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Lukasz L. Stelinski-Statement of Current Research

Lukas L Stelinski*

Entomology and Nematology Department, University of Florida, USA

My research focuses on development of integrated management strategies for insect pest control. Although citrus is the focal commodity for my current research program, I extensively collaborate with colleagues on research projects involving insect pests of temperate tree fruit, small fruit (both temperate and tropical), as well as in other agricultural commodities such as ornamental plants, vegetables, and forest ecosystems. Two current foci are vectors of plant disease: 1) Asian citrus psyllid, vector of the causal pathogen of citrus greening and 2) Redbay ambrosia beetle, vector of the causal agent of Laurel wilt disease. My research interests address both principles-level fundamental questions as well as practical applied questions geared toward providing solutions to major problems facing a diversity of agricultural commodities. My philosophy is to meld basic and applied research as a single pursuit. My approach is to conduct research on the behavior and ecology of arthropods and nematodes and subsequently develop biorational management solutions. Current ongoing projects include: 1) development of behavior modifying chemicals, including attractants and repellents, for pest control with a focus on but not exclusive to citrus pests, 2) toxicological investigations of insect growth regulators, antifeedants, and botanical pesticides, 3) quantitative measurement of pest movement patterns and dispersal behavior in relation to management practices, 4) identification of herbivore-induced volatile emissions from plant roots that recruit entomopathogenic nematodes, 5) development and optimization of mating disruption technologies for moth pests, 6) enhancement of biological control by identification and development of recruitment pheromones and kairomones for natural enemies, 7) pesticide resistance management, 8) development of antifeedants to prevent plant pathogen transmission by insect vectors, 9) pheromone-mediated multitrophic parasitoid-prey interactions, 10) insect sensory physiology as it relates to pheromone and kairomone perception, and 11) optimization of pesticide spray technologies.

Recently, my research at University of Florida has led to the submission of two provisional patent applications. The first patent will protect the discovery of plant-based repellents for the Asian citrus psyllid. These repellent chemicals reduce populations of this disease vector in Florida citrus groves and could serve as a tool for management of this important pest. Importantly, these chemicals are an environmentally friendly pesticide alternative. This technology has received interest from several pest control companies, who have attempted to develop a practical product. One of these (ISCA Technologies, Riverside, CA) has developed a field-ready formulation from this discovery, which could be made available to citrus growers in Florida and abroad as early as 2012. This discovery was featured in the 2009 Annual Research Report of the Florida Agricultural Experiment Station and IFAS (Page 23). My second patent application protects the discovery of a single unique chemical released by citrus roots upon feeding by larval Diaprepes root weevils (major citrus pest) that attracts entomopathogenic nematodes. Exogenous application of the synthetic chemicals increases weevil mortality in the soil by attracting beneficial nematodes to areas of beetle infestation. This chemical may have broad application against various ground-dwelling insect pest species in various cropping systems. This discovery has also received considerable attention and was recently featured in Agricultural Research magazine (January 2011 issue pages 8-9) published by the U.S Department of Agriculture.

My research has significantly impacted the practical use of synthetic pheromones for pest control in fruit crops. By unraveling the underlying mechanisms of mating disruption, my research has guided the pheromone industry's development of practical pheromone-based tools. In Florida, my research has resulted in the development of the first pheromone-based pesticide alternative product for management of citrus leaf miner. The product is called SPLAT-CLM and it has received registration for use in FL citrus from the U.S. Environmental Protection Agency. It works by preventing mating of these pests, thereby reducing damage to citrus leaves and consequent infection by citrus bacterial canker. In 2010, I also completed development of a new mating disruption technology for grape root borer management in Florida. In collaboration with colleagues from temperate tree fruit growing regions, I have investigated and co-developed various technologies for control of moth pests of tree fruit including formulations that co-release insect pheromones and host plant volatiles and electrostatically charged powders for targeted auto-dissemination of pheromone+insect growth regulators. Also, my research has significantly contributed to the use and adoption of low volume spray technology for application of pesticides for Asian citrus psyllid management, which results in an approximate cost savings of $40 million annually for the Florida citrus industry.

Among my fundamental, principles-level research interests, I have been interested in speciation of insect herbivores and their parasites. Characterizing the underlying basis of biodiversity, both with respect to defining conditions that are conducive to the formation of new species, and describing mechanisms involved in the speciation process itself, is an elusive goal. A recent collaboration of mine published in the flagship journal *Science* (2009) with colleagues from the University of Notre Dame and Michigan State University, shows how biodiversity itself can be a major generator of subsequent biodiversity. As new species form, they create new opportunities for others to exploit, which, in turn, leads to evolution of new species. Forbes et al. showed that the parasitic wasp *Diachasma alloeum* (Hymenoptera: Braconidae) has formed new incipient species as a result of specializing on hosts in the fruit fly genus *Rhagoletis* (Diptera: Tephritidae) – hosts that are themselves in the process of evolutionary diversification or speciation. The beginning of the formation of one new species has had a cascading effect in the ecosystem and triggered a second incipient speciation event in the parasite wasp that attacks the fly. The "speciation cascade" phenomenon provides new insights to address longstanding questions about biodiversity. For example, how does biodiversity return following mass extinction? Why are some species with particular life histories

***Corresponding author:** Lukas L. Stelinski, Entomology and Nematology Department, University of Florida, USA, E-mail: stelinski@ufl.edu

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more diverse than others? Why do some geographic areas have higher levels of biodiversity than others? The paper by Forbes et al. allows us to approach these questions with a new perspective.

One of my recent study systems in this area has been an ongoing investigation of belowground plant-insect-parasite interactions. While the role of herbivore-induced volatiles in plant-herbivore-natural enemy interactions is well documented aboveground, only recent similar investigations have been initiated belowground. Because of previous methodological limitations, no one had previously detected belowground herbivore-induced volatiles in the field or quantified their impact on attraction of diverse entomopathogenic nematode (EPN) species. My laboratory recently demonstrated how belowground herbivore-induced volatiles can enhance mortality of agriculturally significant root pests. In real time, we identified pregeijerene (1,5-dimethylcyclodeca-1,5,7-triene) from citrus roots after initiation of larval feeding by a key citrus root pest. Application of collected volatiles from weevil-damaged citrus roots attracted native EPNs and increased pest mortality as compared to controls in citrus orchards. Furthermore, we tested the generality of this root-zone signal by application of pregeijerene in blueberry fields in New Jersey; mortality of blueberry pests was again increased by attracting naturally occurring populations of EPNs. Thus, this specific belowground signal attracts natural enemies of widespread root pests in distinct agricultural systems and may have broad potential in biological control of root pests. Our current efforts are focusing not only on application of synthetic attractants in the field so as to enhance root-zone biological control, but also on engineering plants so that they are better capable of calling in beneficial nematodes in response to insect attack.

Some of my other recent research on plant-insect interactions has involved an additional component of plant pathogen infection. Recently, my laboratory demonstrated specific mechanisms through which a bacterial plant pathogen induces plant responses that modify behavior of its insect vector. *Candidatus Liberibacter asiaticus*, a fastidious, phloem-limited bacterium responsible for causing huanglongbing (greening) disease of citrus, induces release of a specific volatile chemical, methyl salicylate, which increases attractiveness of infected plants to its insect vector, *Diaphorina citri*, and causes vectors to initially prefer infected plants. However, the insect vectors subsequently disperse to non-infected plants as their preferred location of prolonged settling because of sub-optimal nutritional content of infected plants. The duration of initial feeding on infected plants is sufficiently long for the vectors to acquire the pathogen before they disperse to non-infected plants, suggesting that the bacterial pathogen manipulates behavior of its insect vector to promote its own proliferation. Collectively, my lab's results uncovered for the first time that the host selection behavior of an insect vector is modified by bacterial infection of plants, which alters release of specific headspace volatiles and plant nutritional contents. Furthermore, we proved that this pathogen-mediated manipulation of vector behavior facilitates pathogen spread. In another plant-insect-pathogen interactions system under investigation currently in my lab, we are discovering how fungal symbionts of invasive ambrosia beetles species, including redbay ambrosia beetle, interact with host trees to produce odorant cues for beetles to locate suitable habitats.

Research publications resulting solely from work in my laboratory or as part of collaborative projects with numerous colleagues, nationally and internationally, consistently result in high quality publications in discipline-specific journals in the subject areas of Entomology, Chemical Ecology, Animal Behavior, Chemistry, Insect Physiology, Plant Pathology, Biological Control, and Agricultural Sciences or in general science/biology journals.