 14

Urbaneja-Bernat, P., Rodriguez-Saona, C., Cloonan, K., Salazar-Mendoza, P., and Zhang, A.

Wild blueberries are more attractive than cultivated blueberries to the invasive vinegar fly Drosophila suzukii

Rutgers University, New Brunswick, New Jersey, USA; Acadia University, Nova Scotia, Canada, University of São Paulo, Piracicaba, Brazil and; SDA-ARS, Beltsville, Maryland, USA.

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Highbush blueberry is a crop native to the northeast USA that has been domesticated for only about 100 years. During the breeding process, blueberries were selected for several agronomic traits but most importantly for large fruit size and high yields. In the present study, we conducted choice tests to compare the attraction of the invasive pest Drosophila suzukii to wild and cultivated blueberries. We also conducted headspace analysis and gas chromatography-electroantennogram detection (GC-EAD) assays to identify antennally-active compounds. Fruit from wild and cultivated blueberries, growing in proximity, were sampled from three different sites in the Pinelands national reserve in New Jersey (USA), a region where blueberries were first domesticated and with a forest understory consisting largely of wild blueberries. In choice bioassays, D. suzukii flies were more attracted to volatiles from wild than cultivated blueberries. Wild blueberries emitted higher amounts of volatiles than cultivated blueberries. Nine EAD-active compounds were identified from wild blueberries and are currently being tested in behavioral assays. Overall, our results show that breeding for agronomic traits has lowered volatile emissions in blueberry fruit, which decreased attraction to D. suzukii. This study documents the potential effects of crop domestication on an invasive frugivorous insect pest.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 76

Van Alstyne, K.L., Bartlett, S., and Eisenlord, M.

Defenses against Wasting Disease in the Eelgrass Zostera marina

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Eelgrass meadows are critical habitats in coastal waters of North America and Europe, including the Salish Sea. The eelgrasses that form the foundation of these meadows are threatened by a variety of interacting stressors, including nutrient pollution, changing environmental conditions associated with climate change, and disease. The primary disease threat to eelgrasses is the protist Labyrinthula zosterae, which infects eelgrasses throughout their range. Phenolic compounds have been hypothesized to be the primary chemical defense against Labyrinthula in the eelgrass Zostera marina; however, only one phenolic compound, caffeic acid, has been shown to inhibit Labyrinthula growth, and caffeic acid was absent from a collection of Z. marina from Ship Harbor, Washington. To determine whether Z. marina in the Salish Sea produces chemical defenses against L. zosterae, we collected eelgrass from Padilla Bay and created crude extracts, which were then partitioned into polar and non-polar fractions. In laboratory bioassays, both fractions inhibited the growth of L. zosterae when incorporated into an agar-based medium at natural concentrations. Further work is currently being done to isolate the compounds responsible for this inhibition. Our results show that multiple eelgrass compounds are involved in inhibiting wasting disease in the Salish Sea.

Themed Session: Other

POSTER

Number: 106

Vander meer RK[1]., Porter S[1]., Cardosa Y[2].

Phorid Flies and their attraction to host fire ants

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Phorid flies are parasites of fire ant workers. They find fire ant worker,attack and lay an an egg in their thorax. The developing larva migrates to the ant's head where it develops and just prior to pupation the ant dies and its head falls off. The ants remove the head/pupa to the midden pile outside the ant nest where the fly emerges to an adult ready for business. We will look at how the flies find their hosts through use of the ants chemistry.

Themed Session: Chemical Communication of Social Insect Associates: Espionage, Weaponry and Stealth

POSTER

Number: 29

Vošvrdová N[1]., Modlinger R[1]., Johansson A[2]., Jakuš R[1]., Turčáni M[1]., Schlyter F[1].

Use of trained dogs as a possible alternative to detect bark beetle attacked spruce trees

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Spruce stands in the middle Europe has been experiencing intensive European spruce bark beetle (Ips typographus) calamities in recent years. There are many causes of this gradation. One of them is the late clearing of the infested trees – currently due to insufficient processing capacity. For the bark beetle calamity management is the most important the on-time detection of the freshly infested trees. Detection failure causes rapid spreading of bark beetles. To the present, visual inspection of the trunk by bark beetle specialist was the only reliable method how to locate bark beetle attacks. Here, we are reporting the way of the early detection of freshly attracted spruce tree with the using of olfaction cue of specially trained detection dogs. These dogs are trained on synthetic Ips typographus pheromone compounds (2-methyl-3-buten-2-ol, cis-verbenol, ipsdienol, verbenone). Consequently, we setup the forest test to compare detection efficiency and detection speed of dog with handler vs bark beetle specialist. Results showed higher speed and efficiency of the pair dog and its dog handler within the detection of the early attacked trees.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 77

Li Y., Wang Z.

Loosing the Arms Race: Sensed but Ignored by Greater Wax Moth on Bee Alarm Pheromones

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The greater wax moth (GWM), Galleria mellonella L. is one of main pests of the honeybees. The larvae burrow into the bee comb, which not only damages the bee comb, degenerating bee products, but also cause severe effects like driving the whole colony to abscond. In the present study, we used electroantennogram (EAG) and Y maze, oviposition site choice bioassay to test whether GWM could eavesdrop on bee alarm pheromones (IPA, OA, BA and 2-HP), to target on bee colony, or the bee alarm pheromones would effect their preference of oviposition site. The results turned out that GWM showed highly electrophysiological response to these four compounds of bee alarm pheromones even in a low concentration (100ng/μl), while they showed highest response to OA than the other three main bee alarm components (BA, IPA and 2-HP). But GWM behavioral results showed no significant preference or avoidance to these four bee alarm pheromones. These results indicate that bees are loosing the arm race since GWM could sense bee alarm pheromones, however, these alarm pheromones were ignored by GWM.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 97

Zhang H-J[1,2,3]., Xu W[3,4]., Chen Q-m[1]., Sun L-N[1]., Anderson A[2]., Xia Q-Y[1]., Papanicolaou A[3,5].

Sensory neuron membrane proteins (SNMPs) in moths

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Sensory neuron membrane proteins (SNMPs) play a critical role in the insect olfactory system but there is a deficit of functional studies beyond Drosophila. Here, we provide functional characterisation of insect SNMPs through the use of bioinformatics, genome curation, transcriptome data analysis, phylogeny, expression profiling, and RNAi gene knockdown techniques. We curated 81 genes from 35 insect species and identified a novel lepidopteran SNMP gene family, SNMP3. Phylogenetic analysis shows that lepidopteran SNMP3, but not the previously annotated lepidopteran SNMP2, is the true homologue of the dipteran SNMP2. Digital expression, microarray and qPCR analyses show that the lepidopteran SNMP1 is specifically expressed in adult antennae. SNMP2 is widely expressed in multiple tissues while SNMP3 is specifically expressed in the larval midgut. We functionally characterised SNMP1 in the silkworm using RNAi and behavioural assays. Our results suggested that Bombyx mori SNMP1 is a functional orthologue of the Drosophila melanogaster SNMP1 and plays a critical role in pheromone detection. Split-ubiquitin yeast hybridization study shows that BmorSNMP1 has a protein-protein interaction with the BmorOR1 pheromone receptor, and the co-receptor (BmorOrco). Concluding, we propose a novel molecular model in which BmorOrco, BmorSNMP1 and BmorOR1 form a heteromer in the detection of the silkworm sex pheromone bombykol.

Themed Session: Molecular Mechanisms in Terrestrial and Aquatic Chemical Ecology

POSTER

Number: 65

Yang C-q[1]., Deng J-c[1], Qin W-t[1], Yang W-y[1,2], Liu J[1,2].

Metabonomics Analysis of Soybean Pod Response to Field Mold Infection

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Prolonged, continuous rainfall is the main climatic characteristic of autumn in Southwest China, and it has been found to cause mildew outbreaks in pre-harvest soybean fields. Previous research found that some kind of soybean pod has mildew resistance. In order to explore the field mildew resistance mechanism of soybean pod, UPLC-Q-TOF/MS untargeted metabonomics method was adopted to characterize the metabolic response of ND12 (sensitive) and D49 (resistance) after infecting with Fusarium moniliforme. And the key metabolic pathways were scheduling target validation. The results showed that infected by fungal for 7 days, 182 metabolites including Flavone, fatty acids and other secondary metabolites were significant changed in pod of D49 while 50 metabolites especially the sugar and amino acids were significant changed in pod of ND12. The metabolic pathway analysis showed that the starch and sucrose metabolism, phenylalanine, tyrosine and tryptophan biosynthesis, pentose and glucuronate interconversions were obviously responded in the pod of ND12, and the Linoleic acid metabolism, flavone and flavonol biosynthesis were strongly responded in the pod of D49. The sequential monitoring results of different kinds of soybean pod fatty acid and isoflavone component response to field mould showed that field fungal infection can promote the accumulation of isoflavones in fungus resistant soybean pod, and weaken the accumulation of linolenic acid, linoleic acid and other nutrients.

Themed Session: Metabolomics in Chemical Ecology

POSTER

Number: 57

Yang K.

Evaluation of trap designs and food attractants for trapping *Eucryptorrhynchus scrobiculatus* (Coleoptera: Curculionidae)

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Eucryptorrhynchus scrobiculatus (Motschulsky) is a serious pest of tree of heaven, Ailanthus altissima (Mill.) Swingle in China. Laboratory choice tests were conducted to compare attractiveness of vinegar, ethanol, apple juice, the vinegar-ethanol mixture (VE), vinegar-apple mixture (VA), ethanol-apple mixture (EA) and vinegar-ethanol-apple mixture (VEA) to E. scrobiculatus. VEA showed significantly higher attractiveness to E. scrobiculatus than vinegar, ethanol, apple juice alone, VE, VA or EA. The field experiments were conducted to evaluate the efficiency of commercial pitfall traps baited with different ratios of VEA (Apple: VE, m:m) for trapping E. scrobiculatus. Field evaluations showed that the number of marked and wild E. scrobiculatus in traps baited with the VEA (Apple: VE, 30:70 ratio, m:m) was significantly higher than traps baited with other ratios of VEA. Further testing of four types of trap baited with this VEA (Apple: VE, 30:70 ratio, m:m) indicated that captures in homemade pitfall trap design were significantly higher than in any other trap design (commercial pitfall traps, cross-vane versus traps and six-unitfunnel traps). The results demonstrated that homemade pitfall traps baited with the VEA (Apple: VE, 30:70 ratio, m:m) have potential for E. scrobiculatus monitoring.

Themed Session: Natural Product Application in Insect Pest Control

POSTER

Number: 78

Zhang, Y.

Identification of Caragana plant volatiles, overlapping profiles, and olfactory attraction to *Chlorophorus caragana* in the laboratory

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Chlorophorus caragana (Coleoptera: Cerambycidae) is a trunk borer that feeds on Caragana shrubs in the desert. There are five species of Caragana plant in the distribution area of Ch. caragana. We investigated damaged Caragana plants in the field. Olfactory responses of female Ch. caragana to plants and identified volatile compounds from Caragana plants were further evaluated. Caragana davazamcii was severely damaged in the field, followed by Caragana microphylla. No damage was found to the other three species. Behavioral experiments showed that C. davazamcii, C. microphylla, and Caragana korshinskii were attractive to female insects. Caragana ordosica could repel and avoid female insects. Caragana brachypoda had no effect on the orientation behavior of female insects. Seventy volatile components were identified from the Caragana plants, and (Z)-β-ocimene, 1,3-pentadiene, (Z)-3-hexenyl acetate, perillene, chrysanthenone, and limonene were the most abundant volatiles identified from the Caragana plants. The volatiles were categorized into three groups. Those most attractive to Ch. caragana consisted of chrysanthenone, 1,3-pentadiene, and (Z)-β-ocimene. Those repelling Ch. caragana consisted of perillene, dibutyl phthalate, nonanal, and pentadecane, and those irrelevant to each other consisted of (Z)-3-hexenyl acetate, 1-octene, nonene, decanal, (Z)-3-hexenol, and α-pinene.

Themed Session: The Chemical Ecology of Host and Mate Selection

POSTER

Number: 98

Xu C., Su J., Wang M., and Zhou A.

Chemical and visual cues mediate mutualism between ghost ant *Tapinoma melanocephalum* and invasive mealybug *Phenacoccus solenopsis*

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Many studies have demonstrated ant tending protects hemipterans from predators and parasitoids. However, it's unclear how ant tending helps hemipteran defend against their natural enemies. Our previous studies showed that there is a close mutual relationship between ghost ants, *Tapinoma melanocephalum* and invasive mealybug, *Phenacoccus solenopsis*. Parasitism of *P. solenopsis* by the dominant endoparasitoid, *Aenasius bambawalei*, was significantly reduced on plants with ants. Interestingly, the parasitoids are seldom attacked by ghost ants. It is unclear how the ghost ants adversely affect parasitoids. In this study, we evaluated the effects of chemical and visual cues involved in the mutualism on the performance of *A. bambawalei*. Our results showed that honeydew produced by P. *solenopsis* can obviously attract *A. bambawalei*. When supplied with less honeydew, searching activity and longevity of *A. bambawalei* were significantly reduced, resulting in a significantly lower rate of parasitism. We also found that *A. bambawalei* avoided pygidial gland secretions and visual cues of ghost ants. Parasitism rates in plants treated with pygidial gland extracts and individual components, such as 6-methyl-5-hepten-2-one and actinidine, were significantly lower than those in control plants. In conclusion, honeydew consumption by ants may negatively influence the performance of parasitoids. The pygidial gland secretions and visual cues of ghost ants also significantly inhibit the parasitism.

Themed Session: The Chemical Ecology of Symbiotic Interactions

POSTER

Number: 103