The Proceedings of the 2018

National Conference on Urban Entomology
and
Invasive Pest Ant Conference

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Edited by
Allison T. Allen
National Pest Management Association

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INTRODUCTION

This publication documents the National Conference on Urban Entomology and Invasive Pest Ant Conference which took place May 20-23, 2018 in Cary, NC. This was the 16th NCUE and, like the conferences before, it met its mission to open channels of communication and information between scientists in industry, academia, and government, and to foster interest and research in the general area of urban and structural entomology.

The objectives of NCUE as an organization include:
1. Promoting the interest of urban and structural entomology.
2. Providing a forum for the presentation of research, teaching and extension programs related to urban and structural entomology.
3. Preparing a written/electronic proceedings of all invited and accepted papers given or prepared at the biennial meeting.
4. Promoting scholarship and the exchange of ideas among urban entomologists.
5. Awarding scholarships to students pursuing scholastic degrees in urban entomology.
6. Hosting an onsite student competition for students who are currently involved in their undergraduate or graduate programs.

The 2018 continued to meet all these objectives with new research, students, and attendees. The conference gathered 198 professionals who came with ideas to share and left with new knowledge and a stronger network of colleagues and friends.

The next NCUE & IPA Conference will take place in Mobile, AL in May 2020. The planning committee encourages everyone to keep in touch throughout the years by joining the NCUE Facebook Group and subscribing to the mailing list.

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BACHELORS OF SCIENCE

Growth Dynamics of Blattabacterium, an Endosymbiont of German Cockroaches

EMILY L VERNON, Madhavi L Kakumanu and Coby Schal
North Carolina State University

Abstract

Blattabacterium is an obligatory endosymbiotic bacterium found in most cockroach species, including the German cockroach (*Blattella germanica*). *Blattabacterium* is involved in nitrogen recycling and uric acid metabolism in its host, and appears to play an important role in the growth and development of cockroaches. We observed significant variations in the abundance of *Blattabacterium* among field-collected populations of German cockroaches. The factors that determine the abundance and fluctuations of this bacterium in its host are poorly understood. Therefore, we investigated the dynamics of *Blattabacterium* in German cockroaches in relation to developmental stage, mating, sex and diet. German cockroaches were reared and sampled at intervals, followed by DNA extraction of each sample. Genomic DNA from different treatments was analyzed with qPCR to quantify the growth kinetics of *Blattabacterium,* using specific primers validated for this endosymbiont. The work is ongoing and we hypothesize that *Blattabacterium* abundance will vary with sex, diet and the reproductive cycle in female cockroaches. A deeper understanding of host-symbiont association might open new approaches for controlling German cockroach populations.

DOCTORAL

Toxicity and Neurophysiological Impacts of Plant Essential Oil Components on Bed Bugs (Cimicidae: Hemiptera)

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Abstract

Bed bugs (*Cimex lectularius* L.) are globally important human parasites. Integrated pest management (IPM) approaches, which include the use of naturally derived insecticidal compounds, have been proposed for their effective management. This study aimed to define insecticidal activity and neurophysiological impacts of major plant essential oil constituents. The topical and fumigant toxicity of 15 compounds was evaluated against adult male bed bugs. Neurological effects of the 6 most toxicologically active compounds were also determined. In both topical application and fumigant exposure

bioassays, carvacrol and thymol were the most active compounds. The topical toxicity of bifenthrin (a pyrethroid insecticide) was 80,000 times higher than carvacrol, while vapors of dichlorvos (an organophosphate insecticide) were 475 times more toxic than thymol to bed bugs. Spontaneous electrical activity measurements of the bed bug nervous system demonstrated neuroinhibitory effects of carvacrol, thymol and eugenol, whereas citronellic acid, linalool and (±)-camphor produced an excitatory effect. Bifenthrin also caused neuroexcitation, which is consistent with its known mode of action. Overall, the baseline toxicity of essential oil components against bed bugs reported here provides a platform for development of natural product based insecticides that can be used in bed bug IPM. The electrophysiology data for the most active compounds from bioassays further verifies that certain essential oil constituents are neurologically active and provide critical information leading into future mode-of-action studies, especially for compounds such as citronellic acid, linalool and (±)-camphor.

STUDENT PAPER COMPETITION

Apartment-Dwelling versus Laboratory Cockroaches: A Diet Study

SAMANTHA MCPHERSON, Coby Schal and Jules Silverman
North Carolina State University

Abstract

Blattella germanica, the German cockroach, is a common pest of human structures worldwide. German cockroaches are controlled primarily with insecticidal baits, which are formulated with palatable foods to facilitate consumption. Defined diets with an approximate 1:3 protein to carbohydrate ratio are self-selected by B. germanica reared in the laboratory on rodent chow. Field insects, however, are exposed to a broad range of foods, and so we predicted that they would self-select to accommodate this diet heterogeneity. We compared diet self-selection between laboratory and field populations of B. germanica by offering choices of diets with 1:1 and 1:11 protein to carbohydrate ratios both in field apartments and to field insects in the laboratory. We observed that field collected insects, both in the laboratory and in situ, selected for higher protein levels than insects from the laboratory cultures.

Is There a Difference Between Bacterial Communities of Monogyne and Polygyne Fire Ant Colony Soils?

NICHOLAS V. TRAVANTY, Loganathan Ponnusamy and Charles S. Apperson
North Carolina State University

Abstract

North American populations of red imported fire ants (*Solenopsis invicta*) include monogyne and polygyne social variants. We investigated differences in the structure of bacterial communities in soils inhabited by the two social forms. Because monogyne ants are highly territorial and do not share food resources intercolonially, we hypothesized that soils nested by monogyne ant colonies would harbor relatively distinct bacterial communities compared to those of polygyne ants that forage on common resources. Soils were collected, including tumulus and nearby ant-free soils at two depths from monogyne and polygyne fire ant colonies in Raleigh, North Carolina, from which DNA was extracted, and Illumina libraries of 16S amplicons were prepared and sequenced. Alpha and beta diversity of bacterial communities indicated no distinction between monogyne and polygyne fire ant soils. Bacterial taxa found in soils and differences between fire ant impacted soils and ant-free soils are reported.

Effect of Ingestion of an Insect Growth Regulator on German Cockroach Survivorship, Feeding Behavior and Reproduction

Jamora Hamilton, Ayako Wada-Katsumata and Coby Schal
North Carolina State University

Abstract

Chitin synthesis inhibitors prevent the formation of chitin and thus interfere with the molting process. They can also kill embryos by disrupting their normal development. We examined the effects of novaluron on nymphs and adults of the German cockroach (*Blattella germanica*). We determined the minimal novaluron intake that would interfere with molting and reproduction by exposing feeding stage nymphs and adult females to novaluron-supplemented food. We also conducted choice assays to assess the palatability of novaluron in rodent chow. Ingested novaluron prevented nymphs from molting and females fed novaluron produced inviable egg cases. Novaluron appears to be an effective insecticide that could be combined with other active ingredients in bait rotation and resistance management programs.

The Distribution and Agonistic Interactions of the Invasive Dark Rover Ant, *Brachymyrmex patagonicus* Mayr, in South Carolina

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Abstract

The invasive range of the dark rover ant, *Brachymyrmex patagonicus* was investigated in South Carolina and a county distribution map will be presented, including 35 new county records for this species. Implications for environmental influence and control will be discussed. Low agonistic interactions between *B. patagonicus* and other invasive or aggressive ants will also be reported, confirming field reports on this species by pest management professionals.

Evaluation of Backmister Blower for Barrier Treatments

BENJAMIN MCMILLAN, Nicky Gallagher, Sally Paulson
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Abstract

Barrier sprays have been utilized to provide an additional tool for suppressing the population of mosquitoes in areas that are resilient to other forms of treatment. Even when the same device is used to apply the pesticide, there are many other variables related to the technician that can impact efficacy, such as the distance from the target, movement of the technician during application, throttle setting, flow setting, and the presence/absence of a baffle. We evaluated these variables to determine some best practice recommendations for barrier spraying, using a Stihl SR200 backpack mist blower and water sensitive cards to measure percent coverage at 12 points in the vegetation. The results indicated that the level of discharge of the product, the distance of the applicator from the foliage, and the setting of the throttle all had significant effects on the penetration of the product into the foliage. The motion of the application and the absence of a baffle had no significant effects on the penetration of the application, although differences were present. The purpose of this study was to analyze the individual impacts of the tested variables, and as such the interactive effects of the variables were not examined.

What's in a Name? The Importance of Taxonomic Rigor in Managing Invasive Ant Species

JASON L. WILLIAMS and Andrea Lucky
University of Florida

Abstract

Invasive species have major economic impacts and are the second-greatest threat to biodiversity worldwide. Ants that are introduced to new localities through human-mediated dispersal are called "tramps" and have the potential to become destructive invasive species. Over 240 ant species have purportedly been introduced outside of their native ranges, and every new introduction poses the risk that a potentially destructive species will become irreversibly established. While a fraction of these introduced ants are already known to be invasive, very little is known about the rest. Often, the biology, natural history, and even the taxonomic identity of an invasive species remains unknown until after such introductions take place, at which point it may be too late for eradication. The most cost-effective way to manage invasive ants is to prevent their spread in the first place. Prevention is critical, but requires taxonomic rigor,

including effective tools and expertise for proper species diagnosis. There are two types of misidentifications that can occur: “false positives” and “false negatives”. At ports of entry, false positive records of an invasive species result in unnecessary, potentially costly measures including quarantine, treatment, and rejected shipments, and false negative records come with the risk of allowing invasive species to expand their ranges and accrue greater long-term costs. What are the costs of misidentification, and which type is costlier? To answer these questions, a cost-benefit analysis will be performed. Survey data will also be assessed to determine how taxonomic tools are used and could be improved to reduce misidentification.

Water Relations of Several Stages of the Asian Cockroach, *Blattella asahinai*

PATRICK J THOMPSON, Gokhan Benk, Xing P. Hu, and Arthur G. Appel
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Abstract

The Asian Cockroach, *Blattella asahinai* (Blattodea: Ectobiidae), is a peridomestic pest that was first identified in the United States in the 1980’s. Since then, it has spread throughout the Southeastern United States, often around homes. Water loss is important for insects because of their relatively large surface area to volume ratio. Using HCN-killed and live *B. asahinai* we determined the water loss rate, cuticular permeability, and total water content (%TBW) of male and female adults and small, medium and large nymphs. Cockroaches were desiccated in an 11-L chamber 30^{o}C and 0-2%RH. Their masses were recorded after 0, 2, 4, 6, 8, 10 and 24 hours of desiccation. Adult females had 67.50 + 0.54 %TBW and a cuticle permeability value of 17.97 $\pm$ 0.98 μg cm^{-2}h^{-1} mmHg^{-1}, while adult males had 68.19 $\pm$ 0.46 %TBW and a cuticular permeability value of 17.38 $\pm$ 1.48 μg cm^{-2} h^{-1} mmHg^{-1}. Nymphs had a wide range of %TBW and permeability. Water content ranged from 61.74 $\pm$ 0.75 %TBW for large nymphs to 75.94 $\pm$ 3.24 %TBW for small nymphs. Cuticular permeability ranged from 17.32 $\pm$ 2.51 μg cm^{-2}h^{-1} mmHg^{-1} to 30.2438 $\pm$ 6.74 μg cm^{-2}h^{-1} mmHg^{-1} for large and small nymphs, respectively. These results show that all stages of *B. asahinai* have relatively high rates of water loss and may explain the need for this species, particularly smaller instars, to select moist harborage.

Water Loss and Desiccation Tolerance of Several Stages of the Kudzu Bug, *Megacopta cribraria*

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Department of Entomology and Plant Pathology, Auburn University, Auburn, AL

Abstract

The Kudzu bug, *Megacopta cribraria* (Hemiptera: Plataspidae), is an invasive insect that was first detected in the United States in 2009 in Georgia. It is an urban nuisance pest that invades homes and is a major pest of soybeans in the Southeastern United States. Water loss affects the survival and development of insects including the kudzu bug. In this study, we examined the water relations and desiccation tolerance of nymphal and adult stages of kudzu bugs and compared percentage body water content (%TBW) and cuticular permeability of living and dead bugs. Body masses were recorded initially and after 2, 4, 6, 8, 10 hours of desiccation at 30 °C and 0-2% RH. Results show that mortality of adults began after 10 hours of desiccation. Then, the result has shown that although cuticular permeability of adult females (8.71%$\pm$1.88 µg cm^{-2} h^{-1} mmHg) kudzu bugs was greater than adult males (6.47%$\pm$1.15 µg cm^{-2} h^{-1} mmHg), %TBW of adult males (54.79%$\pm$ 1.21) was greater than that of adult females (51.37%$\pm$1.77). In addition, when we compared %TBW of nymphs, the second instar had the highest %TBW of 81.48%. This study demonstrates that environmental stress (desiccation) may differentially affect the survival of adult and nymphal kudzu bugs instar and thus affect the relative abundance of this species in the fields and around homes.

Knockdown of the Chromatin Remodeling Gene Brahma by RNA Interference Reduces Reproductive Fitness and Lifespan in Common Bed Bug (Hemiptera: Cimicidae)

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Abstract

The common bed bug, Cimex lectularius L. (Hemiptera: Cimicidae) is a nuisance household pest causing significant medical and economic impacts. RNA interference (RNAi) of genes that are involved in vital physiological processes can serve as potential RNAi targets for insect control. Brahma is an ATPase subunit of a chromatin-remodeling complex involved in transcription of several genes for cellular processes, most importantly the homeotic genes. In this study, we used a microinjection technique to deliver double stranded RNA into female bed bugs. Delivery of 0.05 and 0.5 µg/insect of brahma dsRNA directly into hemocele resulted substantial reduction in oviposition. Eggs laid by bed bugs receiving both doses of brahma dsRNA exhibited significantly lower hatching percentage as compared to controls. In addition, brahma RNAi in female bed bugs caused significant mortality. Our results disclosed the potential of brahma RNAi to suppress bed bug population through injection of specific dsRNA, suggesting a critical

function of this gene in bed bugs' reproduction and survival. Based on our data, brahma can be a promising RNAi target for suppression of bed bug population.

SUBMITTED PAPERS: BED BUGS

Impact of Bed Bugs on the Microbial Diversity of Infested Homes

MADHAVI L KAKUMANU, Zachary C. Devries, Alexis Barbarin, Richard G. Santangelo and Coby Schal
North Carolina State University and North Carolina Department of Health and Human Services

Abstract

Bed bug infestations are a growing concern in United States, especially in low-income communities. Bed bug infestation might range from a few insects to thousands of individuals in an infested home. While bed bugs are not known to transmit any human pathogens, several bacteria including some human pathogens were detected in bed bugs. In infested homes, bed bug feces and dead bugs regularly add microbes and organic residues which might alter the microbial diversity of the home environment. We investigated the effects of bed bug infestation on the microbial diversity of household dust and subsequently the effect of bed bug elimination with spatial heat on the dust microbiome. Dust samples were collected from uninfested homes and from bed bug infested homes before and after heat interventions and were analyzed by high-throughput sequencing of the variable V3-V4 region of 16S rRNA gene on the Illumina Mi-Seq platform. The results showed a strong influence of bed bugs on the microbial diversity of dust in infested homes. The DNA from dust samples of infested homes contained a high representation of *Wolbachia* and an unclassified Gamma-proteobacteria which are known endosymbionts of bed bugs. A shift in the microbial community was observed in the dust samples collected after heat treatments; however, this shift was mainly due to reduction in relative abundance of *Wolbachia*. While there is a correlation between bed bug infestation and dust-associated microbes, further studies are warranted to understand the viability of these communities and the potential risk they pose on human health.

Sex- and Stage-Specific Recognition in the Bed Bug, *Cimex lectularius*

AHMED M SAVEER, Eduardo Hatano and Coby Schal
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Abstract

The common bed bug, *Cimex lectularius* is an obligate blood-feeding human ectoparasite that has become a global pest causing enormous public health concerns. One of the reasons for the bed bug outbreak is the development of resistance against

commonly used insecticides. Alternative approaches are needed, such as development of novel, non-insecticidal control strategies. One promising approach is to target the bed bug's heavy reliance on their sense of smell (olfaction) to locate aggregation sites, mating partner and human hosts. The focus of our research is to understand the mating behavior of *C. lectularius* and to identify volatile and/or non-volatile chemicals that mediate this behavior. The outcome of these studies may facilitate the development of effective odorant-based bed bug traps for better surveillance and control.

Bed Bugs and Histamine: A Public Health Risk?

ZACHARY C. DEVRIES, Richard G. Santangelo, Alexis Barbarin and Coby Schal
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Abstract

Bed bugs are widely considered to be of limited medical importance because health issues typically relate to either adverse reactions to their bites, or psychological distress during or following an infestation. Bed bugs produce histamine as a component of their aggregation pheromone in their feces. Because bed bug populations can attain hundreds or thousands of individuals, it is possible that significant amounts of histamine accumulate in infested homes and pose a potential health risk to residents. We investigated the accumulation of histamine in household dust, and the effects of bed bug eradication with spatial heat on histamine levels in dust. Bed bug infested homes were vacuum sampled, and house dust was analyzed for histamine by GC-MS before and up to three months following heat intervention to eradicate the infestations. Histamine levels in bed bug infested homes were significantly higher than in control homes not infested with bed bugs (> 54 µg/100 mg of sieved dust vs. < 3 µg/100 mg of sieved dust, respectively). Heat treatments that eradicated the infestation did not affect the dust histamine levels for 3 months following treatment. Here we report a clear association of histamine in household dust with bed bug infestations. The high concentrations of histamine in fine household dust, its persistence, proximity to humans during sleep, and propensity for chronic exposure, suggest that bed bug-produced histamine may pose a serious health concern in the indoor environment.

Effects of Color Contrast on Bed Bug Locomotion Behavior

Salehe Abbar, Changlu Wang and Roselyn Giordano
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Abstract

While it is known that the common bed bug, *Cimex lectularius* L. (Hemiptera: Cimicidae), has an affinity towards specific colors, our understanding of how bed bugs perceive contrast in color is unknown. The bed bugs preference to color contrast was measured using traps of different color patterns: completely black, completely white, black traps with white tape on exterior wall, and white traps with black tape on exterior wall. Pairs of different colored traps were placed into each arena with white or black floors. A few hundred bed bugs were released in each arena and trap catch was recorded after 6-7 hours. Black traps with black tape on the exterior wall caught significantly more bed bugs than the white traps with black tape on the exterior wall. In black arenas, the black traps with white tape caught significantly more bed bugs than white traps with black tape; this difference disappeared in white arenas. Black traps with black tape on the exterior wall and black traps with white tape on the exterior wall caught similar number of bed bugs in black arena. Bed bugs placed in black traps with black tape on the exterior wall are more likely to escape than white traps with black tape on the exterior wall. Results suggest that color contrast is not important in bed bug movement and bed bugs strongly oriented towards darker areas.

SYMPOSIUM: BED BUG RESISTANCE MANAGEMENT

Use of Synergists for Management of Insecticide Resistance in Bed Bugs?

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Introduction

Ever since the first report of bed bug resistance to pyrethroid in modern bed bugs, research efforts have aimed at understanding the development of resistance to these and other classes of insecticides that has been gradually introduced in the market for bed bug control. This information is crucial for monitoring and management of resistant bed bugs in field conditions. Multiple resistance mechanisms have been implicated in the evolution of pyrethroid resistance in bed bugs, including reduced cuticular penetration (Adelman et al. 2011, Koganemaru et al. 2013, Lilly et al. 2016), target site insensitivity (e.g. knockdown resistance, *kdr*-type) (Zhu et al. 2010, Dang et al. 2015), metabolic resistance (e.g., cytochrome P450 monooxygenases, glutathione S-transferases, carboxylesterase, and esterases) (Adelman et al. 2011, Mamidala et al. 2011).

Studies on the involvement of detoxifying enzymes in insecticide resistance have been conducted through molecular, biochemical and synergist bioassays (Romero 2018). In *C. lectularius*, deep-sequencing studies demonstrated that P450s, GST and esterases were significantly over-expressed in pyrethroid resistant bed bug strains (Adelman et al. 2011, Mamidala et al. 2011). Biochemical assays also demonstrated elevated activity of these enzymes in bed bug populations highly resistant to pyrethroid and neonicotinoids (Romero and Anderson 2016). Synergists have been also used to infer the enzymatic mechanisms involved in insecticide resistance (Jones 1998). Furthermore, synergists such as Piperonyl Butoxide (PBO) have been used for decades and have contributed to improve the efficacy of insecticides, particularly when problems of resistance have emerged (Bernard and Philogène 1993, Romero et al. 2009). Recently, Lilly et al. (2016) used PBO and N16/5-1 (a PBO analogue) to demonstrate that P450s and esterases, respectively, were involved in deltamethrin resistance in Australian strains of *C. lectularius* (Lilly et al. 2016). To our knowledge, there is no information about the use of synergists to suppress glutathione S-transferases and carboxylesterase activity in pyrethroid-resistant bed bug populations. The aim of this study was to use a set of inhibitors of detoxifying enzymes involved in the metabolism of pyrethroids and infer the relative contribution of each enzymatic group to the pyrethroid resistance in two bed bug populations. Metabolic routes blocked by synergists can be an effective way to manage pyrethroid resistance in bed bugs.

Materials and Methods

Three strains of bed bugs were used in all experiments; two pyrethroid resistant strains (Jersey City and Cincinnati) and the susceptible Fort-Dix. Insects were fed in the laboratory through a parafilm-membrane feeder with defibrinated rabbit blood which is heated to 39°C with a circulating water bath (Montes, 2002). Evaluations began 7–12d after adult emergence, and insects were tested 3 day-post-feeding. Insects were treated topically with a sublethal dose (5%) of either PBO, DEM, or DEF. Topical applications (1 μl) of each synergist were made onto the dorsal surface of the abdomen with a micro-applicator equipped with a 25-μl glass syringe. The insects were exposed topically to deltamethrin two hours after synergist treatments and the range of concentrations of deltamethrin used on each strain was defined in preliminary tests. Temperature was maintained at 26°C after initiation of the exposure. Mortality was determined after 24-h exposure. PoloSuite software was used for Probit analysis and calculations of LD_{50} values and synergism ratios. The calculation of lethal dose ratios at LD50 (LDR_{50} or synergism ratio, SR) and their 95% confidential limits (CL) was performed as described by Robertson et al. (2007). Synergism ratio was considered significant (P= 0.05) if their 95% CL did not include the value of 1.0.

Results and Conclusions

We used three synergists PBO, DEM, and DEF to study the involvement of major groups of detoxifying enzymes in deltamethrin resistance in bed bugs. Overall, analysis of synergism ratios and 95% CLs in assays with the susceptible strain Fort-Dix showed that pretreatment with synergists did not significantly increase deltamethrin toxicity (Table 1). These results indicate that increased toxicity of deltamethrin observed in assays with the pyrethroid-resistant strains Jersey City and Cincinnati was due solely to the effect of the synergists. Analysis of synergism ratios and 95% CLs in assays with the field-derived strains showed that pretreatment with the cytochrome P450 monooxygenase (P450) inhibitor piperonyl butoxide (PBO) significantly increased deltamethrin toxicity in Cincinnati (synergism ratio: 158.8, 95% CL: 22.1-1138.8), and Jersey City (synergism ratio: 20.5, 95% CL: 4.5-88.6) (Table 1). These results suggest that cytochrome P450 monooxygenases are involved in deltamethrin resistance in bed bugs, but its impact was variable. Therefore, a greater level of synergism of insecticides with PBO might be achieved when P450s play a significant role in insecticide resistance. On the other hand, since P450s have a broad spectrum of activity against different insecticides (Mitchell et al. 2012), the increased level of P450s in bed bugs populations brings concern about cross resistance among insecticides currently in use or those that will be used in a future.

The calculated LD_{50} value from DEM + deltamethrin in Cincinnati was significantly reduced in comparison with those determined for the deltamethrin treatment alone (Table 1), resulting in a SR of 58.8 (95% CL: 9.6-358). LD_{50} values for Jersey City with DEM was also significantly reduced, but with a lower synergism ratio (SR=11.7, CL: 1.1-130.8). Significant levels of synergism with DEF (esterase inhibitor) was detected in Jersey City only (SR: 102.3, 95% CL: 16.8-621.3). Enhanced levels of esterase activity have been documented in pyrethroid resistant populations of *C. lectularius* (Adelman et al. 2011, Zhu et al. 2013, Romero and Anderson 2016). Further evidence of the role of esterases as metabolic resistance mechanisms in bed bugs was provided recently with the development of the EN16/5-1, a specific inhibitor of esterases, that synergized deltamethrin in Australian *C. lectularius* (Lilly et al. 2016).

Our results indicate that bed bug populations differ in their detoxifying resistance mechanisms which emphasizes the need for characterizing and monitoring metabolic resistance in field bed bug populations. This is the first study to investigate multiple detoxifying mechanisms of pyrethroids in bed bugs via synergists. Since resistance to deltamethrin was reduced with pre-exposure of PBO in both strains, the cytochrome P450 mixed function oxidase enzymes seem to contribute significantly to deltamethrin resistance in bed bugs. Additional research to determine enzyme expression levels and the molecular basis for pyrethroid resistance (*kdr*) in these two strains is currently underway. From a practical point of view, the development and use of single or multifunctional metabolic synergists that suppress enzymes responsible for metabolic detoxification of insecticides offer an interesting avenue for management of insecticide resistance management in bed bugs.

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How to Build a Bed Bug Bait

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Abstract

Pest management professionals utilize a variety of tools and techniques to control urban pests. Baiting, used either as discrete placements or as systemics, have revolutionized the management of urban pests, including cockroaches, ants, termites, fleas, and rodents. Despite their impact on pest control, we still do not have a bait available for controlling bed bugs. To correct this problem, we have been working on the three components necessary to develop an artificial liquid bait, namely attractants, feeding stimulants, and ingestible active ingredients.

Residual Efficacy of Several Pesticide Products for Bed Bugs on Contaminated Surfaces

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Abstract

Pyrethroid / neonicotinoid combination products are used to treat harborages of bed bugs. If the bed bug infestation has been ongoing, it is likely that these harborage sites might be contaminated with bed bugs' feces and other excretory materials. To understand the potential effect of these organic materials on residual performance of the insecticides, we examined the mortality responses of bed bugs when they are exposed (4 h) to paper substrates (clean or fecal-contaminated) treated with of a pyrethroid / neonicotinoid combination product. The combination product's single-component counterparts (either pyrethroid-only or neonicotinoid-only) were also tested. When tested as a fresh residue with recently fed bed bugs, the combination product performed better on the clean paper than on the fecal-contaminated paper. On the clean paper, the aged residues of combination product showed substantial reduction in their efficacy at 1 month. However, the aged residue of combination product on the fecal-contaminated paper appeared either to slightly increase or maintain their insecticidal effectiveness up to 2 months. The pyrethroid-only product showed a similar trend, but to a lesser degree. When tested with recently fed bed bugs, both the combination product and pyrethorid-only product showed substantial reduction in their residual efficacy at 3 months regardless the presence or absence of fecal contaminants. The neonicotinoid-only product did not provide any consistent / substantial mortality of bed bugs as the residual treatment on the paper substrates. Potential explanation for the observed phenomenon will be discussed.

Threshold-Based Bed Bug Management

Changlu Wang and Richard Cooper
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Abstract

We tested a threshold-based bed bug (Cimex lectularius L.) management approach with the goal of achieving elimination with minimal or no insecticide application. Thirty-two bed bug infested apartments were identified. These apartments were divided into four treatment groups based on apartment size and initial bed bug count, obtained through a combination of visual inspection and bed bug monitors: I- Non-chemical only in apartments with 1–12 bed bug count, II- Chemical control only in apartments with 1–12 bed bug count, III- Non-chemical and chemical control in apartments with >12 bed bug count, and IV- Chemical control only in apartments with ≥11 bed bug count. All apartments were monitored or treated once every two weeks for a maximum of 28 wk. Treatment I eliminated bed bugs in a similar amount of time to treatment II. Time to eliminate bed bugs was similar between treatment III and IV but required significantly less insecticide spray in treatment III than that in treatment IV. A threshold-based management approach (non-chemical only or non-chemical and chemical) can eliminate bed bugs in a similar amount of time, using little to no pesticide compared to a chemical only approach.

SYMPOSIUM: TICKS

Fight the Bite: Commercial Tick Services

Glen Ramsey
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Abstract

Tick management is important for customer satisfaction and to protect public health, but how a service is performed is just as important as understanding why it is done that way. In this presentation of commercial tick management we will discuss how the media affects public perception, tick seasonality, options for management that are commercially available for use around a customer's home, and pest management professional's safety considerations while performing treatments.

Insights on Tick-Borne Disease Prevention Education from a Crowd-Sourced Tick Surveillance Program

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Reported cases of tick-borne disease have more than doubled in the past decade (Rosenberg et al. 2018). Despite widespread education initiatives in tick-endemic regions, numerous studies have shown that overall public perception and knowledge surrounding tick identification, tick-borne disease risk, and proper disease prevention strategies is low (Herrington 2004, Valente et al. 2014, Butler et al. 2016). The University of Rhode Island TickEncounter Resource Center (TERC) promotes tick-borne disease prevention by engaging, educating, and empowering people to take action against tick bites. Its website (www.tickencounter.org) serves as the main point of contact with the public, receiving over 1 million views each year. TERCs main messages center on teaching tick identification, encouraging daily tick checks, using effective skin and clothing repellents, and treating yards with effective acaricides. These initiatives are laser-focused on overcoming widespread myths about ticks and tick-borne disease transmission, particularly in regard to tick habitat and active seasons, repellent and pesticide safety, tick species/pathogen associations, and proper tick removal strategies. However, TERC recognizes that simply providing the public with more information and assuming the problem is merely an information deficit, is not an adequate method for increasing tick literacy (Gross 1994).

TERC incorporates key tenants of scientific communication theory to overcome barriers to action and prevent tick-borne disease within a personal context (Fig. 1). This approach is a major component of our TickSpotters crowd-sourced surveillance program that provides tailored risk assessment and tick bite prevention information in response to photographs of encountered ticks and general encounter details. Current research supports the validity of experts interpreting digital photos for accurate tick surveillance (Koffi et al. 2017), thereby using the "power of the crowd" to help provide an incredible wealth of information for better understanding tick range distribution, phenology, and what can best be described as peoples' "lived experiences" with ticks. We examined TickSpotters data from 2015-2016, and identified some preliminary lessons that will guide our future approach and research endeavors.

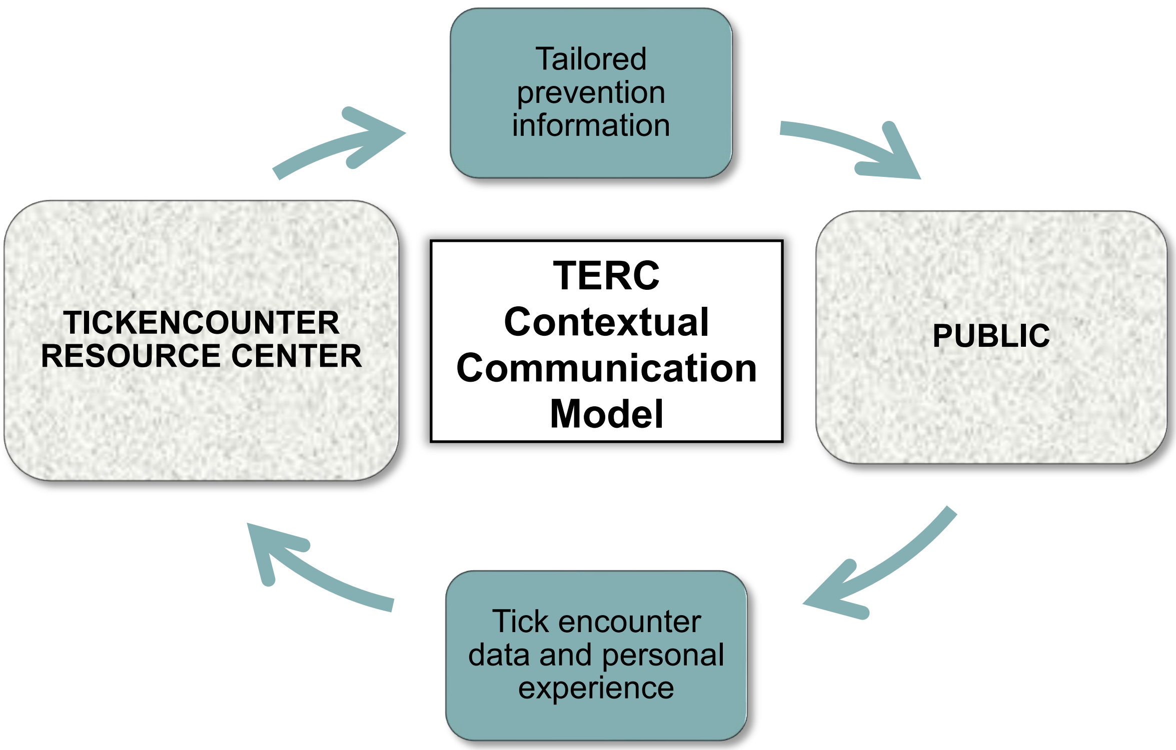


Figure 1. The communication strategy behind TickEncounter Resource Center messaging, based on the contextual model of scientific communication (Gross 1994).

1. The human connection matters

The main theme of messages included with tick submissions is that people are scared. Hyped media reports and inconsistent information about ticks creates anxiety. Fear often leads to latching onto anything that sounds good, which can result in adopting practices that do not actually protect against tick-borne disease. The goal of TickSpotters is to guide knowledge and actions to use effective preventive behaviors and products, and not provide a false sense of tick safety. A responsive, go-to expert resource is worth its weight in gold in an increasingly automated and self-directed age. We plan to further investigate the role of TickSpotters' responses in improving prevention behaviors.

2. Public tick identification is poor

Incorrect identification poses serious implications for understanding disease risk and next steps in potential disease management. Between 2015-2016 67.5% of submissions to TickSpotters were incorrectly identified (n=1032), and roughly 4-5% of submissions were not ticks. However, deer ticks (*Ixodes scapularis*) were more often identified correctly (p=0.001), but it is unknown whether this is a false positive simply because email correspondences indicate that many assume any encountered tick to be a deer tick. Nymphs were notoriously misidentified (p=0.001), and people living in the southeastern and Pacific regions of the United States were more likely to misidentify ticks than those in other regions (p=0.05 and p=0.001, respectively). Ticks that were found having fed for four days were more likely to be misidentified than other engorgement sizes (p=0.01).

3. Health care provider tick identification is poor

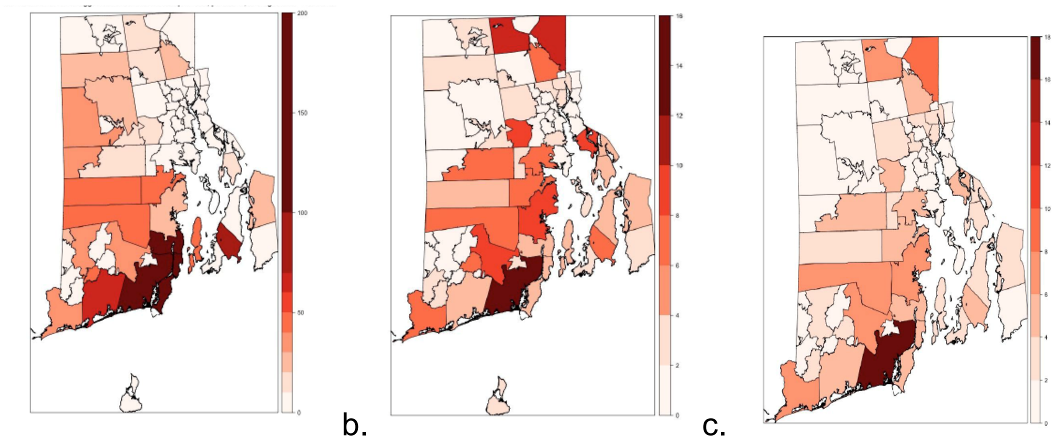
Submission comments and additional correspondence with TickSpotters users revealed that people often seek out physicians, whether primary care professionals or emergency room staff, for tick identification and guidance on next step prophylaxis or disease testing. Our anecdotal reports corroborate established research that tick identification among health care professionals is poor (Butler et al. 2016, Falco et al. 1998). Because accurate tick species and stage identification is so critical for assessing disease risk, we seek to expand upon this research to test whether identification tools can improve physicians' *in situ* identification ability, and thereby foster more accurate diagnoses and proper treatment.

4. Pets are not treated with tick preventative in colder months

We observed a greater proportion of ticks encountered on pets in the fall and winter months, corresponding with adult blacklegged tick (*I. scapularis*) season (Table 1). We attribute this to a knowledge gap regarding tick seasonality, and a lack of pet tick preventative applied in the colder months because of the widespread assumption that ticks are not active at this time. This reveals an educational target opportunity for veterinary professionals as well as general practitioners because of the risk posed by pets carrying ticks inside.

5. Passive surveillance is a potential proxy for active surveillance

We compared actively collected nymphal *I. scapularis* data (1999-2013) by zip code tabulation area (ZCTA) to confirmed passively reported *I. scapularis* TickSpotters submissions in Rhode Island from 2015-2016. Using a correlation autoregressive Bayesian model to predict the mean density of blacklegged ticks, we found that the passively reported tick encounters closely matched active surveillance. We plan to further evaluate this finding on a larger scale, to identify whether passive, crowd-sourced surveillance can be a valid, inexpensive alternative to active tick surveillance.



a. b. c.

Figure 2. a) Mean density of nymphal blacklegged ticks (*I. scapularis*) collected per hour by zip code in Rhode Island, 1999-2013 b) Blacklegged tick (*Ixodes scapularis*) reports (n=215) selected of total ticks reported to TickSpotters by Rhode Island ZCTA, 2015-2016 c) Density of TickSpotters blacklegged tick (*I. scapularis*) reports by ZCTA predicted by CARBayes model covarying with nymphal *I. scapularis* tick abundance and offset by human population (2012) with New Shoreham removed

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SYMPOSIUM: ASSESSMENT-BASED PEST MANAGEMENT

Minimum Trap Number and Quick Inspection Combinations to Determine Bed Bug Building-Wide Infestation Rates

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Abstract

Mid- to high-rise housing for the elderly and disabled continues to be the most challenging environment in which to manage bed bugs. Many apartment managers rely on resident reporting which can result in 100% of infestations unreported. Building-wide bed bug inspections would not rely on resident actions and could find all infestations at the same time, thus discovering populations when they are low and limiting spread. In this study, we evaluated building-wide inspection techniques in eight buildings. In six buildings, quick inspections were conducted in all apartments and monitors (2, 4 or 8) were placed where bed bugs were suspected but not found. Monitors were checked at either 2wk or 3 mo. In two other buildings, monitors (2 or 4) were placed in all apartments. Monitors were checked at 3 mo and quick inspections were conducted if monitors were void of bed bugs. This study further reinforced the concept that relying on resident reporting is flawed and that building-wide inspections are needed. On average, managers were unaware of 73% of the bed bug infestations. The techniques tested were all effective. Little difference in the time to conduct each technique was noted when a quick inspection was performed first. However, placing two or four monitors in every apartment increased the time and cost of the building-wide inspection technique. Two room entries were required, one to place the monitor and one to inspect the monitor and possibly the apartment. Monitors were placed in only a mean 7.9% of the apartments when quick inspections were conducted first. Placing monitors in every apartment nearly doubled the overall cost of the inspection technique. We also noted that facilities lacking building-wide inspections and that relied on chemical control had higher infestation rates and levels.

SYMPOSIUM: URBAN RODENT CONTROL

State of The Union on Urban Rodents

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Abstract

The urban rodents are inherently associated with urban entomological issues along several fronts (e.g., ectoparasites, diseases, structural damage facilitating subsequent insect invasions, etc.). Although strong empirical data would be difficult to obtain, most of the entities that address urban rodent infestations consistently indicate a decade of increases in urban rodent problems and infestation frequencies on a global scale. These entities include city complaint data for many of USA's national metropolises, servicing trends of the pest management industry, and the sales of rodent control materials from retail, the web and from pest professionals. New research over the past five years is providing additional support as to the health significance of urban rodents --- including their arthropod ectoparasites and pathogenic microbial flora). Landmark advances in rodent pest management have occurred during the past three years including the use of carbon dioxide for burrowing rat control, remote rodent sensor technology and novel formulations of non-anticoagulant rodenticides. Important insight has also been recently gained into the urban landscape genomics of the Norway rat as well. Each of these breakthroughs and innovations provides further inroads into rodent management efficiencies along scientific, technological and environmental avenues.

Population Genetics and Pathogens: Understanding Movement and Disease in Urban Brown Rats (Rattus norvegicus)

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Abstract

The brown rat, *Rattus norvegicus,* is a major public health pest in cities around the world. However, we know little about it's basic ecology and movement patterns. Nor do we know how these aspects relate to the distribution of rat-borne pathogens. Population genetics and spatially explicit analyses can provide valuable insights into the biology of commensal rodents and their associated pathogens. Here I demonstrate the utility of population genetics for understanding urban brown rat ecology and describe applications for improved management strategies, using example datasets from New

York City and Vancouver Canada. Additionally, we pair genetic relationships within and among groups of rats with patterns of pathogen and ectoparasite distribution to better understand relationships between host, humans, and zoonotic diseases.

The Use of Cameras in Rodent Management

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Abstract

The use of cameras has become a powerful tool in the Pest Management Industry (PMI), creating a paradigm shift in the surveillance and control strategies of rodents. In the past, many of the solutions to rodent problems were simply based on conjecture and personal experience of PMI professionals. The use of cameras in field research and rodent control management has given the PMI absolutes when dealing with rodents. Traditional methods in evaluating the accurate situation of rodent problems often resulted in an increase of time and effort of the Pest Management Professional (PMP) and increased customer frustration. Cameras have given both the PMP and the customer real time positive identification of target species (e.g. rodents). Cameras also are able to provide still shots and short videos demonstrating different biological and behavioral information of specific rodent species. The twenty-four hour visual monitoring better allows the technician to understand the vulnerability of a site, assisting in problem solving, better selection of bait placement and type, and more effective exclusion, creating the foundation for developing targeted control programs for rodents. Cameras have been proven as an efficient tool in monitoring daily activity of rodents, which provide the PMI with the necessary information needed for control solutions, an essential part of solving rodent problems in the 21st century.

Early Detection of Rodents Demonstrated with the ActiveSense™ System

Joe DeMark[1], Phil Smith[2], Claudia Riegel[2] and Neil Spomer[1]
[1]Dow AgroSciences, [2]New Orleans Mosquito Termite and Rodent Control Board

Abstract

The ActiveSense™ system can reliably monitor rodent activity 24/7 even in hard-to-access locations. The system alerts with a text and/or email to trap activity when it

happens in real time which allows for fast removal of the rodent. Trials conducted in New Orleans with cameras showed that rodents do not avoid ActiveSense sensors. Early detection trials compared sites with snap traps installed with ActiveSense sensors to sites with snap traps serviced per traditional servicing schedules. The ActiveSense system sites were visibly checked 1-2 days after activity notifications with some even checked the same day while the traditionally serviced sites were checked approximately weekly. The ActiveSense system notifications will allow technicians to quickly pin-point trouble areas where inspections could be focused, promptly remove rodents and reset traps in a timely manner for continued, uninterrupted control. Rodent decomposition before removal was also monitored via a rating scale and was found to be overall less for the ActiveSense sites compared to the traditionally serviced sites.

The Use of Dry Ice for Controlling Burrowing Populations of Norway rats, *Rattus norvegicus* in Urban Environments

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BELL LABORATORIES, Madison, WI

Abstract

The EPA granted federal registration to pelletized formulations of dry ice (i.e., frozen carbon dioxide) for controlling exterior burrow infestations (e.g. urban parks, yards, empty lots and other areas vulnerable to Norway rats (Rattus norvegicus) under a Bell Laboratories product “Rat Ice" in early June of 2017. This is a landmark breakthrough on several levels for urban rodent management. First, it coincides with the challenges facing the future use of rodenticide baits. Second, carbon dioxide is highly efficacious in the euthanizing of small mammals (and their fleas, lice, and tick ectoparasites). Third, no secondary toxic threat to non-target hawks and owls exists with CO2 burrow treatments, and, fourth, there is minimal handling hazards to applicators. Environmentally speaking as well as the important consideration for a more humane shift towards necessary lethal rodent control, the use of dry ice is a foregone conclusion towards in a step forward. As of early 2018, wide scale implementation of dry ice for urban rodents still requires a more uniform distribution infrastructure as well as additional state’s to pursue dry ice registration.

Field Evaluation of Selontra Soft Bait Rodenticide Against the House Mouse, *Mus musculus*

Grzegorz Buczkowski, Jason Meyers and KYLE JORDAN
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Abstract

Rodents cause substantial amounts of damage to foodstuff and property around the world. Various methods are used to control rodents, but toxic baits remain the most important control method. Despite concerns about toxicity levels, non-target hazards, potential hazards to children, reduced effectiveness, and humaneness to rodents there have been very few new developments in rodenticides in the last few decades. To address this need, BASF has developed a new bait rodenticide, Selontra Soft Bait Rodenticide (0.005% colecalciferol). The current study evaluated Selontra on a commercial grain farm in Indiana. The study consisted of three phases: (I) non-toxic pre-baiting to assess initial population levels, (II) toxic baiting to target the population, and (III) non-toxic post-baiting to assess the effectiveness of the control program. Pre-baiting demonstrated mouse presence at two buildings utilized for the study. Additionally, numerous signs of mouse presence including droppings, damage to materials, nests, and dead mice were detected at both locations. Phase II demonstrated that Selontra is a highly attractive bait. Signs of feeding and the first dead mice were observed within 24 h of bait placement. The majority of bait was consumed during the first 2 days with little consumption after day 3. Post-baiting demonstrated that Selontra is a highly attractive, fast-acting, and highly effective rodenticide. At the end of the study 100% control was achieved at the first site and 98% at the second site. In summary, Selontra is a highly effective bait and may be especially suitable for performing “clean-outs” in heavily infested accounts.

SUBMITTED PAPERS: ANTS

Transcriptomes of MS Fire Ant Larvae and Pupae

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Abstract

Currently, household ant control depends primarily on synthetic insecticides. Ant pesticides can have hazardous impacts on the environment, and when used indoors they may be a threat to pets and children. Thus the need for safer and more sustainable products and practices remains. One possibility for future ant control products lies in genetics. USDA ARS research will focus on methods for gene disruption, and improving delivery systems. Laboratory cultures of red imported fire ant from the Mississippi Delta were collected, established, maintained and observed in the National Biological Control Laboratory in Stoneville, MS. The ant colonies represent multiple independent genetic samples, and a continuous pool of relatively genetically stable experimental subjects. RNA sequencing and analysis was performed with a goal of identifying specific genes to target for disruption. Insights from the RNA analyses have improved our understanding of these devastating invasive ant pests.

Multiplexed Lateral Flow Immunoassay to Discriminate *Solenopsis invicta* from *Solenopsis richteri*

STEVEN M. VALLES and Anne-Marie Callcott
USDA-ARS, IMPORTED FIRE ANT AND HOUSEHOLD INSECTS RESEARCH UNIT, CENTER FOR MEDICAL, AGRICULTURAL AND VETERINARY ENTOMOLOGY, GAINESVILLE, FLORIDA; Animal and Plant Health Inspection Service, Plant Protection and Quarantine-APHIS, Biloxi, Mississippi

Abstract

A multiplexed lateral flow immunoassay is described capable of identifying the red imported fire ant, black imported fire ant, and their hybrids. The method is field-portable, requires no special training or equipment and can be completed in 10 minutes.

Evaluation of Imported Fire Ant Quarantine Treatments in Commercial Grass Sod: Alabama 2016 and 2017

Fudd Graham[1], Anne-Marie Callcott[2], Kelly Palmer[3] and Josie Tripi[1]
[1]Auburn University, Auburn, AL; [2]USDA-APHIS, Biloxi, MS and [3]Alabama Cooperative Extension System, Auburn, AL

Introduction

Imported fire ants (*Solenopsis invicta, S. richteri, and their hybrid*) are one of the most invasive species of ants. They were introduced through the port of Mobile, AL and have spread throughout the southern United States. They are now established in fourteen states and Puerto Rico (USDA-APHIS 2018) and have been reported in two other states (EDDMaps). They are notorious hitchhikers and are easily transported long distances in articles such as soil, nursery stock and other items.

The Federal Imported Fire Ant Quarantine was implemented in 1958 to slow or prevent the artificial spread of imported fire ants shipped outside of the infested area. The quarantine regulates the movement of certain articles within the regulated area to or through non-regulated areas. When treating sod in compliance with Federal and State quarantine regulations, sod producer's options are limited (USDA-APHIS 2015). One former option was treatment using the active ingredient chlorpyrifos at eight pounds active ingredient per acre. However, there are no chlorpyrifos products registered for imported fire ants in sod at this required rate. Only fipronil and bifenthrin are currently approved for use in sod. Both work well, but activity is slow and sod cannot be shipped until 28-30 days post-treatment.

Field trials were conducted in 2016 and 2017 to evaluate the efficacy of other insecticides for use in fire ant quarantine protocols for sod. Fire ant bait was used as an initial application followed by a broadcast application of a contact insecticide.

Materials and Methods

Both field trials were conducted at FarmLinks Research and Demonstration Golf Course in Fayetteville, AL. Plots measuring 150 ft. X 150 ft. were laid out with each having a 0.25 acre permanently marked circular area in the center that was used as the evaluation area. Each evaluation area had at least 10 active imported fire ant mounds in pre-treatment count. There were three replicates of each treatment arranged in a randomized complete block design. Plots were arranged by numbers of mounds in the sample area and blocked using population size. Treatments were then randomized within the blocks. Imported fire ant populations (presence or absence of live mounds; number per 1/4 acre evaluation area) were evaluated pre-treatment and at approximately 2-3 days, 1, 2, 3, 4, 6, 8, 10, and 12 weeks post-treatment. Mound number data per 0.25-acre plot are presented in graph and table form for each year and were analyzed using SAS PROC MEANS/Tukey, SAS Version 9.4, Copyright® 2016 SAS Institute Inc., Cary, NC.

2016: Pre-treatment counts took place on Jul 18, 20 and 21. Treatments are listed in Table 1 below. Bait applications of Extinguish Plus® were made on Aug 3 with a Herd GT-77-ATV Broadcast Seeder/Spreader® at a rate of 1.5 pounds product per acre. Spray applications were made on Aug 16 using a GPS enabled sprayer calibrated to 32 GPA and set to prevent overlaps in the field, so no application was made out of the plots and no areas were overlapped. Granular applications were made the same day using a Vicon® pendulum spreader. Bait applications were delayed two weeks after pre-treatment counts due to rainy weather. Granular and spray applications were scheduled to be applied 3-7 days after bait application, but were also delayed due to rain. The first data collection post-treatment was on Aug 18, two days after treatment.

2017: Pre-treatment counts took place on October 12, 13 and 16. Treatments are listed in Table 2 below. Bait applications of Extinguish Plus® were made on Oct 19 with a Herd GT-77-ATV Broadcast Seeder/Spreader® at a rate of 1.5 pounds product per acre. Spray applications were made on Oct 26 using a GPS enabled sprayer calibrated to 32 GPA and set to prevent overlaps in the field, so no application was made out of the plots and no areas were overlapped. Granular applications were made the following day using a Vicon® pendulum spreader. The first data collection post-treatment was on Oct 30, three days after treatment. The six-week data collection (due Dec 6) and the ten-week data collection were delayed one week due to cold rainy weather. Data collections were extended past the 12-week cutoff to 22 weeks to gather more information on the performance of the products.

Results and Discussion

2016: There were no significant differences between any treatments until the 14-day count on Aug 30 when all treatments had significantly fewer mounds than the control, (Table 3, P>0.05, Tukey). For some reason, Taurus Trio G failed in one replicate, but performed well in the other two replicates (Figure 1). As a result, on dates after Aug 30 all treatments except the Taurus Trio G with no bait treatment had fewer mounds than the control (P>0.05, Tukey). All treatments, other than the Taurus Trio G with no bait treatment, achieved greater than 90% control by Sep 12 and, all but the Bait+Taurus Trio G treatment on Nov 16 (87% control) maintained that level of control until the end of the trial. None of the combinations performed any faster than current products on the market for use in sod and only the Bait + Aloft treatment provided 100% control for the duration of the trial.

Treatment	Bait	Contact ai/acre	Contact product/acre
Aloft GC SC® + Bait	Yes	Aloft GC SC® (0.17 lb ai bifenthrin/A + 0.35 lb ai clothianidin/A)	Aloft GC SC® (20 oz/A)
Onyx Pro® & Sevin SL® + Bait	Yes	Onyx Pro EC® (0.2 lb ai bifenthrin/A) Sevin SL® (4 lb ai carbaryl/A)	Onyx Pro® (13.9 oz/A) Sevin SL® (4 qts/A)

Taurus Trio G® + Bait	Yes	Taurus Trio G® (0.0124 lb ai fipronil + 0.2 lb ai bifenthrin + 0.051 lb ai lambda-cyhalothrin)	Taurus Trio G® (87 lb/A)
Taurus Trio G®	No	Taurus Trio G® (0.0124 lb ai fipronil + 0.2 lb ai bifenthrin + 0.051 lb ai lambda-cyhalothrin)	Taurus Trio G® (87 lb/A)
Control	No	None	

Table 1. 2016 Insecticide applications, rates and total active ingredient applied

Date	Pretrt	8/18/16	8/23/16	8/30/16	9/6/16	9/12/16	9/29/16	10/13/16	11/16/16	12/14/16
Treatment	Mean Number of Mounds per 1/4 Acre*									
Bait+Aloft	13.67a	1.67a	1.33a	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b
Bait+Bif+Carb	12.33a	3.00a	2.00a	0.33b	1.67b	1.00b	0.00b	0.667b	1.00b	0.00b
Bait+Taurus	13.00a	3.67a	2.67a	1.67b	3.67b	0.00b	1.33ab	0.667b	1.667b	0.33b
Taurus only	16.67a	8.67a	7.00a	3.00b	8.33ab	6.00ab	10.00ab	6.33ab	5.33ab	5.67ab
Control	12.00a	9.00a	9.33a	9.33a	15.00a	12.67a	13.33a	12.33a	12.33a	13.00a
	*Means with the same letter not different P>0.05, Tukey									

Table 3. Mean number of mounds per 0.25 acre, 2016

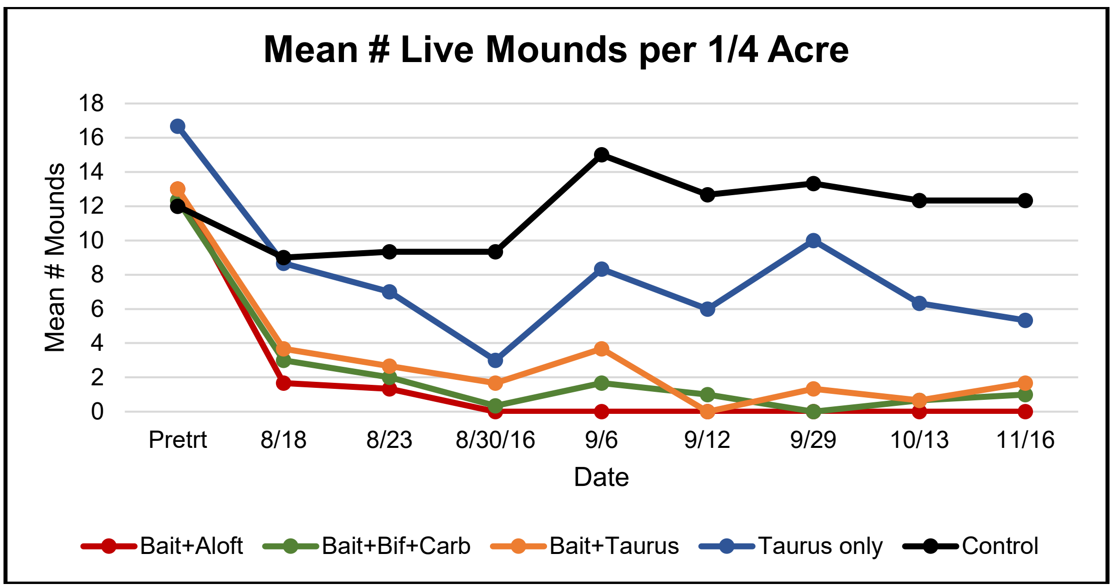

Figure 1. Mean number of mounds per 0.25 acre, 2016

2017: There were no significant differences between any treatments until week 2 on Nov 9 when the Bait+Bifenthrin+Sevin treatment had significantly fewer mounds than the control, but was not significantly different from the other treatments. (Table 4, Figure 2, P>0.05, Tukey). On all other dates all treatments had significantly fewer mounds than the control (P>0.05, Tukey). However, by Nov 21 (week 4), only the Bait+Bifenthrin/Sevin treatment had a control level above 90%. All treatments had reduced mound numbers by 90% by Dec 13. The Bait+Bifenthrin/Sevin reached 100% control at week 17 and the Bait+Taurus treatment reached 100% control at week 21. As in 2016, none of the treatments worked faster than the current recommended quarantine products.

Treatment	Bait	Contact ai/acre	Contact material/acre
Aloft GC SC® + Bait	Yes	Aloft GC SC® (0.17 lb ai bifenthrin/A + 0.35 lb ai clothianidin/A)	Aloft GC SC® (20 oz/A)
Onyx Pro® & Sevin SL® + Bait	Yes	Onyx Pro EC® (0.2 lb ai bifenthrin/A) Sevin SL® (4 lb ai carbaryl/A)	Onyx Pro® (13.9 oz/A) Sevin SL® (4 qts/A)
Taurus Trio G® + Bait	Yes	Taurus Trio G® (0.0124 lb ai fipronil + 0.2 lb ai bifenthrin + 0.051 lb ai lambda-cyhalothrin)	Taurus Trio G® (87 lb/A)
Control	No	No	

Table 2. 2017 Insecticide applications, rates and total active ingredient applied

Date	Week Pretrt	10/30	1 11/02	2 11/09	3 11/16	4 11/21	7 12/13	11 1/10	13 1/24	18 3/1	22 3/28
Treatment	**Mean Number of Mounds per ¼ Acre***										
Bait+Taurus	17.67a	8.00	8.33a	6.00ab	4.00b	2.67b	0.33b	1.00b	0.33b	0.33b	0.00b
Bait+Bifen/Sevin	26.67a	12.67a	8.33a	3.67b	3.67b	1.67b	0.67b	0.33b	0.33b	0.00b	0.00b
Bait+Aloft	25.67a	20.00a	15.67a	6.33ab	8.67b	5.33b	1.67b	0.33b	0.33b	0.00b	0.00b
Control	18.00a	17.67a	26.00a	17.33a	29.33a	28.00a	17.33a	24.33a	12.33a	14.67a	18.00a

*Means with the same letter not different P>0.05, Tukey

Table 4. Mean number of mounds per 0.25 acre, 2017-2018

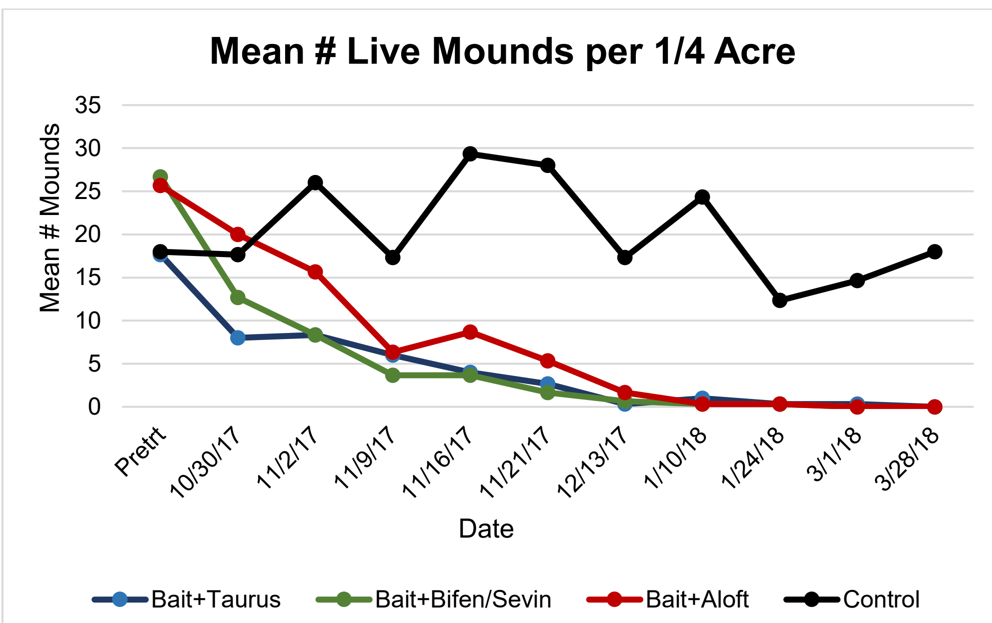

Figure 1. Mean number of mounds per 0.25 acre, 2017-18

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Why Fire Ant Female Sexuals Mate Only Once

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Abstract

Mating male ants have evolved many mechanisms to help ensure that their sperm is not displaced by a competing male. Fire ant female alates rarely mate more than once, despite an abundance of males organized in a horizontal lek 150 m in the air. This presentation explores known ant mechanisms that produce single matings, as well as specific possibilities that contribute to single mating in *Solenopsis invicta*.

The Future of the Federal Imported Fire Ant Quarantine Program

RICHARD N. JOHNSON, Anne-Marie Callcott, Melinda Sullivan and Ronald Weeks
USDA, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, PLANT PROTECTION AND QUARANTINE

Abstract

The Animal and Plant Health Inspection Service Plant Protection and Quarantine (APHIS/PPQ) and National Plant Board (NPB) joint Regulated Domestic Pest Program Evaluation Committee directed the review of the federal imported fire ant (IFA) quarantine program. The review team solicited stakeholder comments on the effectiveness of the program and suggestions for improvement. In general, stakeholders encouraged maintaining the federal quarantine program. The on-line interactive quarantine map and rapid assay tests were two advances in the program which were significant developments for many stakeholders. As imported fire ants and other invasive pest ants continue to expand their range in the U.S., it is important that

many industries involved in moving regulated material stay vigilant to prevent the human-assisted movement of these invaders.

Improving Federal Imported Fire Ant Quarantine Treatments: Tracking Water and Bifenthrin Movement in Soil with Signal™ Green Dye

Karla Addesso[1], Jason Oliver[1], Anthony Witcher[1], Anne-Marie Callcott[2], Nadeer Youssef[1], and Paul O'Neal[1]
[1]Tennessee State University, [2]USDA-APHIS-PPQ Biloxi Station

Abstract

Balled and burlapped root ball injections were initiated to minimize water use in fire ant quarantine treatments. One challenge of developing treatment protocols is the large volume of contaminated soil that results. The objective of this study was twofold: to use Signal™ Green dye to track water movement through root balls and to determine whether Signal Green can be used as a proxy for bifenthrin in treatment development protocols. In the first experiment, root balls were treated with a dye solution using different injection methods. Dye was extracted and quantified from soil at 7 locations around the root ball. In the second experiment, both dye and bifenthrin were injected into root balls using a single angled injection. Dye and bifenthrin were extracted and quantified. A portion of soil from the extraction sites was used in an ant toxicity assay. The results of the root ball treatment methods showed uneven movement of dye across the root ball in all treatments. Root balls with multiple injections had the least dye across sites due to the large volume of liquid flowing from previously established channels. A strong linear correlation was observed between dye and bifenthrin in the soil extractions. Fire ant mortality reached 100% when exposed to some, but not all soil sample locations. Our results suggest that Signal Green dye can be used as a proxy for bifenthrin, however, caution must be taken to establish standard curves for extraction of both dye and bifenthrin in the specific soil or media under investigation.

Improving Federal Imported Fire Ant Quarantine Treatments for Post-Harvest Field-grown Nursery Stock

Jason Oliver[1], Karla Addesso[1], Anthony Witcher[1], Anne-Marie Callcott[2], Nadeer Youssef[1] and Paul O'Neal[1]
[1]Tennessee State University, [2]USDA-APHIS-PPQ Biloxi Station

Abstract

Federal Imported Fire Ant Quarantine (FIFAQ) field-grown nursery treatments are presently limited to a post-harvest balled and burlapped (B&B) root ball dip in bifenthrin or chlorpyrifos or a post-harvest B&B drench in chlorpyrifos. A pre-harvest field-grown chlorpyrifos treatment also is allowed, but presently no insecticide labels are available that support the use pattern. The chlorpyrifos drench treatment previously required six consecutive drenches to runoff, but was amended in March 2015 to allow two drenches at 20% root ball volume with a root ball rotation between drenches. Although the new drench treatment is FIFAQ approved, USDA-APHIS research with colony infested B&B plants revealed a concern that colonies may be able to retreat to the root ball centers and avoid the drench treatments. The objective of the present research study was to determine if injection treatments could be used to improve FIFAQ treatments of B&B nursery stock. The study evaluated injection angles and number, solution volume, and movement of colored dye to determine the optimal method to treat 30-cm diameter B&B plants. Soil moisture was monitored with time domain reflectometry. Results indicated fewer injections had more uniform moisture distribution due to less solution channeling and leakage from other injection points. Injection angle also affected moisture distribution with an entry angle parallel to the plant stem providing the most consistent moisture distribution. A single frontal injection combined with the current FIFAQ drench protocol achieved soil moisture levels similar to a root ball dip immersion. Four insecticides evaluated as mound drenches provided complete colony control within 48 hours, and therefore, could have potential for use as injection treatments to quickly eliminate fire ant colonies hiding inside B&B plants. The insecticides were applied to mounds in 7.57 liters of solution / 0.9 m diameter area and included bifenthrin (1.77 or 3.84 ml OnyxPro Insecticide), chlorpyrifos (1.18 or 2.37 ml Chlorpyrifos SPC4), lambda-cyhalothrin (2.96 ml Scimitar GC), or permethrin (2.37 or 4.73 ml Perm-Up 3.2EC). The addition of carbaryl (0.15 ml Sevin SL) to the above insecticide treatments did not enhance colony control over using the products alone. Overall, injection treatments did enhance solution distribution to areas of B&B root balls not effectively treated by drenches alone, and combination of injections with the above insecticides would be likely to achieve FIFAQ level control.

Rain, Rain Go Away; Unless Water Resistant Fire Ant Baits Are on Display?

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Fire ant baits typically consist of toxicant dissolved in a food attractant, such as soybean oil, which is absorbed onto a corn grit carrier (Lofgren et al. 1975, Williams et al. 2001). However, this formulation degrades in wet conditions when the carrier absorbs water, becomes mushy, and is supposedly not foraged upon by the ants. As a result, bait efficacy is reduced. This is problematic in irrigated landscapes and nurseries, as well as in rainy climates (Barr et al. 2005, Souza et al. 2008, Hara et al. 2014). Two water-resistant fire ant baits (Erasant-Pyro Hydrophobic Fire Ant Bait, 0.5% pyriproxyfen, Chung Hsi Chemical Plant; zein bait, 0.1% pyriproxyfen, J. Chen USDA-ARS formulation) and a standard bait (Esteem Ant Bait, 0.5% pyriproxyfen, Valent) were tested against laboratory fire ant colonies. Interestingly, all formulations including the standard were effective and caused an average 70-100% (n=3) reduction in brood volume after being either: a) soaked in water, b) soaked in water then allowed to air dry for 18-23 hours, or c) left dry. Fire ants would feed on the wet, water soaked baits including the non-water resistant standard bait which were dispensed in piles. This suggested that the reduced efficacy of fire ant baits could be a function of accessibility of the bait particles after rain or irrigation. When baits are applied by broadcasting, baits are deposited as individual particles on the ground and water may be washing away or burying the particles. In contrast, piled bait is more protected from the water.

Broadcast applications of the standard and Erasant baits were made to irrigated landscapes in the desert climate of the Coachella Valley, California. In addition, the standard bait was applied in piles in a grid pattern. In irrigated landscapes, standard bait applied in piles had similar reductions (44%) in fire ant foraging after 11 weeks as water resistant and standard bait formulations that were applied by broadcasting (45-51%, n=4). In contrast, foraging was significantly greater ($P \leq 0.05$) in control plots which increased from pretreatment sampling. Baits were applied in the summer and fire ants were observed foraging on bait piles that were irrigated during the day when temperatures were over 45.6 °C (105 °F). It is thought that the increased humidity at the boundary layer of the moist, irrigated soil permitted foraging despite the high, ambient air temperatures. The mediocre reduction in fire ant activity when baits were either broadcast or piled indicated that further studies are needed to determine if making baits more water resistant or if modifying application methods will improve bait performance under wet conditions.

Acknowledgements

We appreciated the logistical assistance of Roberta “Bobbye” Dieckmann and Jennifer Henke (Coachella Valley Mosquito and Vector Control District); Nancy Lee and Allis Lu (Chung Hsi Chemical Plant, Taipei, Taiwan), Jian Chen (USDA-ARS, Stoneville, MS), and Mike Riffle (Valent USA) for providing fire ant bait formulations. The research was supported in part through a grant from the Coachella Valley Mosquito and Vector Control District. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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Carpenter Ant-Microbe Interactions: A Focus on Yeast Associates

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Abstract

The yeast microorganisms associated with *Camponotus vicinus* are discussed. Experiments where worker ants and larvae were fed holidic or nutrient deficient diets and then exposed to the yeast, *Debaryomyces polymorphus* showed that pupal weight was sometimes positively affected by exposure to *D. polymorphus*. It is speculated that the yeast may aid in more efficient assimilation of nutrients when fed nutrient-deficient diets, particularly diets lacking sterols.

Introduction

The carpenter ant *Camponotus vincinus* (Mayr) is widespread pest of wood in service particularly in the Pacific Northwest where it is common (Mankowski and Morrell, 2000). Workers possess a buccal filter or infrabuccal pocket limiting the ability of large food particles to enter the midgut (Eisner and Happ 1962). The yeast *Debaryomyces polymorphus* (Kloecker) has been found in the infrabuccal pocket as well as in the nests of *C. vincinus* (Mankowski and Morrell 2004). The nutritional contribution associated with this yeast to the diet of *C. vicinus* is unknown. Ba *et al*. (1995, 2000) found yeasts associated with colonies of the fire ant *Solenopsis invicta* (Buren) appeared to contribute to overall colony health producing exogenous sterols the ants themselves could not generate. In beetles, yeast-like endosymbionts present in the digestive systems supply nutrients and necessary metabolic compounds for larval development

(Pant and Dang 1972). Other insects use yeasts to aid in the synthesis of nutrients absent in their diets such as B complex vitamins and sterols (Dadd 1985).

We examined the potential contribution of the yeast *D. polymorphus* to the nutrition of *C. vicinus* using component deletion of a holidic artificial diet developed in a previous study (Mankowski and Morrell 2014).

Materials & Methods

The effects of adding live *D. polymorphus* to diets was assessed by feeding the ants a basal diet containing all dietary components and diets deficient in particular components. Four diets were tested: A basal (complete) diet, the basal diet minus B vitamins, the basal diet minus B vitamins and cholesterol, and sugar water only. Ants and larvae were fed these diets only and a second set fed these same diets augmented with live *D. polymorphus* cultures.

Sixteen groups of *C. vicinus* consisting of 8 workers and 15 second to third instar larvae were fed the aforementioned diets for a 12 week period (Mankowski and Morrell, 2014). Half of the replicates were exposed to yeast cultures using a suspension of *D. polymorphus* grown in 125 ml of vitamin free media (Barnett et al. 1990) and filtered through a 0.22μ filter paper. Yeast cells were removed from the filter paper and added to 20 ml of sterile water. The yeast suspension was applied topically to the worker ants and larvae in 100 μl aliquots so that the workers would ingest the yeasts as they groomed themselves and larvae. Larval development was monitored for the 12 week period and pupae were removed as they developed and incubated at 25° C until the cuticle of the ant inside darkened. When this occurred the ant was physically removed from the pupal case and its weight were recorded.

Results and Discussion

Pupal weights for ants and larvae fed four diets and the same diets plus live yeast cultures are shown in Figure 1. Pupal weights were highest for ants fed the complete basal diet only. This same diet plus exposure to yeast resulted in slightly lower pupal weights. All other diets resulted in lower pupal weight compared to the basal diet only. Ants fed diets lacking both B vitamins and cholesterol, but exposed to live yeast, had heavier pupae than those not exposed to yeast and fed the same diet.

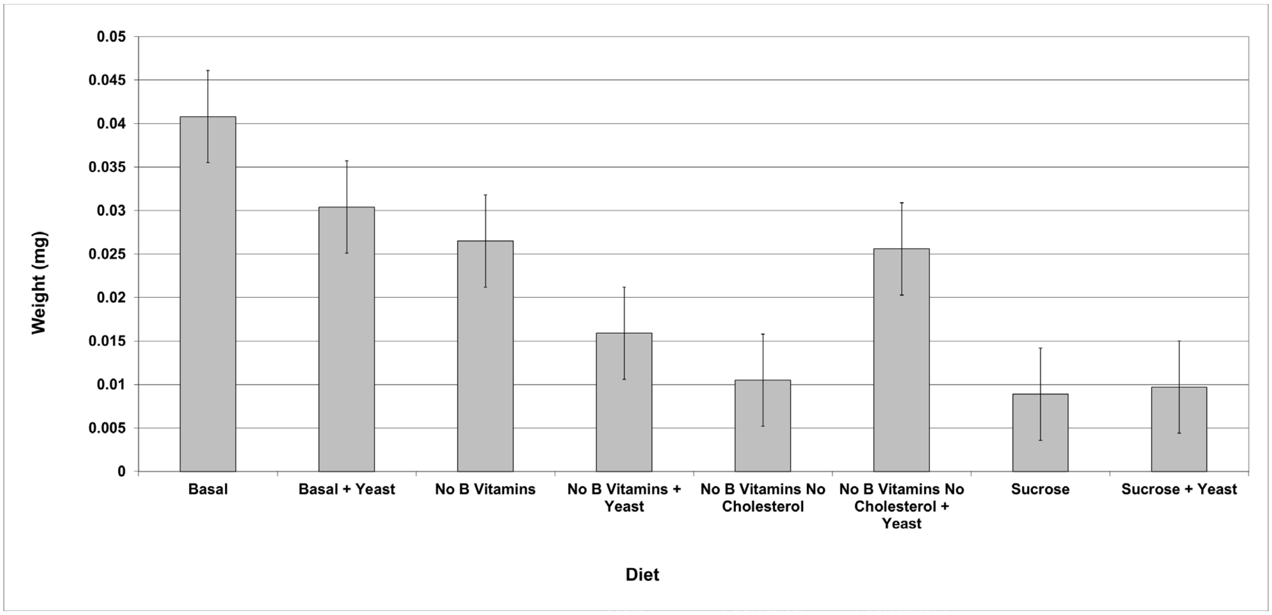

Figure 1. Average pupal weight of 2nd and 3rd instar *C. vicinus* larvae fed four diets and the same four diets augmented with live *D. polymorphus* after 12 weeks.

Exposure of *C. vicinus* larvae to various diets and the same diets augmented with live *D. polymorphus* affected pupal weights particularly those fed diets lacking both B vitamins and cholesterol and exposed to live yeast. Interestingly, brood exposed to a diet lacking all B vitamins and exposed to live yeast did not react similarly indicating that the yeast may supply sterol compounds that aid in pupal development. Unlike vertebrates, which biosynthesize sterols directly from acetate, insects have no way of synthesizing sterol compounds and must obtain them from their diet or microbial symbionts (Friend and Dadd, 1982). In insects, sterols are necessary for molting to occur and are necessary for proper development and growth (Schneiderman and Gilbert 1964). Although the yeast may have helped the brood in the treatments minus cholesterol and B vitamins, ants fed sugar water only and sugar water with yeast did not differ. Sucrose treatments also lacked B vitamins and cholesterol, but there was little or no difference between the ants exposed and those not exposed to yeast. Ba et al. (1995) measured sterol levels in fire ants and concluded that fire ants may obtain ergosterol from associated midgut yeasts. Maurer et al. (1992) examined sterols associated with leaf-cutting ants and found that the ants obtained sterols from their fungal symbiont. Smith (1944) found that carpenter ant colonies reared smaller brood on diets without yeast extract, indicating that yeast or something produced by yeast was beneficial to brood development.

The presence of *D. polymorphus* may have affected larval development of *C. vicinus* by producing nutrients or enzymes that facilitated larval digestion. Although we have only tested this for *D. polymorphus*, a more complex microbial community is probably involved in associations between carpenter ant nutrition and the infrabuccal pocket.

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Supercolony Formation in Invasive Populations of the Tawny Crazy Ant *Nylanderia fulva*

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Abstract

The tawny crazy ant, *Nylanderian fulva*, is native to South America. It has been established in Florida since the 1950s and was first reported in Texas in 2002. It has since spread to many parts of the Gulf Coast where it forms highly dense populations that displace native fauna and cause serious problems in urban areas. It's often assumed that this species forms supercolonies, but to date there have been no studies of its colony structure. We performed behavioral and genetic tests within and across sites in Texas. We found no behavioral aggression among different nests within sites (>30 m apart) or across sites (100-300 km apart) in Texas. We also found no genetic differentiation among nests within a site or between sites in Texas or even between sites across the Gulf Coast. The invasive population shows lower genetic diversity than the native range, consistent with N. fulva having experienced a genetic bottleneck upon introduction. However, colonies in the native range have low genetic diversity and high nestmate relatedness suggesting the presence of a single or few queens per colony, whereas colonies in the invasive range have relatively high genetic diversity and low levels of genetic relatedness indicative of high numbers of unrelated queens. Taken together, these results suggest that invasive populations of N. fulva form supercolonies that differ dramatically from the genetic structure of native colonies. The results further suggest that there was a single introduction to the US that has spread throughout the Gulf Coast states.

Let's Get the Info Out About the Crazies (Tawny Crazy Ants, That Is)...Stakeholder Resources Now Available!

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Abstract

Over the past decade, areas along the Gulf of Mexico and the Atlantic Ocean have become overrun by an invasive pest ant, the tawny crazy ant, NYLANDERIA FULVA **(Mayr, 1862)**. Tawny crazy ants cause serious ecological, agricultural, and economic impacts in areas they inhabit. Tawny crazy ants continue to spread to new areas each year, which created a need for resources for stakeholders, extension agents and industry professionals regarding this pest. In an effort to meet this need, a workgroup was created, and educational materials developed. Information sheets are available fdSix stakeholder videos are now available on the web for viewing and for download to use in presentations. The videos are located at http://www.eddmaps.org/tca/ and https://www.youtube.com/user/alcoopextensionvideo/playlists. If you cannot download from this site, the videos are also available through a download link by contacting Kelly Palmer or Fudd Graham. Information sheets on the tawny crazy ant for homeowners, pest management professionals, livestock producers and nurserymen will soon be

available on the EDDMaps site. In addition, bookmarks and shade displays will be distributed to tawny crazy ant working group members for use in presentations and displays in their state.

Establishment of a New Invasive Ant Species *Plagiolepis alluaudi*, in Florida

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Abstract

Florida is in a latitudinally temperate zone yet includes both subtropical and tropical climates. With numerous shipping ports and high urban activity, new species are frequently introduced to South Florida. There are currently over 230 ant species in Florida, approximately one quarter of which are classified as exotic, and most of the household pest ant species are considered invasive. In 2017, a newly invasive species was discovered in South Florida as its first New World continental record. *Plagiolepis alluaudi* (Emery) (Formicinae), the little yellow ant, is native to the Madagascar area, and has spread to many tropical islands around the world. It presumably arrived in South Florida via the robust boating industry throughout the West Indies to ports in South Florida. *Plagiolepis alluaudi* is extremely small (<1 .5 mm), with an entirely yellow body, and has the ability to form large polydomial, polygynous supercolonies. It primarily nests in rotten twigs on trees or on the ground, and tends to aphids, mealybugs and scale insects, feeding on their honeydew. It has apparently displaced a long-established population of *Pheidole megacephala*. As it nests in "yard waste" material, it has strong dispersal capability via local waste management services, and is expected to rapidly spread throughout South Florida. In high densities, it can infest structures, and is commonly found in bathrooms and kitchens. It also potentially can an agricultural pest. The use of liquid bait may temporarily reduce the ant activity in households, but recurrent re-infestations from surrounding landscapes are inevitable.

How Citizen Science Can Benefit Invasion Science

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Abstract

Citizen science projects and emerging high-throughput sequencing techniques each have the potential to vastly improve the amount of data available for invasive species research. These two tools can be used synergistically to better understand the origin and spread of commonly encountered introduced species in urban North America, and may be especially useful for species that proliferate in urban environments, including ants. This study analyzed the continent-wide population structure of citizen-collected specimens of the commonly encountered and long-established exotic Pavement Ant (*Tetramorium immigrans,* formerly known as *T. caespitum,* or *T.* sp. E.) in the United States of America. Specimens collected across the continent were sampled through the School of Ants citizen science project. Data from double-digest restriction-site associated DNA sequencing (ddRADseq) confirm that the U.S. populations of pavement ants belong to a single species with low genetic diversity, which suggests a single introduction with subsequent spread across the continent through dispersal and human transportation. These results demonstrate how collections-based public participatory science can lead to better scientific and public understanding of invasive species, and suggest that this model is particularly well suited for research on common taxa that are ecologically important but poorly understood. Citizen science may be an especially helpful tool in monitoring the extent and spread of recently introduced invasive ant populations and informing public audiences about the threats of invasive species. The most effective programs combine targeted, engaging science communication, offer participants the opportunity to engage with real, ongoing scientific endeavors, and assess the educational value of participation.

Confirmation of *Tapinoma sessile* Clades in Knox County Tennessee Using a Novel and Cost-Efficient Assay

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Abstract

Tapinoma sessile (Say), or the odorous house ant (OHA), is a native, invasive species found throughout the US in a wide range of habitats. Recent research proposes this ant may consist of four closely related mitochondrial clades, two of which were reported from Tennessee. Determining clade presence in an area is important because management strategy outcomes may be clade specific. This study determined the OHA clades present in Knox County, TN using Sanger sequencing as well as tested a new, potentially cost efficient method (PCR-RFLP) to identify these clades. Ants were collected locally and sent by contributors from other US regions with suspected north and south clades. OHA were visually confirmed with morphological characters prior to analyses. To identify the mitochondrial clades, DNA was extracted, COI gene was amplified with PCR, and select samples were sequenced and compared to known

clades. To improve cost and time efficiency, we identified a restriction enzyme that only cut the north clade (~300/400bp) and left the south intact (~750bp). We compared clade identity success, and time and cost of the restriction enzyme assay to Sanger sequencing. Both north and south clades were found in Knox County and both methods identified each clade. PCR-RFLP was more time and cost efficient. Now that Knox county is known to host multiple clades of OHA future research will more finely delineate the distribution of each clade in Knox County and further validate the efficiency of this novel assay with increased, more widespread sampling.

SUBMITTED PAPERS: FLIES & MOSQUITOES

Fruit Flies as Potential Vectors of Foodborne Illness

S. J. Barcay, E. P. Black, G. J. Hinrichs, and D. B. Gardner
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Abstract

Fruit flies are a familiar sight in many food service facilities. Although they have been long considered as ''nuisance pests,'' some of their daily activities suggest they may pose a potential public health threat. The aim of this study was to assess the ability of fruit flies to transfer bacteria from a contaminated source to surfaces or ready-to-eat food. Laboratory experiments were conducted by using specialized enclosures to assess the bacterial transfer capability of fruit flies. *Drosophila repleta* were capable of transferring *Escherichia coli* O157:H7, *Salmonella Saint Paul*, and *Listeria innocua* from an inoculated food source to various uncontaminated surfaces. In addition, using an inoculated doughnut and non-contaminated lettuce and doughnut surfaces, fly-mediated cross-contamination of ready-to-eat food was demonstrated. Fruit flies were shown to be capable of accumulating approximately 2.93103 log CFU of *E. coli* per fly within 2 h of exposure to a contaminated food source. These levels of bacteria did not decrease over an observation period of 48 h. Scanning electron micrographs were taken of bacteria associated with fly food and contact body parts during a selection of these experiments. A study of microbial diversity of fruit flies and their breeding sites at multiple restaurants in Minnesota will also be mentioned. These data, coupled with the feeding and breeding behavior of fruit flies in unsanitary areas of commercial kitchens and their propensity to land and rest on food preparation surfaces and equipment indicate a possible role for fruit flies in the spread of foodborne pathogens.

Alpine® 0.5% Fly Bait: Different but the Same

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BASF Corporation, 26 Davis Dr., Research Triangle Park, NC 27709

Abstract

PT® Alpine® II Pressurized Fly Bait is a ready-to-use product developed by BASF Corporation. It contains 0.5% dinotefuran as the active ingredient. The application is a fine mist which dries clear with no odor. It can be applied as a spot, area, or band treatment or as a removable bait placement. Applications can be made in sensitive areas like food handling establishments. The product provides fast knockdown and high

mortality on a number of nuisance flies include blue bottle, filth, house, phorid and fruit flies. It is currently under review by the EPA.

PT® Alpine® Pressurized Fly Bait containing 1.0% dinotefuran is the current product offering from BASF. When used in food handling establishments this product can only be applied to the interior of refuge receptacles, removable bait placements, or in stations. The reason for these limitations is the food additive tolerance was established at 0.5% which is significantly lower than the 1.0% loading of the current product. The development of PT® Alpine® II Pressurized Fly Bait with a loading of 0.5% will allow this product to be applied without the limitations of the current 1.0% formulation.

Comparison testing between PT® Alpine® II Pressurized Fly Bait and PT® Alpine® Pressurized Fly Bait formulations shows no disadvantages of the lower loading over the 1.0% loading in terms of knockdown (Kd) and mortality. PT® Alpine® II Pressurized Fly Bait showed significantly quicker knockdown of house flies than PT® Alpine® Pressurized Fly Bait (Fig. 1). There were no significant differences between the two formulations in percent mortality at 24 hours (91.7% for the 0.5% formulation vs 100% for the 1.0% formulation).

Additional studies showed excellent efficacy of PT® Alpine® II Pressurized Fly Bait on house and other flies in both field and lab studies. House flies exposed to ceramic tiles aged for 28 days in the laboratory showed no significant differences in 24-hour mortality from tiles aged for one day (97.3% vs. 100.0%, respectively). Excellent mortality was achieved within 2-3 days with PT® Alpine® II Pressurized Fly Bait on both laboratory and field strains of house flies in the laboratory. Field trials conducted in dairies show PT® Alpine® II Pressurized Fly Bait compares favorably with Quikstrike® Fly Bait in the number of accumulated dead flies in treated pans.

PT® Alpine® II Pressurized Fly Bait is comparable to PT® Alpine® Pressurized Fly Bait in terms of efficacy and spectrum. The application limitations in food handling establishments of PT® Alpine® Pressurized Fly Bait should not be an issue with PT® Alpine® II Pressurized Fly Bait. EPA registration is anticipated in second quarter of 2019.

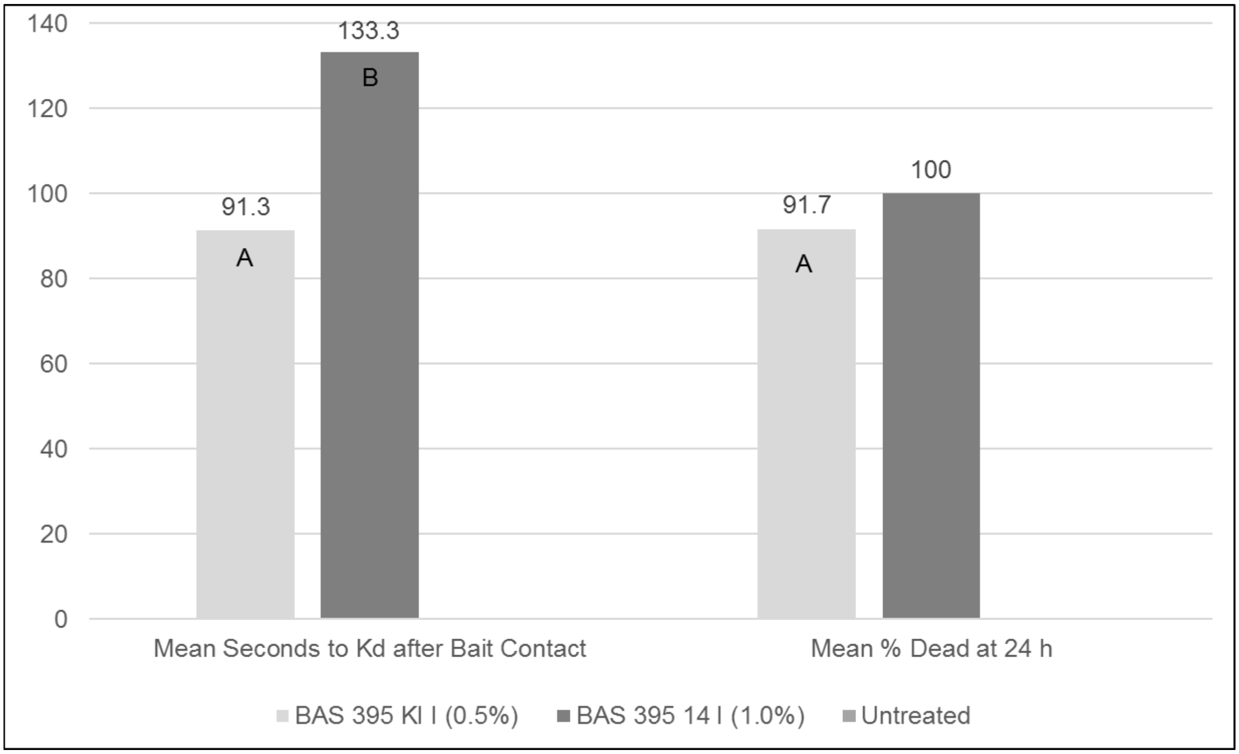

Figure 1. Comparison of PT® Alpine® Pressurized Fly Bait and PT® Alpine® II Pressurized Fly Bait containing 1.0% and 0.5% dinotefuran, respectively, against house fly adults showing knockdown and mortality in the laboratory.

SUBMITTED PAPERS: COCKROACHES & TERMITES

German Cockroach Aggregation is Mediated by Gut Bacteria

AYAKO WADA-KATSUMATA, Coby Schal
North Carolina State University

Abstract

Aggregation of the German cockroach is regulated by fecal aggregation agents, including volatile carboxylic acids (VCAs). We demonstrated that the gut microbial community contributes to production of the these semiochemicals. Chemical analysis of fecal extracts revealed 40 VCAs. Feces from axenic cockroach (no microorganisms in the alimentary tract) lacked 12 major fecal VCAs and the 24 remaining compounds were represented at extremely low amounts. Olfactory and aggregation bioassays demonstrated that nymphs strongly preferred a synthetic blend of six fecal VCAs over a solvent control or a previously identified VCA blend. To test whether gut bacteria contribute to the production of fecal aggregation agents, fecal aerobic bacteria were cultured, isolated, and identified. Inoculation of axenic cockroaches with individual bacteria taxa significantly rescued the aggregation response to the fecal extract, and inoculation with a mix of gut bacteria contributes to production of VCAs that act as fecal aggregation agents. Cockroaches discriminate among the complex odors that emanate from a diverse microbial community. Out results highlight the pivotal role of gut bacteria in mediating insect-insect communication. Moreover, because the but microbial community reflects the local environment, local plasticity in fecal aggregation pheromones enables colony-specific odors and fidelity to persistent aggregation sites.

The Role of the Gut Microbiota in the Reproductive Life History of the German Cockroach

Jose E. Pietri, Dangsheng Liang
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Abstract

German cockroaches harbor a diverse bacterial community in the gut, as well as vertically transmitted intracellular symbionts (*Blattabacterium*) that reside in fat body tissue. A limited number of studies, primarily between the 1950’s and 1970’s, have examined the role of symbiotic bacteria in the development and reproduction of the German cockroach using antibiotic treatments. While these studies indicate that consumption of antibiotics may adversely impact reproductive life history, they fail to distinguish between effects mediated by the removal of fat body symbionts, and those

dependent on the perturbation of the gut microbiota. Since this work, advances in molecular biology tools have facilitated the investigation of interactions between insects and their microbial communities with greater depth and precision. Here, we demonstrate that several life history parameters are altered in German cockroaches lacking commensal bacteria. Further, using complementary methods to selectively eliminate bacteria, we show that both the gut microbiota and *Blattabacterium* symbionts are involved in this physiology. Our results suggest that targeting the symbiotic bacteria of cockroaches may help improve the efficacy of current control methods.

A New Borate-Based Dual-Active Cockroach Bait

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Abstract

A preliminary test was conducted, using a new borate-based dual-active cockroach bait (5.0% Boric Acid and 0.008% Fipronil), bait 526, to determine efficacy against two cockroach species that are public health pests. Bait 526 achieved 100% mortality against German and American cockroach populations within 13 days. Efficacy results indicate that bait 526 is ideal for inclusion into a IPM cockroach rotation program.

Introduction

The number of cockroach species world-wide is estimated to be around 3500, with 70 species found in the United States (Bennett et al. 2016). Of these 70 species, two are major health pests in urban dwellings – the German cockroach (*Blattella germanica*) and the American cockroach (*Periplaneta Americana*). Insecticide resistance continues to grow particularly stronger within these two cockroach species (Wang et al 2004, Lee et al. 2016). A proper IPM program that reduces the increase of insecticide resistance is needed to adequality maintain continued control of cockroach populations. Rotating different products in conjunction with the Insecticide Resistance Action Committee (IRAC) modes of action is the proper strategy to control and delay the development of insecticide resistance in all cockroach species (IRAC 2018). A combination of a borate (Group 8: Miscellaneous non-specific (multi-site) inhibitors) and a fiprole (Group 2: GABA-gated chloride channel antagonists) has never been used in a cockroach bait, but this combination and particular low loading level of active ingredients might best represent what would meet the IRAC guidelines and significantly reduce insecticide resistance in cockroach species. The German cockroach (*Blattella germanica*) and the American cockroach (*Periplaneta Americana*) were used as preliminary test subjects.

Materials and Methods

Plastic greenhouse trays measuring (25-cm W x 45-cm L x 17.5-cm H) were used as test arenas with PVC piping as harborage. Roaches were reared on apple cuttings and dry dog food which was replenished as needed. This same mixture of food was used as the control food source. Petri dishes (9 cm diameter) were used as containers for the different bait substances. A digital balance (Satorius model GD-503) was used for weighing the test-bait-substance Petri dishes before and after applications. The average environmental conditions recorded during the study were 74°F and 53% humidity. A standard 20-pound CO_2 cylinder with a regulator was used to anesthetize the individual roaches and sort them into the test arenas prior to exposure to the test baits. Test individuals were adequately allowed to recover from anesthetization before being exposed to the different test baits.

After all the cockroaches were transferred into the arenas, the study was continued only after obtaining conformation that the cockroaches were alive and exhibited normal behavior. The cockroaches were allowed a 24-hour acclimation period without food prior to the introduction of the test baits. Afterwards, 1.0 g of bait was added to each test arena. To evaluate the amount of weight change per bait due to water loss/gain, control baits for each test substance were placed inside a container of the same type without the roaches. All bait weights were collected at pre-treatment and at the completion of the study.

A semi-randomized block design using repeated-measures was used for the experiment. Five replications were conducted for each bait formulation. One replication consisted of ten individual cockroaches placed in a test arena. The number of alive, knockdown (roaches exhibited some movement, but could not crawl), and dead individuals per container were recorded at the time of introduction of the treatment, and at 1, 3, 5, 7, 9, 11, and 13-days post-treatment. Alive, knockdown, and dead observations were collected by raising the test arenas and gently blowing air on the individuals, followed by lightly prodding and/or lightly shaking the test arena to provoke movement.

Results and Discussion

Bait 526 achieved 100% mortality at 13 days against both German and American cockroach populations (Figure 1 and 2). The untreated control population recorded 10% mortality at day 13. In comparison, the other professional bait formulations achieved mortality within the range between 58-95% at day 13. There was no correlation between average bait weight loss and mortality. From the preliminary testing, one concludes that a combination of boric acid (0.5%) and Fipronil (0.008%) provides effective control against these two cockroach public health pests. Using this proper combination to levels commensurate with loading levels of these active ingredients should reduce insecticide resistance under the IRAC guidelines.

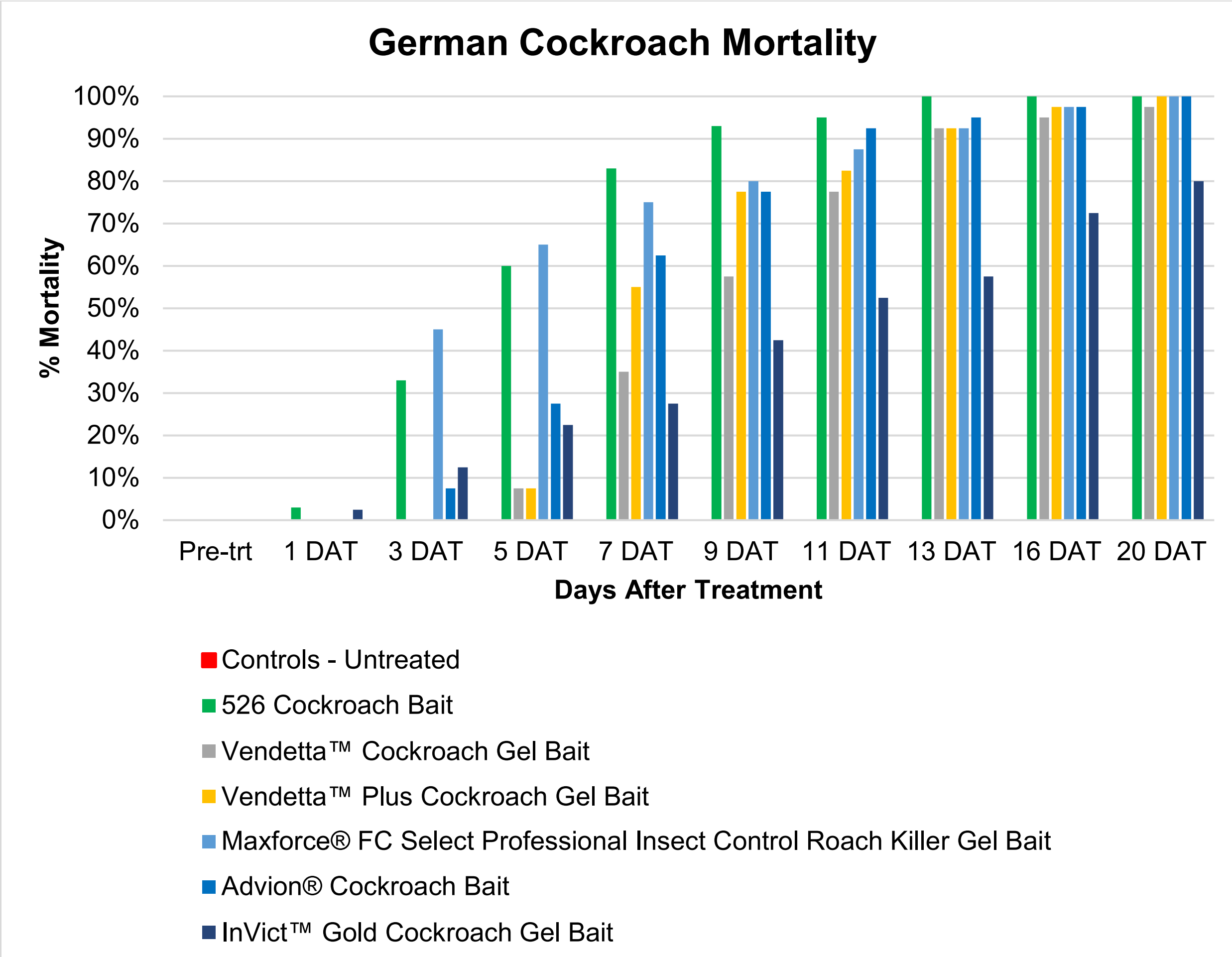

Figure 1. German Cockroach Mortality

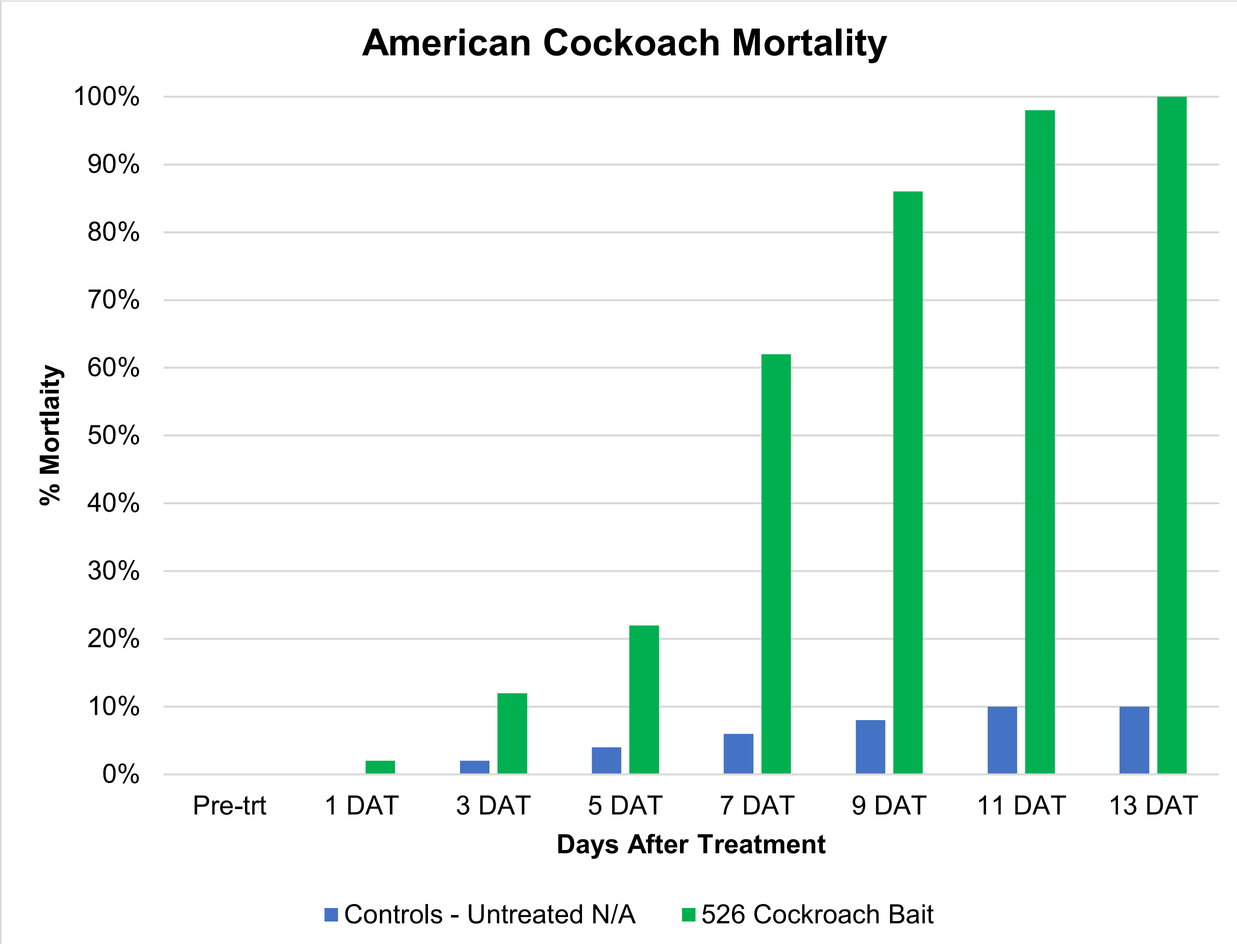

Figure 2. American Cockroach Mortality

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Assessing Residents' Attitudes Toward German Cockroach Infestations in Apartment Buildings

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Abstract

The German cockroach (*Blattella germanica* L.) is a common indoor pest that contaminates food and triggers allergy and asthma. Low-income communities often have high rate of cockroach infestations. To reduce the cockroach infestations in these communities, it is critical to understand the social and behavioral factors that may have impeded the success of cockroach control efforts. The objective of this study is to assess residents' attitudes and house-keeping practices in association with German cockroach infestations. We conducted resident interviews, placed sticky traps to detect presence of German cockroaches, collected residents' demographic information, and assessed apartment conditions. A total of 388 apartments from seven low-income apartment buildings occupied by senior citizens in New Jersey, USA were included. Among the surveyed residents, 63% are bothered when seeing a single cockroach, 59% are bothered when seeing cockroaches monthly. The majority of residents in the surveyed communities tolerated low-level German cockroach infestations. Presence of German cockroaches is associated with residents' high tolerance of cockroaches and poor sanitation rating, but is not associated with clutter, resident gender or ethnicity. These findings could be used to design better cockroach management strategies and reduce the infestation rates in low-income communities.

Molecular Insights into Invasive Subterranean Termites (*Coptotermes, Heterotermes*) in the Caribbean Basin

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Abstract

Subterranean termites in the genera *Coptotermes* and *Heterotermes* (Dictyoptera: Rhinotermitidae) include a number of species that are invasive in the Caribbean Basin. We discuss our first records of the Formosan subterranean termite, *Coptotermes formosanus*, on Grand Bahama (Jones et al. 2017 *Journal of Entomological Science* 52(4): 445–449). *C. formosanus* was first collected in the Port Lucaya area of Freeport, Grand Bahama in August 2010, with alates collected in 2015 and thereafter. Human dispersal appears to be responsible for the now widespread distribution of *C. formosanus* in Freeport. Elsewhere in the Caribbean, the Asian subterranean termite, *C. gestroi*, is a growing threat (reviewed by Evans et al. 2013. *Annual Review of Entomology* 58: 455–474). It appears to be a relatively recent invader in Puerto Rico and was reported only in San Juan in 2003. *C. gestroi* now is widely distributed on Puerto Rico (Jones and Eaton, in prep.).

Subterranean termites in the genus *Heterotermes* are pantropical wood feeders that can cause significant structural damage. In the Caribbean, some *Heterotermes* spp. lack robust morphological characteristics of the soldier caste, which limits reliable species identification (Griebenow et al. 2017. *ZooKeys* 725: 17–29). However, our phylogenetic analyses of the mitochondrial 16S and cytochrome oxidase II (COII) genes have provided a much better understanding of *Heterotermes* species diversity in Puerto Rico and the Caribbean Basin. Using a large dataset (76 *Heterotermes* samples from Puerto Rico plus GenBank unique sequences [n = 73 for 16S; n = 22 for COII]), we found that *H. cardini* and *H. convexinotatus* are widespread in the arid coastal regions of the Puerto Rican mainland, whereas *H. tenuis* is uncommon and may represent a relatively new introduction to Puerto Rico (Eaton et al. 2016 *Journal of Insect Science* 16(1): 111; 1–9). This contrasts with the previous report of only *H. convexinotatus* from the Puerto Rican archipelago, which was based on three Puerto Rican termite samples included in a total of “63 West Indian and other *Heterotermes* samples subjected to DNA sequencing” of the 16S gene (Szalanski et al. 2004. *Annals of the Entomological Society of America* 97: 556–566). Furthermore, we found that Szalanski’s et al. (2004) proposed *Heterotermes* sp. from Grand Cayman, Jamaica, and southern Florida, USA, grouped with *H. cardini* and therefore was phylogenetically indistinct from *H. cardini*. Additional mitochondrial sequence data lend support to our hypothesis that the geographic distributions of *H. cardini*, *H. convexinotatus*, and/or *H. tenuis* are overlapping in the Caribbean, not almost mutually exclusive as proposed by Szalanski et al. (2004). Our subsequent analyses of a nuclear locus, the internal transcribed spacer (ITS) array, has provided further insights into Puerto Rican *Heterotermes* species diversity (Jones and Eaton, in prep.).

SUBMITTED PAPERS: ADDITIONAL TOPICS

Direct Treatment and Residual Efficacy of Fendona™ CS Insecticide on Striped Bark Scorpions, *Centruroides vittatus* (Say)

ROBERT DAVIS and Matthew Lee
BASF Professional and Specialty Solutions and Entomology Consultants, LLC.

Abstract

Scorpions are serious seasonal pests of the Southwestern United States. PMP's can struggle offering services that provide adequate control. The topical and residual surface treatment efficacy of Fendona™ CS Insecticide on Striped Bark Scorpions was evaluated. Topical treatments of Fendona (0.05%), TalstarOne® Multi-insecticide (0.06%) and Demand® CS Insecticide (0.06%) provided 100% knockdown at 30 minutes after treatment (MAT). However, at 1 hour after treatment (HAT) Fendona provided for 70% mortality vs. Demand CS & Talstar (0% mortality each). At 4 HAT, Fendona caused 80% mortality vs. 40% dead for Demand CS and 0% for Talstar. Fendona CS and Demand CS provided for 100% mortality at 24 HAT (Talstar-70%). All treatments provided 100% mortality at 72 HAT. Residual treatments (4 hour exposure) were evaluated on vinyl, concrete, wood and sand surfaces at 0, 14, 30, 50 & 90 DAT. In general, efficacy was greater in vinyl > concrete > wood > sand. Fendona CS & Demand CS exhibited 100% while Talstar exhibited 80% mortality at 0 DAT-24 hours after exposure (HAE) to treated vinyl surfaces. Fendona CS, Demand CS and Talstar (24 HAE) provided 100%, 100% & 70% at 14 DAT, 100%, 100%, & 60% at 30 DAT, 50%, 60%, & 0% at 60 DAT, and 50%, 40% & 20% at 90 DAT respectively, Similar data on other substrates will be presented. This efficacy data supports use of Fendona CS for topical and residual control of scorpions.

Novel Strategies to Explore Insect Attractants and Repellents

EDUARDO HATANO, Ayako Wada-Katsumata, Ahmed M. Saveer and Coby Schal
North Carolina State University

Abstract

Semiochemicals are compounds that mediate communication between organisms and can be implemented as attractants or repellents in pest control. In order to evaluate the potential application of a semiochemicals for pest management, we must address how susceptible these compounds are to reactions with environmental factors (e.g., pollution). While some environmental factors may be detrimental to insect chemical communication, some species may actually be adapted to benefit from them as agents

that activate semiochemicals. We are exploring the role of environmental abiotic factors in the activation of attractive cues for insects. Cuticular hydrocarbons (CHC) are known to provide protection against desiccation and microbes, and are essential for nestmate recognition in social insects. We tested the hypothesis that CHC serve an additional role: they are precursors of insect volatile pheromones that are activated by environmental factors (i.e., oxidants), serving as long-range attractants. For this purpose, we are using several insect species as models including the American cockroach, *Periplaneta americana*. Our results show that multiple decomposed compounds become airborne and are perceived by the insect antennae. Behavioral tests in arenas revealed that these compounds excite insects compared to undecomposed CHC. These results demonstrate the substantial role of decomposed metabolites as attractants or repellents, and sets a new pool of semiochemicals never before exploited for pest control applications.

Hands-On Training Facilities for Pest Management Professionals in Texas

Michael E. Merchant[1] and Robert Puckett[2]
[1]Texas A&M AgriLife Extension Service, Dallas, TX and [2]College Station, TX

Abstract

This year Texas A&M AgriLife celebrated its 72nd Annual Pest Control Conference and Workshop for pest management professionals (PMPs). As one of the largest pest control training conferences in Texas, the College Station-based event provided continuing education units (CEUs) for 345 attendees from 57 Texas counties. As is typical for most CEU courses in Texas, training at the event consists mostly of lecture-format, with speakers addressing large groups of attendees.

The Texas A&M Conference and Workshop is one of dozens of invitational CEU workshops offered each year in Texas by Texas A&M AgriLife Extension faculty, pesticide distributors, state and national associations, and other providers. Nearly all these courses follow the same format and pedagogy: namely an expert lecturing on a topic (usually with PowerPoint slides) and students passively receiving knowledge with only a brief opportunity to ask questions or interact with the instructor.

But is this the best way to teach PMPs new concepts, reinforce proper pest management practice and ingrain pesticide safety skills? Probably not, according to current theories of adult learning, known as andragogy (Knowles et al, 2012). Adults have different learning styles than children, including the following major differences:

- More independent, favoring self-directed learning
- Able to draw on a reservoir of experiences for learning
- Readiness to learn is more oriented to current roles and responsibilities
- Most interested in learning subjects with immediate relevance to their job or life

- Motivation to learn is more internal

Some of the goals of our combination of lecture and hands-on programming includes
- allowing participants more freedom to tailor their own learning experiences (selecting what hands-on activities to participate in, choosing their roles on teams, etc.)
- Providing a safe environment for trial and experimentation (including the freedom to fail)
- Keeping training topics relevant to the typical PMP
- Focus training activities on problem solving

Fifteen years ago, the Philip J. Hamman Termite Control Training School, located in College Station, TX, was founded to provide an alternative learning experience for termite control technicians. The school is offered on demand (usually twice a year) to termite technicians wanting a more in-depth background in termite management. The school is a comprehensive 3-day workshop designed to expose technicians to modern termite treatment tools and techniques. Instructors from the course come from the Texas A&M Urban and Structural Entomology Center, Texas A&M University AgriLife Extension, the Texas Department of Agriculture, and from industry suppliers.

Topics of the course include termite identification, Wood Destroying Insect inspections, termite IPM, pesticide safety, construction design, and laws and regulations. The school takes place in a seminar room at the Rollins Urban and Structural Entomology Center on the Texas A&M campus in College Station, and at a ¼ acre site located at the Texas A&M RELLIS campus in Bryan, TX. The RELLIS location consists of a shade pavilion and approximately 20 stations built to resemble different construction features likely to be encountered by termite technicians. After classroom instruction, students tour the features and have opportunities to discuss the best way to treat each feature. Students also practice proper termiticide application techniques to include horizontal and vertical concrete drilling, trenching, rodding, and foaming wall voids.

Classes are typically evaluated with the use of pre- and post-tests. Test questions are of moderate-high difficulty and consist of T/F, multiple choice and fill-in-the-blank questions. The most recent pre- post-test results are typical of the workshop and demonstrated ~120% increase in post-test scores. The class has been offered 10 times in the past five years, averaging 16.9 attendees.

The IPM Experience House is a converted dormitory located on the Texas A&M AgriLife Research and Extension Center in Dallas, TX. The structure is approximately 2,000 sq ft and has been remodeled to simulate different indoor locations PMPs might encounter as part of their work. Rooms in the IPM Experience House include a lab bench with microscopes, and mock-ups of a residential kitchen and living room, restaurant, commercial kitchen and dishwash area, and hospital room. Termite and rodent classes make use of the outside of the building and the partially floored attic.

Principles we follow at the IPM Experience House include handle, engage, partner, solve and test. Regarding hands-on skill development, we follow a progression of telling, showing, and then having students perform the skill. We get students engaged by having them fill out worksheets for all lab exercises. We work in teams, with partners. We give students problems to solve in order to engage higher order learning. And we test their skills in a post test. As we continue to develop new curricula, we attempt to incorporate these principles in every new class. Examples of activities that implement these ideals include:

- Provide keys to termite genera and have students make observations and attempt identification of drywood termites, carpenter ants, Formosan termites and eastern subterranean termites.
- Draw and label a diagram of IPM Experience House to estimate number of gallons of termiticide needed for job. Must make decisions about whether to include sidewalks and where drilling is necessary.
- Observe and practice installation of underground and above ground termite bait stations. Practice use of auger for installing stations.
- Make observations and answer questions about safety and establishing a termiticide trench. Calibrate sprayer and practice making foam application to mock wall void.

The IPM Experience House has been hosting classes since 2017 and curricula are still under development. So far, class titles and numbers of classes held at the facility include:

- Introduction to termite control for technicians (3)
- Honey bee control and removal (1)
- Mosquito control for PMPs (2)
- Rodent Academy (2)
- General Household Pests (1)
- Prep class for Associate Certified Entomologists (1)

As of August 2018, 206 students have participated in classes held at the house. Class evaluations have been very positive. When comparing overall satisfaction ratings from students attending 2017 hands-on IPM Experience House classes vs. traditional style lecture courses held at the Dallas Center (2014-2017), satisfaction ratings were significantly higher for hands-on classes ($t=3.73$, $d.f.=10$, $P>0.0039$).

Each IPM Experience House class is evaluated using a retrospective-post evaluation form. Forms are given to participants upon completion of the class, and they are asked to score their knowledge on selected topics before and after taking the class. In two termite control classes held in 2017, students reported increases in knowledge ranging from 26-97% (Figure 1). Greatest gains in understanding were in termite identification and biology, followed by understanding of how to estimate the cost of a termite job.

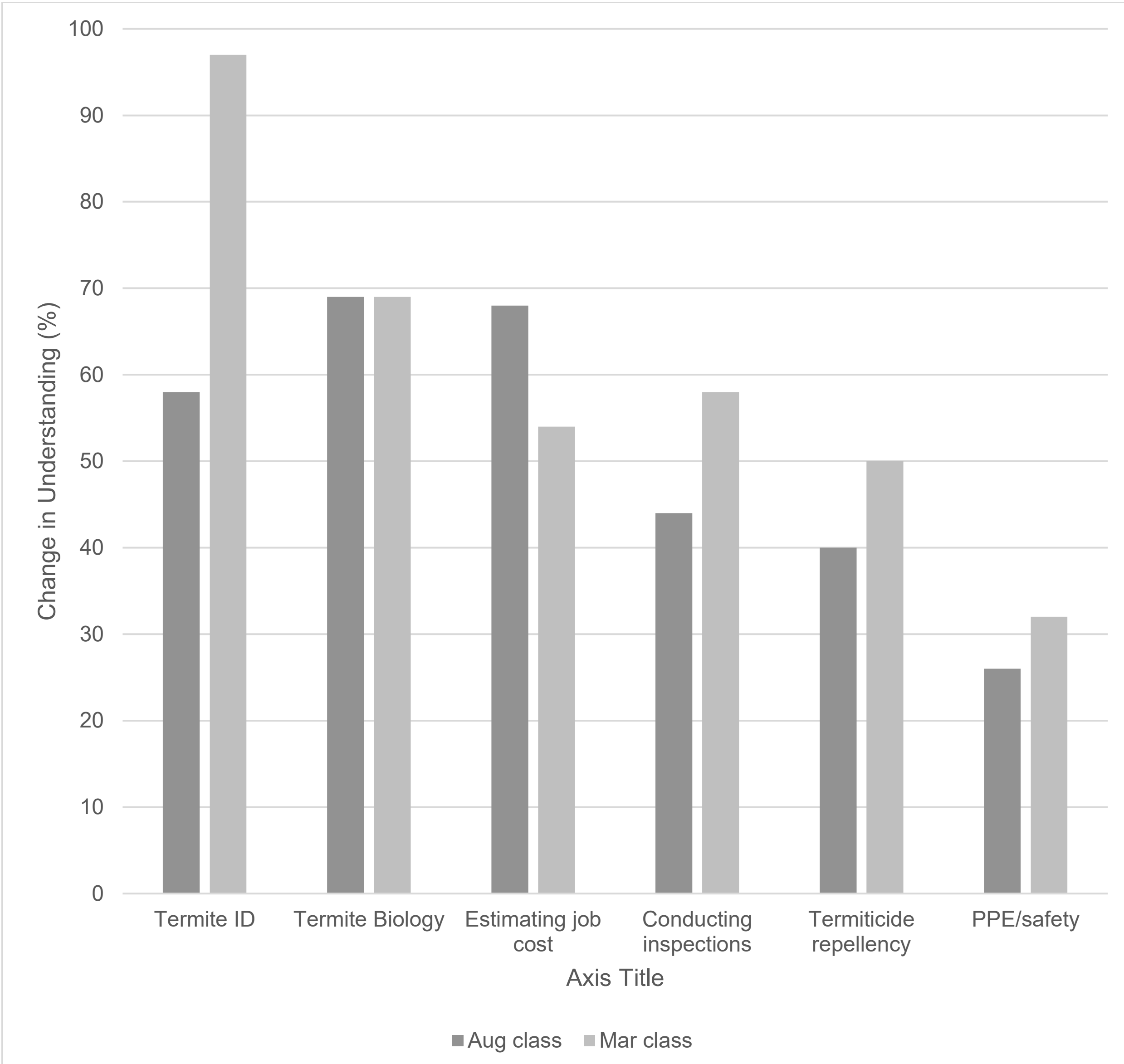

Figure 1. Self-reported change in understanding of key termite control concepts following IPM Experience House training. Termite Control for Technician Trainings (March and August, 2017), IPM Experience House, Texas A&M AgriLife Research and Extension Center at Dallas.

Conclusions

Hands-on training courses provide a valuable supplement to training options for PMPs. The Philip J. Hamman Termite Training School has successfully attracted students for over 15 years, and the IPM Experience House is getting high scores from students attending classes there. Smaller class sizes, greater opportunity to interact with instructors, and in-depth training content undoubtedly contribute to the success of these courses; however, the opportunity to problem solve, see pests in the field, handle and manipulate tools such as application equipment and microscopes, is likely also an important factor. We plan to continue making hands-on training opportunities an essential part of Texas A&M AgriLife Extension outreach to PMPs in Texas.

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The Synergy of Adulticides with IGRs Against Cat Fleas

Michael K. Rust[1] and W.L.H. Hemsarth[2]
[1]University of California Riverside and [2]Hartz Mountain Inc.

Introduction

With the registration of fipronil and imidacloprid as spot on-applications on pets to control cat fleas, *Ctenocephalides felis felis* (Bouché), in the mid 1990's, there was a paradigm shift in the management of fleas (Rust 2005, Rust 2017). Control strategies shifted from environmental treatments by pet owners and pest management professionals (PMPs) to on-animal treatments with an emphasis of active ingredients that could interrupt the life cycle of the cat flea. In the past 2 decades, the use of combination products with several active ingredients have been become an important component of IPM strategies against cat fleas. For example, the insect growth regulators (IGRs) methoprene and pyriproxyfen have been incorporated with adulticides such as fipronil and imidacloprid. The potential advantages of such combinations include a broader spectrum of active against immature stages of cat fleas, faster reductions of cat flea infestations (Blagburn 2002), and possibly delaying the development of insecticidal resistance (Blagburn and Dryden 2009). A clinical field trial by Young et al. (2004) suggested that methoprene may have synergized the activity of fipronil against immature stages of cat fleas. Numerous other clinical trials have reported the successful control of fleas with these combination products (Rust 2017). However, there is very little data concerning the interaction of the insecticide combinations and whether they are synergistic, additive, or antagonistic.

The objective of this study was to determine if methoprene or pyriproxyfen altered the biological activity of the topical adulticides fipronil or imidacloprid. The testing of serial dilutions of each of the insecticides and their combinations at constant ratios provides a methodology to determine if they are synergistic, additive or antagonistic. This methodology is also applicable to other new active ingredients and combination products being used to control cat fleas.

Materials and Methods

Insects. A laboratory strain of *C. f. felis* (UCR) was maintained on five cats. Cat flea eggs and debris were collected from a tray underneath the cat and passed through metal sieves, the eggs being retained on the 60-mesh screen. The eggs were placed on larval rearing media consisting of 2950 g 30-mesh play sand, 375 g finely ground dog chow, 75 g hemoglobin freeze-dried (MP Biomedicals. LLC, Solon, OH), and 50 g Brewer's yeast. The larvae were held in a desiccator chamber maintained at 75% RH (saturated NaCl solution, Winston and Bates 1960) and 26.7º ± 1º C. The larvae spun cocoons in 10-12 days and the larval medium was passed through a 16-mesh sieve to remove the cocoons. Adults typically emerged 16-18 days after the egg collection. Approximately 20 adult females and 20 adult males were placed on cats every 2 weeks. The maintenance of the cats and rearing of cat fleas was conducted under protocols approved by the Institutional Animal Care and Use Committee of the University of California, Riverside.

Cat flea eggs were placed in glass petri dishes (9 cm diam) with 5 cc of larval rearing media and maintained at 75% RH and 26.7º ± 1º C. Larvae were selected from the media for testing 4-5 days after egg collection with a fine paint brush lightly moistened with water.

Insecticides. Technical fipronil (98.6%, Pestanal® D-30918, Sigma-Adlrich, Seetze, Germany), imidacloprid (99.9%, Pestanal® 37894 , Sigma-Aldrich, Seetze, Germany), methoprene (99.2%, Chem Service, West Chester, PA), and technical pyriproxyfen (99.3%, Chem Service, West Chester, PA) were used to prepare the serial dilutions in acetone because it does not adversely affect the larval rearing media (Rust et al. 2002). Methoprene, pyriproxyfen, imidacloprid, and fipronil and their various combinations were initially prepared at 100 ppm and then serially diluted.

Larval Medium Studies. The larval treatments were modified from Rust et al. (2002). Aliquots of 0.2 ml of each test solution were applied to 2 g of larval rearing medium in plastic vials (76 by 20 mm diam, Sarstedt, Newton, NC) and allowed to dry for at least 2 hours under a fume hood. The treated larval medium was transferred from the plastic vial to a glass petri dish (5 cm diam by 1.7 cm) that contained 10 larvae. A strip of parafilm (ca. 1 cm by 3 cm) was stretched around about 2/3 of the dish to help secure the lid and prevent adult fleas from escaping. The dishes were then placed into a desiccator maintained at 75% RH held at 26.7º ± 1º C. After 21 days, the dishes were placed in the freezer for 2 hours and the number of adult fleas was counted.

Statistical Analyses. The adult development data for each insecticide and combination were analyzed by probit analysis with POLO program (Robertson and Preisler 1992). To determine the effects of the combination treatments the data were analyzed with the Chou-Talalay Method (Chou and Talalay 1984; Chou 2006, 2010). Advantages of this method are 1) it provides a diagnostic median-effect plot, 2) this plot provides parameters that can be used to obtain a general equation for dose-effect relations, 3) the analysis which involves logarithmic conversions and linear regression is readily carried out by a computer, and 4) its simplicity allows for the minimal number of data points (Chou and Talalay 1984). The Combination Index (CI) provides a quantitative value and a basis for determining if combinations are synergistic, additive or antagonistic for each dose. Chou (2006) categorized CI values as follows: <0.1- very strong synergism, 0.1-0.3 – strong synergism, 0.3-0.7 – synergism, 0.7-0.85 – moderate synergism, 0.85-0.90 – slight synergism, 0.9-1.10 – nearly additive, 1.10-1.12 – slight antagonism, 1.20 -1.45 – moderate antagonism, 1.45 - 3.3 antagonism, 3.3 -10 – strong antagonism, >10 very strong antagonism. The Dose Response Index (DRI) measures the potential reduction of the dose of each IGR in the combination compared with the IGR alone. A DRI > 1 does not necessarily indicate synergism, but indicates a greater dose reduction for a given effect (Chou 2006). This is extremely useful information, especially if there is concern about the toxicity of the treatment to the host.

Results

Combinations of imidacloprid:methoprene provided consistently lower LC_{50}'s than did imidacloprid alone (Table 1). The range of responses to imidacloprid and the combination with methoprene was narrow and the slopes of the lines ranged from 2.26 to 5.25. The CI's indicated that the combinations provided synergism to slight synergism across all effective doses (Table 2). Even combinations of imidacloprid 40: methoprene 1 provided synergy.

When imidacloprid is combined with methoprene, the doses of both compounds can be reduced and still remain as active as the imidacloprid alone. For example, the Dose-Reduction index (DRI) for the 1:1 combination indicates that the concentration of imidacloprid can be reduced by 4.07 and the methoprene by 1.81 (Table 3). Combinations of imidacloprid and pyriproxyfen provided lower LC_{50}'s than did the imidacloprid alone (Table 4). The CI's ranged from 0.49 (synergism) to 0.93 (nearly additive) across the spectrum of combinations tested (Table 5). The combination of imidacloprid 20: pyriproxyfen 1 showed synergism across the effective doses tested. The combination of fipronil 1: methoprene 1 provided significantly lower LC_{50}s than fipronil alone, whereas the other combinations were similar (Table 6). As a result, the CIs ranged from 0.46 to 1.66 (Table 7).

The studies with firponil and pyriproxyfen are ongoing.

Neither imidacloprid or fipronil synergized either of the IGRs. In fact they were typically very antagonistic at most of the ED tested.

Treatment	N	Slope	LC_{50} (95% CI)	LC_{95} (95% CI)
Im 40: Me 1	630	5.25 ± 0.69	0.50 (0.368-0.586)	1.03 (0.861-1.520)
Im 20: Me 1	950	3.68 ± 0.34	0.58 (0.469-0.669)	1.62 (1.368-2.131)
Im 10: Me 1	1010	4.10 ± 0.43	0.57 (0.464-0.648)	1.43 (1.235-1.818)
Im 5: Me 1	950	2.26 ± 0.16	0.30 (0.222-0.378)	1.61 (1.215-2.429)
Im 1: Me 1	650	3.26 ± 0.60	0.26 (0.110-0.339)	0.81 (0.624-1.718)
Imidacloprid	890	2.84 ± 0.21	0.74 (0.620-0.845)	2.79 (2.296-3.671)
Methoprene	1000	3.32 ± 0.24	0.36 (0.307-0.410)	1.13 (0.949-1.438)

Table 1. Activity of media treated with imidacloprid (Im), methoprene (Me), and their combination against larval cat fleas. Both expressed in ppm.[a]

Combination	ED_{50}	ED_{75}	ED_{90}	ED_{95}
Im 40: Me 1	0.43	0.53	0.66	0.77
Im 20: Me 1	0.66	0.73	0.82	0.88
Im 10: Me 1	0.59	0.69	0.82	0.92
Im 5: Me 1	0.59	0.62	0.65	0.67
Im 1: Me 1	0.52	0.61	0.72	0.79

Table 2. The Combination Index (CI) at each Effective Dose (ED) for the combinations of imidacloprid (Im) and methoprene (Me).

Combination	ED_{50}		ED_{75}		ED_{90}		ED_{95}	
	Im	Me	Im	Me	Im	Me	Im	Me
Im 40: Me 1	2.48	39.11	1.99	32.83	1.60	27.55	1.38	24.46
Im 20: Me 1	1.69	14.92	1.52	13.06	1.36	11.42	1.67	9.77
Im 10: Me 1	2.13	8.54	1.79	7.44	1.50	6.48	1.33	5.89
Im 5: Me 1	2.55	5.12	2.39	4.97	2.24	4.83	2.07	4.67
Im 1: Me 1	6.76	2.67	5.60	2.31	4.63	2.00	4.07	1.81

Table 3. The Dose-reduction Index (DRI) at each Effective Dose (ED) for the combinations of imidacloprid (Im) and methoprene (Me).

Treatment	N	Slope	LD_{50} (95% CI)	LD_{95} (95% CI)
Im 40: Py 1	600	4.51 ± 0.51	0.56 (0.427-0.661)	1.30 (1.048-2.003)
Im 20: Py 1	720	2.26 ± 0.22	0.40 (0.295-0.506)	2.13 (1.421-4.559)
Im 10: Py 1	1210	4.15 ± 0.30	0.49 (0.414-0.558)	1.22 (1.080-1.453)
Im 5: Py 1	800	4.21 ± 0.42	0.37 (0.310-0.423)	0.91 (0.784-1.155)
Im 1: Py 1	760	2.21 ± 0.23	0.19 (0.133-0.236)	1.04 (0.791-1.578)
Imidacloprid	890	2.84± 0.21	0.74 (0.620-0.845)	2.79 (2.296-3.671)
Pyriproxyfen	1040	2.29 ± 0.24	0.28 (0.192-0.357)	1.46 (1.112-2.326)

Table 4. Activity of imidacloprid, pyriproxyfen and the combination of imidacloprid (Im) and pyriproxyfen (Py) expressed in ppm.

Combination	ED_{50}	ED_{75}	ED_{90}	ED_{95}
Im 40: Py 1	0.60	0.67	0.75	0.82

Im 20: Py 1	0.49	0.53	0.59	0.65
Im 10: Py 1	0.65	0.59	0.57	0.56
Im 5: Py 1	0.85	0.66	0.54	0.49
Im 1: Py 1	0.93	0.78	0.67	0.63

Table 5. The Combination Index (CI) at each Effective Dose (ED) for the combinations of imidacloprid (Im) and pyriproxyfen (Py).

Treatment	N	Slope	LD_{50} (95% CI)	LD_{95} (95% CI)
Fp 20: Me 1	930	4.69 ± 0.31	1.14 (1.058-1.216)	2.56 (2.297-2.940)
Fp 10: Me 1	930	4.04 ± 0.33	0.89 (0.785-0.974)	2.27 (1.998-2.707)
Fp 5: Me 1	830	5.40 ± 0.44	0.90 (0.808-0.979)	1.82 (1.628-2.119)
Fp 1: Me 1	710	2.40 ± 0.19	0.35 (0.277-0.420)	1.69 (1.321-2.423)
Fipronil	1340	2.99 ± 0.23	1.23 (1.021-1.411)	4.36 (3.640-5.628)
Methoprene	1000	3.32 ± 0.24	0.36 (0.307-0.410)	1.13 (0.9498-1.438)

Table 6. Activity of media treated with fipronil (Fp), methoprene (Me), and their combination against larval cat fleas. Both expressed in ppm.[a]

Combination	ED_{50}	ED_{75}	ED_{90}	ED_{95}
Fp 20: Me 1	1.63	1.18	0.86	0.71
Fp 10: Me 1	1.39	1.04	0.77	0.64
Fp 5: Me 1	1.43	1.16	0.96	0.84
Fp 1: Me 1	1.47	1.54	1.61	1.66

Table 7. The Combination Index (CI) at each Effective Dose (ED) for the combinations of fipronil (Fp) and methoprene (Me).

Discussion

Our research clearly shows that the activity of imidacloprid against larval cat fleas was synergized by the IGRs methoprene and pyriproxyfen. The DRI suggest that the concentration of both the imidacloprid and the IGRs in the preparation could be reduced and still be as active as the imidacloprid alone. One product in the marketplace (Advantage II contains 9.1% imidacloprid + 0.46% pyriproxyfen, ca. 20:1 ratio, Bayer HealthCare, Shawnee Mission, KS) would have synergistic activity against cat flea larvae. However, another product also contains permethrin (K9 Advantix II, contains 9.1% imidacloprid, 0.46% pyriproxyfen, 44% permethrin, Bayer HealthCare, Shawnee Mission, KS) and it is uncertain how the three compounds might interact. This certainly warrants additional investigation.

The combination of fipronil with methoprene or pyriproxyfen was not as synergistic as those combinations with imidacloprid. At some effective dosages the combinations were actually antagonistic. One product (Frontline Plus) contains 9.8% fipronil and 1.8% methoprene and this combination would be slightly antagonistic against immature stages of the fleas.

Numerous clinical field trials have shown the fipronil and combination products provide significant reductions of adult fleas on the pet and in the environment (Rust 2017). In recent years there has been concern that the effectiveness of certain products has been declining. Less than optimal formulations against the immature stages of fleas may in part explain this decline. This is certainly something that warrants additional research. Combinations of certain insecticides can result in synergistic activity against immature stages of fleas as was shown with imidacloprid and methoprene or pyriproxyfen. Since the nature of these synergies are largely unknown there is no way to anticipate how different insecticides might interact. Each of the active ingredients and their combinations must be systematically tested. One of the positive outcomes of such tests is that the activity of the combinations can be optimized in the laboratory prior to expensive field testing. In addition, the combinations may result in reduced amounts of insecticides being applied and providing maximum effect and extending their residual activity.

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Need Resources – We've Got 'Em

JANET HURLEY
TEXAS A&M AGRILIFE EXTENSION

Abstract

Ever been asked to give a presentation on a topic you are somewhat familiar with but don't know where to start? How about handing out a fact sheet at an event or after meeting with a client? Need to brush up on your IPM or pest knowledge? If you answered yes, then come to this session to learn where you can find all of these resources, what websites to bookmark, and what you can use without obtaining a ton of permissions. Also learn what you should and should not do with public materials. Even where you might want to post your images so others can use.

The Lesser Mealworm, Darkling Beetle RNA Sequencing and RNA Interference

Jingjing Xu, Sharath Chadra, Subba Reddy Palli and Dangsheng Liang
Apex Bait Technologies, Inc. and University of Kentucky

Abstract

The lesser mealworm beetle (*Alphitobius diaperinus*:Tenebrionidae: LMB) is a serious insect pest in poultry production facilities. Heavy and prolonged use of insecticides for LMB control has resulted in high levels of resistance. To understand the mechanism of insecticide resistance, we performed sequencing of RNA isolated from different developmental stages of LMB. The sequences were assembled and annotated. The Blast2GO was used to predict the functions of assembled transcripts and to assign Gene Ontology terms. We identified 4880 common genes across all the developmental stages of LMB. There are also 57, 46, 442, 40 and 412 specific transcripts detected in the egg, larvae, pupa, female and male adult stages respectively. To test whether RNA interference works in the LMB, We synthesized double-strand RNA (dsRNA) targeting genes coding for, Actin, Dynamin, Cactus, α-soluble NSF attachment protein, IAP, and GAWKY. Injection of these dsRNAs into the third instar larvae caused 90, 70, 50, 30, 60 and 20 percent mortality respectively. These data suggest that RNA interference works in the LMB.

SYMPOSIUM: MILLENIAL COCKROACH MANAGEMENT

Nutrients as Deterrents in Cockroach Baits

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Abstract

In response to strong selection with insecticidal baits containing sugars as a phagostimulants, populations of the German cockroach have rapidly evolved a novel behavior, aversion of sugars, which is highly adaptive because cockroaches avoid eating toxic baits. Glucose-aversion is a heritable trait and we previously demonstrated that while the sweet-responding gustatory receptor neurons (GRNs) in the mouthparts of wild-type (WT) and glucose-averse (GA) cockroaches process glucose as a phagostimulant, bitter-responding GRNs in GA cockroaches acquired a new function – they detect glucose as a bitter compound. Sugar aversion affects not only food choice but also other behaviors that involve the gustatory system. During courtship, the female mounts the male and evaluates his quality by tasting a nuptial secretion that he offers on his tergum; the secretion contains sugars. GA, fructose-averse and glucose-fructose-averse females spent significantly less time in nuptial feeding than WT females, resulting in frequent failure to copulate. Sugar-averse females also tended to mate later than WT females. Although there were no significant differences in fecundity of sugar-averse and WT females, their lower mating success and delayed mating resulted in slower population growth of sugar-averse cockroaches. We conclude that under natural selection adaptive evolutionary changes in the peripheral gustatory system can profoundly affect traits that are under sexual selection, resulting in changes in sexual communication, mate choice and population dynamics.

Insecticide Application Strategies for Cockroach Management: Not A Simple Subject

Robert Puckett
TEXAS A&M AGRILIFE EXTENSION SERVICE

Abstract

There are a multitude of products and strategies available to pest management professionals for the management of German cockroach (*Blattella germanica*) infestations in home and commercial accounts. The application of insecticidal baits and residually active contact insecticides are widely used. However, there exists a fundamental dogma among PMPs that baits are never to be used in conjunction with

the application of residual insecticides. This presentation will address the results of a laboratory trial in which German cockroaches were offered cockroach baits that had been ‘oversprayed’ with two residual insecticides that are commonly used for management of these insects.

Stubby, Precocious and Sterile? Overcoming IGR Inhibition in Pest Control Technicians

Dr. Tim Husen, BCE
Rollins Inc.

Abstract

Cockroaches are a constant nemesis for the pest control industry. Currently, cockroach baits are the prominent control product, replacing the more historically used insect growth regulator (IGR), ULV fogging, and liquid residual insecticide based approaches. This presentation focuses on the understanding of how IGRs work and the reasons for their use (or lack thereof) by today’s pest management technician, and potential methods to improve each area.

SYMPOSIUM: REAL-WORLD APPLICATIONS OF MOLECULAR RESEARCH IN URBAN ENTOMOLOGY

Use of a Biodegradable Hydrogel to Deliver Aqueous Bait to Control Argentine Ants (Hymenoptera: Formicidae) in Residential Settings

Jia-Wei Tay[1], Mark Hoddle[1], Ashok Mulchandani[2], and Dong-Hwan Choe[1]
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Abstract

Insecticide sprays used for ant control generally cause environmental contamination. Liquid bait is effective, but requires bait stations to dispense the toxicant. In this study, we develop a natural alginate hydrogel to deliver liquid bait, without the use of bait stations. Hydrogel beads conditioned in a sucrose solution with 0.0001% thiamethoxam provided complete control of all castes of Argentine ant *Linepithema humile* (Mayr) colonies, by 5 days post-treatment in the laboratory trial, and provided a 79% reduction in ant activity after 8 weeks in the field trial. This work demonstrates the potential of alginate hydrogel as an effective tool to deliver liquid bait in controlling Argentine ants. Practical implications and possible future development of the technology will be discussed.

RNAi-Mediated Knockdown of vATPase Subunits Affects Survival and Reproduction of Bed Bugs (Hemiptera: Cimicidae)

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Abstract

The common bed bug, *Cimex lectularius* L. (Hemiptera: Cimicidae) has resurged as one of the most troublesome household pests affecting people across the globe. Bed bug infestations have increased in recent years primarily due to the evolution of insecticide resistance and the insect's ability to hitchhike with travelers. *vATPases* are one of the most evolutionarily conserved holoenzymes in eukaryotes, which are mainly involved in proton transport across the plasma membranes and intracellular organelles. RNA interference (RNAi) has been developed as a promising tool for insect control. In this study, we used RNAi as an approach to knock down subunits A and E of the *vATPase* gene of bed bugs. Delivery of 0.2 µg/insect of dsRNA specific to *vATPase-A* and

vATPase-E into female bed bugs dramatically impaired the laying and viability of eggs over time. Injection of the *vATPase-E* dsRNA decreased survival of the bed bugs over 30 d. Our results also showed that the knockdown of mRNA is highly effective and persistent up to 30 d post injection. This research demonstrated that silencing of the two *vATPase* subunits A and E offers a potential strategy to suppress bed bug populations.

Management of Insecticide Resistance in German Cockroaches (*Blattella germanica* (L.))

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Abstract

Due to insecticide resistance, control failures are frequently encountered in German cockroach (*Blattella germanica* (L.)) field populations. As a first step in our study, cockroaches were collected from low-income multifamily housing complexes in Danville, IL (D-IL) and Indianapolis, IN (I-IN). Mortality data for field-collected cockroach strains to 14 active ingredients (AIs) was generated using vial bioassays. Susceptibility profiles were determined by comparing percent mortalities between the field strains relative to the susceptible lab strain, JWax-S. Boric acid (gel bait), abamectin (gel bait) and thiamethoxam (spray product mixed with lambda cyhalothrin) were the most effective and selected for use in field studies. These field studies specifically investigated impacts of different insecticide deployment strategies (rotation between chemicals, single bait, and spray mixture product) on resistance evolution in cockroach field populations. Next, changes in insecticide susceptibility profiles of field-collected strains exposed to different insecticide deployment regimes in the field for 6 months were investigated. Our field results revealed that all treatments selected for increased resistance to AIs that were used except rotation/boric acid in I-IN and rotation/boric acid and thiamethoxam in D-IL. Thiamethoxam and lambda cyhalothrin selected for strong cross-resistance to abamectin, which has not been reported previously. Due to resistance and cross resistance among AIs, the rotation treatment failed to control cockroach populations. However, rotation is still a viable recommendation for resistance management in cockroaches but it depends on AIs and their potential cross-resistance. We additionally found high initial resistance to all pyrethroids at both sites, and also that mixture products containing pyrethroids + neonicotinoids were ineffective due to apparent cross-resistance between these AIs. Overall, these results provide important new information regarding resistance management in this globally-significant pest.

SUBMITTED PAPERS: TERMITES

Soil Termiticide Barriers Work as Oral Toxins

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Abstract

Soil termiticide barriers have been a mainstay of subterranean termite management for over 60 years. Termites display differential route of entry Lethal Dose (LD) profiles with some active ingredients being more toxic by the oral v dermal routes while others display the opposite (Forschler 2009). A major assumption associated with measuring termiticide efficacy is that the dermal route of entry prevails in protecting structures from termite colonies. The LD_{50}'s for dermal exposure to termiticides are below concentrations obtained at label application rates (Forschler 2009). However, termites exposed for 1-minute to treated soil (more than twice the time a walking termite takes to traverse 15-cm) provide Lethal Concentration (LC_{50}) values higher than attainable by most products at label rates (Forschler 2009). Consequently, questions arise about how soil termiticide barriers impact termite colony behavior in the field (Su 2005, Saran and Rust 2007). A soil treatment should disrupt the colony gallery system and those galleries have to be repaired or replaced to initiate or maintain an infestation. The small proportion of termites in a colony that excavate new galleries use their mouthparts and intuitively those individuals would be subjected to an oral dose (Whitman and Forschler 2007, Li and Su 2009, Bardunias et al. 2010, Cornelius 20012). It is therefore likely that through the act of gallery repair/replacement excavators obtain a lethal oral dose. The death of excavating (foraging) termites means galleries would not re-connect which, in turn, would re-direct colony foraging activity, resulting in structural protection.

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Termidor® HPII: Treat Today Like Tomorrow

FREDER MEDINA, Robert Hickman, Robert Davis, Jason Meyers, Kyle Jordan, Barry Furman and Joe Schuh
BASF CORPORATION

Abstract

Innovation plays an important role at BASF and it provides Pest Management Professionals (PMPs) with the most advance termite treatment products and tools. Since Termidor® first US registration in 2000 until today, more than six million homes have been successfully treated with our product. However, the efficacy of current control methods relies on a methodology that involves proper mixing of the product, digging trenches, drilling abutting hard surfaces, and rodding to depth to establish continuous treatment zones. Therefore, it is critical to make uniform and precise applications around the foundation of the structure, requiring PMPs to spend lots of time and money. With our latest innovations, Termidor® HPII High Precision Termiticide and Termidor® HPII High Precision Injection System, PMPs can apply the product with unrivaled accuracy, precision, minimum disruption to landscape, less water consumption, and most importantly with up to 90%-time savings. Once again, field studies have demonstrated the considerable time savings of Termidor® HPII while maintaining its efficacy against the most destructive termite species in the U.S.

Colony-Level Effects of Liquid Termiticides and Baits on Subterranean Termites

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Abstract

This study addresses the impact of the two primary control methods for subterranean termites on whole *Coptotermes* colonies (Blattodea, Isoptera: Rhinotermitidae). Baits and liquid termiticides have two distinct modes of action on subterranean termites and because of the extended nest structure of colonies from the *Coptotermes* genus, the impact of such treatments on whole colonies may differ. Owing to the difficulty of monitoring whole subterranean termite colonies in the field, incipient *C. gestroi* colonies where established in the laboratory, until they reached ≈60,000 individuals after four years of colony growth. These colonies where established in a complex system of galleries using tubing and planar arenas so as to simulate their field foraging and feeding behaviors. Some of these feeding sites represented a wood structure, 15 m away from the termite colony central nests. Either Chitin Synthesis Inhibitor baits were implemented around the structure, or liquid termiticides perimeter treatment was applied. After 90 days, all colonies exposed to baits were eliminated and damage to the wood structure ceased. Colonies exposed to liquid termiticides survived, as they avoided the treated area resulting from secondary repellency. Long term consequences of each treatment on termite colonies and their potential damage will be discussed.

Building Out Bugs: How the Use of New Building Materials Leads to Sustainable Pest Control

CASSIE S. KREJCI and Roger E. Gold
POLYGUARD BARRIER SYSTEMS and Texas A&M University

Abstract

Current building standards require the use of materials that keep air and moisture out of structures. Recent improvements on these building materials and their installation have made it possible to add termite and pest exclusion to the building envelope as well. Physical barriers are not a new concept, but recent advances in the use of building materials to effectively exclude pests have made it possible to add new dimensions to integrated pest management strategies. Aggregate barrier systems have applications on the exterior of structures and in slab leave-outs as termite barriers. Improved sealants, membranes, and wire meshes can be used as effective barriers to invading insect populations at the soil, concrete slab, veneer interfaces, as well as soffit and roof areas. Advances in the development and installation of elastomeric membranes will provide opportunities for pest management professionals to effectively solve problems with cracked slabs and other post-construction abnormalities, which in the past have resulted in the incursion of pest populations. Implementation of non-pesticide termite and pest barriers can give pest control professionals new opportunities for service, while complementing their IPM protocol.

Identification of a Queen and King Recognition Pheromone in the Subterranean Termite, *Reticulitermes flavipes*

COLIN FUNARO, Katalin Böröczky, Edward L. Vargo and Coby Schal
North Carolina State University, Pennsylvania State University and Texas A&M University

Abstract

Royal recognition is a central feature of insect societies, allowing them to maintain the reproductive division of labor and regulate colony demography. Queen recognition has been broadly demonstrated and queen recognition pheromones have been identified in social hymenopterans, but not in termites. Here we describe behaviors that are elicited in workers and soldiers by neotenic queens and kings of the subterranean termite, Reticulitermes flavipes, and demonstrate the chemical basis for the behavior. Additionally, we identify a royal-specific hydrocarbon –heneicosane– that elicited worker behavioral responses identical to those elicited by live termite queens, namely increased vibratory shaking and antennation. The behavioral effects of heneicosane were amplified when presented with nestmate termite workers' cuticular extracts, underscoring the importance of chemical context in termite royal recognition. This is the first discovery of a termite royal recognition pheromone to date and it is active in both queens and kings of R. flavipes.

Efficacy of Trelona® Compressed Bait for Area-wide Control of Subterranean Termites in Historic Buildings in Mobile, AL

Carrie Cottone[1], Kyle Jordan[2], Bob Hickman[2], and Claudia Riegel[1]
[1]New Orleans Mosquito, Termite, and Rodent Control Board, New Orleans, LA
[2]BASF, Research Triangle Park, NC

Abstract

In 2017, members of New Orleans Mosquito, Termite, and Rodent Control Board were given the unique opportunity to assist the city of Mobile, AL to protect some of their historic buildings from continued termite attack. We worked with local pest management professionals to install Advance® Termite Bait System in-ground stations around the Exploreum Science Center and the History Museum. The first three months after station installation acted as a monitoring phase, during which time the stations were checked

monthly for termite activity. By the end of the monitoring phase, 10 stations were active with Formosan subterranean termites, *Coptotermes formosanus*, and one station was active with native subterranean termites, *Reticulitermes* sp. These colonies were delineated using microsatellite genotyping. At the end of the initial three month period, monitoring devices were replaced with two cartridges of Trelona® Compressed Termite Bait containing 0.5% novaluron and the stations were checked quarterly. Within three months after baiting, we observed only three stations that contained actively foraging termites, and by the end of the year-long trial, there was no observable termite activity in any of the buildings being treated with bait.

Introduction

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is a pest of major economic important throughout the southeast United States. It is the primary structural pest in New Orleans, Louisiana and can outcompete native species (Su 2003). The New Orleans Mosquito, Termite, and Rodent Control Board (NOMTRCB) is responsible for protecting city buildings as well as historically significant structures and trees against termite attack. We have been implementing termite bait systems for approximately 20 years to control termites by eliminating colonies and thus suppressing termite populations. We have used area-wide treatment methods at several sites throughout New Orleans, in which multiple buildings in close proximity to each other are treated with termite bait systems to protect structures while controlling overall termite populations. These sites where area-wide treatment has been successful in the city include the historic French Quarter, Louis Armstrong Park, de La Ronde Plantation Oaks, and Jackson Barracks.

Another city, Mobile, AL, is located only 232 km from New Orleans and experiences high subterranean termite pressure as well. In 2017, NOMTRCB was asked to assist the city of Mobile and act as consultants to protect some of their historic structures from termite damage using Advance Termite Bait Stations with Trelona® Compressed Termite Bait. The three historic buildings to be treated encompassed one full square block and are approximately 180 years old. They are now the location of the Gulf Coast Exploreum Science Center and History Museum of Mobile, AL. They have had an ongoing infestation of Formosan subterranean termites observed within walls and window frames and have been treated and spot treated again with liquid termiticides in recent years. During our initial inspection of the buildings, we observed several conditions conducive to termite infestations. These include wood-to-ground contact, flat roofs that held water and were leaky, infested trees in close proximity to the buildings, an irrigation system that kept the foundation damp, and synthetic stucco on the building exterior that held water.

This cooperative project opportunity involved NOMTRCB, the city of Mobile, BASF, the manufacturer of the Advance® Termite Bait System (ATBS) and Trelona®, and Lewis Pest Control, who was hired by the city of Mobile to perform termite treatments for three historic buildings. We were very fortunate to work with cooperators who wanted to learn how to use bait systems properly, as well as a city government whose mayor understood the importance in area-wide treatment to manage overall termite populations.

Materials and Methods

A total of 248 Advance Termite Bait System in-ground bait stations were installed 3 m apart around all three buildings within the city block and monitored monthly for three months. At the three month inspection interval, all monitors were switched to Trelona® bait containing 0.5% novaluron. We installed two bait cartridges into each ATBS station. Subsequent inspections occurred quarterly for the following year. During each inspection after installation of bait stations, we recorded which stations exhibited actively foraging termites and percent consumption of bait or monitor. If any above-ground termite activity was observed during this study within the buildings, we would use Termidor® DRY Termiticide (0.5% fipronil) or Termidor® Ant & Termite Foam (0.005% fipronil). Treatment would be considered successful if there were no termites present during the one-year evaluation period.

Voucher specimens were collected from each active station during each inspection and stored in 95% ethanol for genetic analysis to determine the number of observed colonies and their foraging territories. Ten individual worker termites from each sample were subjected to DNA extractions using the ISOLATE II Genomic DNA Kit (Bioline, Taunton, MA). Polymerase Chain Reaction (PCR) was performed to amplify microsatellites at two loci, using locus-specific primers under conditions stated in Vargo and Henderson (2000). Electrophoresis was conducted using a LI-COR 4300 DNA Analyzer (LI-COR, Lincoln, NE). To determine whether samples originated from the same colony, allelic frequencies were tested for significant differences using log-likelihood G-statistics (FSTAT; Goudet 2002). Individuals were considered to belong to the same colony if there were no differences detected at the 5% level of significance and no private alleles were observed.

Results and Discussion

At the end of the initial three-month monitoring phase, a total of 11 stations contained live foraging termites within them (Table 1). Ten contained Formosan subterranean termites, and one had native *Reticulitermes* sp. The average percent consumption of the monitors that were active with Formosan subterranean termites was 30%, while the station with *Reticulitermes* sp. was 10% consumed. After the monitors were switched to bait containing 0.5% novaluron, the number of active stations decreased during the subsequent inspections. We also observed fewer termites and reduced bait consumption within each station when compared to the same stations during the monitoring phase. At the one year inspection, no stations exhibited live foraging termites. This inspection took place nine months after monitors were switched to Trelona® bait. Because there was no termite activity detected in any stations or within the structure at the one year inspection, this treatment was considered successful.

Month	No. Active Stations	Avg. Percent Consumption

June 2017	0 – FST 1 – *Retic*. sp.	0% – FST 10% – *Retic*. sp.	Monitoring Phase
July 2017	4 – FST 1 – *Retic*. sp.	6% – FST 10% – *Retic*. sp.	
Aug./Sept. 2017	10 – FST 1 – *Retic.* sp.	30% – FST 10% – *Retic.* sp.	
Monitors switched to Trelona®			
Nov. 2017	3 – FST 0 – *Retic.* sp.	45% – FST 0% – *Retic.* sp.	Treatment Phase
Feb. 2018	1 – FST 0 – *Retic.* sp.	10% – FST 0% – *Retic.* sp.	
May 2018	0 – FST 0 – *Retic.* sp.	5% – FST 0% – *Retic.* sp.	

Table 1. Summary of the number of active stations and the average percent consumption of active stations during each inspection period from June 2017 through May 2018.

A total of 20 samples collected from September 2017 through February 2018 were subjected to microsatellite genotyping. This genetic analysis yielded that there was only one colony each of *Reticulitermes* sp. and *C. formosanus* observed infesting these buildings. The *Reticulitermes* colony was active in only one ATBS station, while the Formosan subterranean termite colony foraged in a much larger area (Fig. 1). Calculating the total percent bait consumed from all stations allowed us to determine that 0.1 bait cartridge equivalent was consumed by the *Reticulitermes* sp. colony, and 1.1 bait cartridge equivalent was consumed by the Formosan subterranean termite colony. Therefore, these colonies did not even need to consume a single bait station's worth of bait to be eliminated.

Termites that were once observed actively foraging in window frames and within walls were not observed during any subsequent inspection after bait stations were installed. Therefore, the use of Termidor® DRY or Termidor® Ant & Termite Foam was not deemed necessary for control of termites during this study. The use of Trelona bait in ATBS stations was successful as a stand-alone treatment.

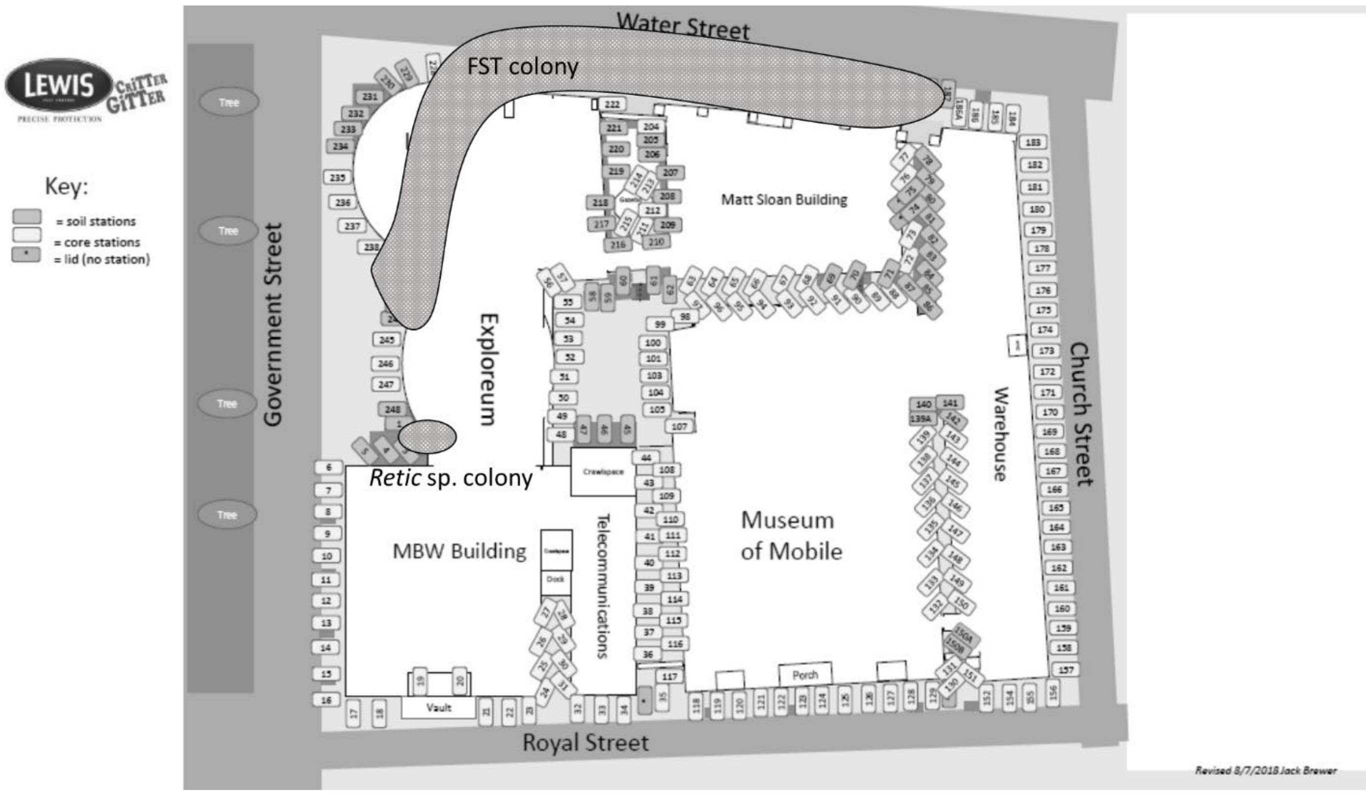

Figure 1. Site map of all three buildings treated within the city block and station locations, overlaid with foraging territories for the *C. formosanus* colony and *Reticulitermes* sp. colony. Original site map courtesy of Lewis Pest Control.

Acknowledgements

We would like to thank the following NOMTRCB personnel for their assistance in the field during inspections and data collection: Ed Freytag, Eric Guidry, Shaun Broadley, Barry Lyons, and Steven Ollar. We would also like to thank Peter Ford and Jack Brewer of Lewis Pest Control, Antonia Chan of BASF, and Kimberly Harden and Mayor Sandy Stimpson of the City of Mobile.

References

Goudet, J. 2002. FSTAT (version 2.9.3.2), a computer package for PCs which estimates and tests gene diversities and differentiation statistics from codominant genetic markers. (http://www2.unil.ch/popgen/softwares/fstat.htm)

Su. 2003. Overview of the global distribution and control of the Formosan subterranean termite. Sociobiology. 41: 7-16.

Vargo, E.L. 2000. Identification of polymorphic microsatellite loci in the Formosan subterranean termite *Coptotermes formosanus* Shiraki. Mol. Ecol. 9: 1919-1952.

The National Pest Management Association's Tiny Termite House Project

Ed Freytag[1], Shaun Broadley[1], Jack Leonard[1], Jim Fredericks[2], Jessica Phelan[3], Patricia Stofanak[3], Danielle Corrato[3], Amanda Polyak[3], Logan Yu[3], Sara Deviva[3], Felicia Schwarz[3], Cindy Mannes[4] and Claudia Riegel[1]
[1]New Orleans Mosquito, Termite and Rodent Control Board, [2]National Pest Management Association, [3]Vault Communications and [4]Professional Pest Management Alliance

Abstract

The Professional Pest Management Alliance is the consumer education and marketing outreach arm of the National Pest Management Association. It is tasked with communicating key messages to consumer audiences about the health and property risks associated with pest problems in and around the home. In 2018, the group has embarked on a consumer campaign to raise awareness about termite infestations, designed to help educate consumers about how to protect against these voracious, wood-destroying insects through prevention, professional inspection and home maintenance. Internally coined, Tiny Termite House, this project will visually show the destructive nature of these pests in a controlled setting utilizing a mix of high resolution video footage and photography. The New Orleans Mosquito, Termite and Rodent Control Board (NOMTRCB) was commissioned in the research and production aspects of this project. The overarching goal of this project was to physically show the destructive nature of termites inside a home in a highly impactful and visual way. A scale model home, constructed as authentically as possible, was infested with approximately 500,000 Formosan subterranean termites, with cameras strategically placed to capture the colony's destructive progress — from introduction to decimation — through photography and video, to impact the emotional connection and concern people have for their own properties.

2018 NCUE & IPA Program

2018

National Conference on Urban Entomology

and

Invasive & Pest Ant Conference

May 20-23

RTP, North Carolina

ncue.tamu.edu

groups/ncue18

#ncue18

NCUE/IPAC schedule at a glance

Refer to daily details for session locations

SUNDAY, MAY 20

1:00-5:00	Urban eXtenson CoP Meeting
6:00-8:00	Welcome Reception

MONDAY, MAY 21

6:30-7:45	Breakfast (included with hotel registration)
7:45-7:55	**WELCOME**
7:55-8:00	**PRESENTATION OF ACHIEVEMENT AWARD**
8:00-9:00	**MALLIS MEMORIAL AWARD LECTURE**
9:00-9:45	**STUDENT SCHOLARSHIP AWARD PAPERS**
9:45-10:00	BREAK
10:00-12:00	**STUDENT PAPER COMPETITION**
12:00-1:15	Lunch on Your Own
1:15-2:30	**SUBMITTED PAPERS** BED BUGS
2:30-3:00	BREAK
3:00-5:00	Concurrent Sessions:
	SYMPOSIUM BED BUG RESISTANCE MGMNT
	SYMPOSIUM TICKS
Dinner & Evening on Your Own	
8:00 – 10:30	Pi Chi Omega at RallyPoint Sport Grill

TUESDAY, MAY 22

6:30-8:00	Breakfast (included with hotel registration)
8:00-10:00	Concurrent Sessions:
	SYMPOSIUM ASSESSMENT-BASED PM
	SYMPOSIUM URBAN RODENT CONTROL
	SUBMITTED PAPERS ANTS
10:00-10:15	BREAK
10:15-12:15	Concurrent Sessions:
	SUBMITTED PAPERS FLIES AND MOSQUITOES
	SUBMITTED PAPERS ANTS
12:15-1:40	AWARDS LUNCHEON
1:45-3:15	Concurrent Sessions:
	SUBMITTED PAPERS COCKROACHES & TERMITES
	SUBMITTED PAPERS ADDITIONAL TOPICS
3:15-3:30	BREAK
3:30-5:30	Concurrent Sessions:
	SYMPOSIUM MILLENNIAL COCKROACH MGMNT
	SYMPOSIUM REAL-WORLD APPLICATIONS OF MOLECULAR RESEARCH IN URBAN ENTOMOLOGY
4:00-5:45	Fire Ant eXtension Meeting
6:00	Buses Depart for NC Museum of Natural Sciences

WEDNESDAY, MAY 23

6:30-8:00	Breakfast (included with hotel registration)
8:00-10:00	Concurrent Sessions:
	SYMPOSIUM FEDERAL POLICY WORK GROUPS
	SUBMITTED PAPERS TERMITES
10:00-10:30	BREAK
10:30-11:30	FINAL BUSINESS MEETING
11:30-12:00	EXECUTIVE COMMITTEE BUSINESS MEETING

Registration Hours:
Sun 2:30-5:00, Mon & Tues 7:00-5:00, Wed 7:00-10:00

Upload your presentation during breaks at the table by registration.

Please be courteous and upload your talk at least one session prior to when you are speaking.

SUNDAY, MAY 20

2:30-5:00 Registration and Paper Upload Available
1:00-5:00 Urban eXtenson CoP Meeting
CAPE HATTERAS
6:00-8:00 Welcome Reception (free hors d'oeuvres)
TRIANGLE BALLROOM

MONDAY, MAY 21

6:30-7:45 **Breakfast (included with hotel registration)**

7:45-9:00 **AWARDS PRESENTATIONS**
TANGLEWOOD/ PINEHURST/ BLOWING ROCK
7:45-8:00 WELCOME
8:00-9:00 **Distinguished Achievement Award in Urban Entomology**
The Arnold Mallis Memorial Award Lecture
Arnold Mallis, a 20th Century Urban Entomologist, and how the next generation can honor his legacy in the 21st
BRIAN FORSCHLER
UNIVERSITY OF GEORGIA
9:00-9:15 **Bachelors of Science Award**
Growth Dynamics of Blattabacterium, an Endosymbiont of German Cockroaches
EMILY L. VERNON, Madhavi L. Kakumanu and Coby Schal
NORTH CAROLINA STATE UNIVERSITY
9:15-9:30 **Masters of Science Award**
Improving Baiting Methods for the European Fire Ant, *Myrmica rubra*
DANIELLE HOEFELE, Jaime Chalissery, Regine Gries, Gerhard Gries
SIMON FRASER UNIVERSITY
9:30-9:45 **Doctoral Award**
Toxicity and Neurophysiological Impacts of Plant Essential Oil Components on Bed Bugs (*Cimicidae: Hemiptera*)
SUDIP GAIRE, Michael Scharf and Ameya D. Gondhalekar
PURDUE UNIVERSITY

9:45-10:00 BREAK

10:00-12:00 **STUDENT PAPER COMPETITION**
TANGLEWOOD/ PINEHURST/ BLOWING ROCK
10:00-10:10 Apartment-Dwelling Versus Laboratory Cockroaches: A Diet Study
SAMANTHA McPHERSON, Coby Schal and Jules Silverman
NORTH CAROLINA STATE UNIVERSITY
10:12-10:22 Is There a Difference Between Bacterial Communities of Monogyne and Polygyne Fire Ant Colony Soils?
NICHOLAS V. TRAVANTY, Loganathan Ponnusamy and Charles S. Apperson
NORTH CAROLINA STATE UNIVERSITY
10:24-10:44 Effect of Ingestion of an Insect Growth Regulator on German Cockroach Survivorship, Feeding Behavior and Reproduction
JAMORA HAMILTON, Ayako Wada-Katsumata and Coby Schal
NORTH CAROLINA STATE UNIVERSITY

10:46-10:56 The Distribution and Agonistic Interactions of the Invasive Dark Rover Ant, *Brachymyrmex patagonicus* Mayr, in South Carolina
DAVID Q. BOWERS and Eric P. Benson
CLEMSON UNIVERSITY
10:58-11:08 Evaluation of Backmister® Blower for Barrier Treatments
BENJAMIN McMILLAN, Nicky Gallagher and Sally Paulson
VIRGINIA TECH; Syngenta Crop Science
11:10-11:20 What's in a Name? The Importance of Taxonomic Rigor in Managing Invasive Ant Species
JASON L. WILLIAMS and Andrea Lucky
UNIVERSITY OF FLORIDA
11:22-11:32 Water Relations of Several Stages of the Asian Cockroach, *Blattella asahinai*
PATRICK J. THOMPSON, Gokhan Benk, Xing P. Hu and Arthur G. Appel
AUBURN UNIVERSITY
11:34-11:44 Water Loss and Desiccation Tolerance of Several Stages of the Kudzu Bug, *Megacopta cribraria*
GOKHAN BENK, Patrick J. Thompson, Arthur G. Appel and Xing P. Hu
AUBURN UNIVERSITY
11:46-11:56 Knockdown of the Chromatin Remodeling Gene *Brahma* by RNA Interference Reduces Reproductive Fitness and Lifespan in Common Bed Bug (*Hemiptera: Cimicidae*)
SANJAY BASNET and Shripat T. Kamble
UNIVERSITY OF NEBRASKA, LINCOLN

12:00-1:15 **Lunch on your own**

1:15-2:30 **SUBMITTED PAPERS**: BED BUGS
TANGLEWOOD/ PINEHURST/ BLOWING ROCK
1:15-1:30 Impact of Bed Bugs on the Microbial Diversity of Infested Homes
MADHAVI L. KAKUMANU, Zachary C. Devries, Alexis Barbarin, Richard G. Santangelo and Coby Schal
NORTH CAROLINA STATE UNIVERSITY; North Carolina Department of Health and Human Services
1:35-1:50 Sex- and Stage-specific Recognition in the Bed Bug, *Cimex lectularius*
AHMED M. SAVEER, Eduardo Hatano and Coby Schal
NORTH CAROLINA STATE UNIVERSITY
1:55-2:10 Bed Bugs and Histamine: A Public Health Risk?
ZACHARY C. DeVRIES, Richard G. Santangelo, Alexis Barbarin and Coby Schal
NORTH CAROLINA STATE UNIVERSITY; North Carolina Department of Health and Human Services
2:15-2:30 Effects of Color Contrast on Bed Bug Locomotion Behavior
Roselyn Giordano, Changlu Wang and SALEHE ABBAR
RUTGERS UNIVERSITY

2:30-3:00 **BREAK**

3:00-5:00 Concurrent sessions:

SYMPOSIUM: BED BUG RESISTANCE MANAGEMENT
TANGLEWOOD/ PINEHURST

Organizer: Alvaro Romero, University of New Mexico

3:00-3:20 Use of Synergists for Management of Insecticide Resistance in Bed Bugs?
ALVARO ROMERO
NEW MEXICO STATE UNIVERSITY

3:20-3:40 Alternative Methods for Bed Bug Control: Do They Play a Role in Insecticide Resistance Management?
A. D. GONDHALEKAR[1], G. M. Bennett[1], A. R. Ashbrook[1], J. Feston[2] and S. Gaire[1]
1 PURDUE UNIVERSITY; 2 Insects Limited

3:40-4:00 A Liquid Bait for Bed Bugs?
ZACHARY DEVRIES, Angela Sierras and Coby Schal
NORTH CAROLINA STATE UNIVERSITY

4:00-4:20 Residual Efficacy of Several Pesticide Products for Bed Bugs on Contaminated Surfaces
DONG-HWAN CHOE
UNIVERSITY OF CALIFORNIA, RIVERSIDE

4:20-4:40 Threshold-based Treatment Strategies for Bed Bugs
CHANGLU WANG, Narinderpal Singh, Chen Zha and Richard Cooper
RUTGERS UNIVERSITY

4:40-5:00 Q&A / Discussion

SYMPOSIUM: TICKS
BLOWING ROCK

Organizers: Nicky Gallagher and Allie Allen
Syngenta Crop Science; NPMA

3:00-3:05 Introduction
NICKY GALLAGHER
SYNGENTA CROP SCIENCE

3:05-3:25 Tick Distribution and Burden
CHARLES APPERSON
NORTH CAROLINA STATE UNIVERSITY

3:25-3:45 Tick Ecology
EMMA WEEKS
UNIVERSITY OF FLORIDA

3:45-4:05 Understanding Repellents: What Homeowners and PMPs Need to Know
JUDI ANDERSON
DEET EDUCATION PROGRAM

4:05-4:25 Tick Management Services: Not Just the What, but the Why
GLEN RAMSEY
ROLLINS, INC.

4:25-4:45 Working with the Public
HEATHER KOPSCO
UNIVERSITY OF RHODE ISLAND TICKENCOUNTER RESOURCE CENTER

4:45-5:00 Questions & Answers

Dinner & evening on your own

8:00-10:30 Pi Chi Omega – Raise the Bar at RallyPoint Sport Grill

TUESDAY, MAY 22

6:30-8:00 **Breakfast (included with hotel registration)**

8:00-10:00 Concurrent sessions

SYMPOSIUM: ASSESSMENT-BASED PEST MGMNT
CAMERON/ REYNOLDS

Organizers: Michael Scharf and Dini Miller
Purdue University; Virginia Tech

8:00-8:12 What is APM?
DINI MILLER
VIRGINIA TECH

8:12-8:24 Assessing Pest Manager Knowledge and Performance
FAITH OI
UNIVERSITY OF FLORIDA

8:24-8:36 Bed Bug Monitoring
RICHARD COOPER
COOPER PEST SOLUTIONS

8:36-8:48 Resistance Assessment for Making Pesticide Choices
MICHAEL SCHARF
PURDUE UNIVERSITY

8:48-9:00 Minimum Trap Number and Quick Inspection Combinations to Determine Bed Bug Building-wide Infestation Rates
KAREN VAIL
UNIVERSITY OF TENNESSEE, KNOXVILLE

9:00-9:12 The HUD Perspective
WITHDRAWN RACHEL RILEY
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

9:12-9:24 Managing Bed Bugs with Ongoing Assessments and Long-term Contracts
ANDREW SUTHERLAND
U.C. STATEWIDE IPM PROGRAM

9:24-9:36 Pest Risk Assessment in the Urban Environment
GENE WHITE
RENTOKIL STERITECH

9:36-9:48 Challenges that Technicians Face and Perspectives on How Assessment Can be Priced Into a Contract
NANCY TROYANO
RENTOKIL STERITECH

9:48-10:00 Baiting Recommendations Based on Sampled Pest Numbers – the Manufacturer's Perspective
NICKY GALLAGHER
SYNGENTA CROP SCIENCE

SYMPOSIUM: URBAN RODENT CONTROL
TANGLEWOOD/ PINEHURST

Organizer: Bobby Corrigan
RMC Pest Management Consulting

8:00-8:20 State of The Union on Urban Rodents
ROBERT M. CORRIGAN
RMC PEST MANAGEMENT CONSULTING

8:20-8:40 Population Genetics and Pathogens: Understanding Movement and Disease in Urban Brown Rats (*Rattus norvegicus*)
MATTHEW COMBS
FORDHAM UNIVERSITY

8:40- 9:00 The Use of Trail Cams in Urban Rodent Pest Management
PHILIP L. SMITH, Friederike M. Bauder, Timothy H. Madere and Claudia Riegel
CITY OF NEW ORLEANS MOSQUITO, TERMITE AND RODENT CONTROL BOARD

9:00- 9:20 Early Detection of Rodents Demonstrated with the ActiveSense™ System
JOE DEMARK[1], Phil Smith[2], Claudia Riegel[2] and Neil Spomer[1]
1 CORTEVA AGRISCIENCE™, AGRICULTURE DIVISION OF DOWDUPONT™; 2 New Orleans Mosquito Termite and Rodent Control Board

9:20-9:40 The Use of Dry Ice for Controlling Burrowing Populations of Norway Rats, *Rattus norvegicus* in Urban Environments
SHEILA HADDAD
BELL LABORATORIES

9:40-10:00 Field Evaluation of Selontra Soft Bait Rodenticide Against the House Mouse, *Mus musculus*
Grzegorz Buczkowski, Jason Meyers and KYLE JORDAN
Purdue University; BASF P&SS

SUBMITTED PAPERS: ANTS
BLOWING ROCK

8:00- 8:15 Transcriptomes of MS Fire Ant Larvae and Pupae
MARGARET L. ALLEN
USDA-ARS BIOLOGICAL CONTROL OF PESTS RESEARCH UNIT NBCL

8:17- 8:32 Multiplexed Lateral Flow Immunoassay to Discriminate *Solenopsis invicta* from *Solenopsis richteri*
STEVEN M. VALLES and Anne-Marie Callcott
USDA-ARS, IMPORTED FIRE ANT AND HOUSEHOLD INSECTS RESEARCH UNIT, CENTER FOR MEDICAL, AGRICULTURAL AND VETERINARY ENTOMOLOGY; Animal and Plant Health Inspection Service, Plant Protection and Quarantine-APHIS

8:34-8:49 Evaluation of Imported Fire Ant Quarantine Treatments in Commercial Grass Sod: Alabama 2016 & 2017
L.C. 'FUDD' GRAHAM, Anne-Marie Callcott, Kelly Palmer and Josie Tripi
AUBURN UNIVERSITY; USDA-APHIS-PPQ-CPHST; Alabama Cooperative Extension System

8:51-9:06 Why Fire Ant Female Sexuals Mate Only Once
ROBERT VANDER MEER, Tappey Jones and Satya Chinta
USDA/ARS; Virginia Military Institute; Foresight, Science and Technology, Inc.

9:08-9:23 The Future of the Federal Imported Fire Ant Quarantine Program
RICHARD N. JOHNSON, Anne-Marie Callcott, Melinda Sullivan and Ronald Weeks
USDA, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, PLANT PROTECTION AND QUARANTINE

9:25-9:40 Improving Federal Imported Fire Ant Quarantine Treatments: Tracking Water and Bifenthrin Movement in Soil with Signal™ Green Dye
KARLA ADDESSO[1], Jason Oliver[1], Anthony Witcher[1], Anne-Marie Callcott[2], Nadeer Youssef[1] and Paul O'Neal[1]
1 TENNESSEE STATE UNIVERSITY; 2 USDA-APHIS-PPQ Biloxi Station

9:42-9:57 Improving Federal Imported Fire Ant Quarantine Treatments for Post-harvest Field-grown Nursery Stock
JASON OLIVER, Karla Addesso, Anthony Witcher, Anne-Marie Callcott, Nadeer Youssef and Paul O'Neal
TENNESSEE STATE UNIVERSITY; USDA-APHIS-PPQ Biloxi Station

10:00-10:15 **BREAK**

10:15-12:15 Concurrent sessions:

SUBMITTED PAPERS: FLIES AND MOSQUITOES
TANGLEWOOD/ PINEHURST

10:15- 10:30 Fruit Flies as Potential Vectors of Foodborne Illness
S. J. Barcay E. P. Black, G. J. Hinrichs and D. B. GARDNER
ECOLAB INC.

10:33- 10:48 WITHDRAWN Texas-Wide *Aedes aegypti* and *Aedes albopictus* Mosquito Surveillance Project
SONJA L. SWIGER, Whitney Qualls and Bethany Bolling
TEXAS A&M AGRILIFE EXTENSION SERVICE; Texas Department of State Health Services

10:51- 11:06 WITHDRAWN Comparison of Mosquito Species in New York City Over 70 Years
MADDIE PERLMAN-GABEL and Waheed I. Bajwa
NYC DEPARTMENT OF HEALTH AND MENTAL HYGIENE

11:09- 11:24 WITHDRAWN The Role of *Culex* Species in Transmission of West Nile Virus in New York City
WAHEED BAJWA, Liyang Zhou, Zahir Shah and Gabriela Fonseca
NYC DEPARTMENT OF HEALTH AND MENTAL HYGIENE

11:27- 11:42 Alpine 0.5% Fly Bait: Different But the Same
CHUCK KLEIN, Keena Mullin, Kyle Jordan
BASF Professional & Specialty Solutions

11:45- 12:00 Creating Credentials for Services Targeting Mosquitoes & Other Public Health Pests
ALLISON ALLEN
NPMA

SUBMITTED PAPERS: ANTS
BLOWING ROCK

10:15-10:30 Rain, Rain Go Away; Unless Water Resistant Fire Ant Baits are on Display?
DAVID H. OI and Chris Cavanaugh
USDA-ARS CENTER FOR MEDICAL, AGRICULTURAL, & VETERINARY, ENTOMOLOGY; Coachella Valley Mosquito and Vector Control District

10:32-10:47 Ant-Microbe Interactions: A Focus on Yeast Associates
MARK E MANKOWSKI and Jeffery J. Morrell
USDA FOREST SERVICE FOREST PRODUCTS LABORATORY

10:49- 11:04 Supercolony Formation in Invasive Populations of the Tawny Crazy Ant *Nylanderia fulva*
EDWARD L. VARGO[1], Bryant McDowell[1], DeWayne Shoemaker[2], Robert Puckett[1], Luis Calcaterra[3] and Pierre-André Eyer[1]
1 TEXAS A&M UNIVERSITY; 2 University of Tennessee, Knoxville; 3 Fundación para el Estudio de Especies Invasivas, Argentina

11:06- 11:21 Let's Get the Info Out About the Crazies (Tawny Crazy Ants, That Is)...Stakeholder Resources Now Available!
KELLY PALMER, L.C. "Fudd" Graham and Jeremy Pickens
ALABAMA COOPERATIVE EXTENSION SYSTEM; Auburn University

11:23- 11:38 Establishment of a New Invasive Ant Species, *Plagiolepis alluaudi*, in Florida
JOHNALYN GORDON and Thomas Chouvenc
UNIVERSITY OF FLORIDA

11:40- 11:55 How Citizen Science Can Benefit Invasion Science?
ANDREA LUCKY, Rob Dunn and Tyler Vitone
UNIVERSITY OF FLORIDA

11:57- 12:12 Confirmation of *Tapinoma sessile* Clades in Knoxville Using a Novel and Cost-efficient Assay
Geordan Hall, Jennifer Chandler, Rebecca Trout Fryxell and KAREN VAIL
UNIVERSITY OF TENNESSEE, KNOXVILLE

12:15-1:45 **AWARDS LUNCHEON**
CHIMNEY ROCK

1:45-3:15 Concurrent sessions:

SUBMITTED PAPERS: COCKROACHES & TERMITES
BLOWING ROCK

1:45- 2:00 German Cockroach Aggregation is Mediated by Gut Bacteria
AYAKO WADA-KATSUMATA and Coby Schal
NORTH CAROLINA STATE UNIVERSITY

2:03-2:18 The Role of the Gut Microbiota in the Reproductive Life History of the German Cockroach
JOSE E. PIETRI and Dangsheng Liang
APEX BAIT TECHNOLOGIES, INC.

2:21- 2:36 A New Borate Based Dual Active Cockroach Bait
REID IPSER
NISUS CORPORATION

2:39-2:54 Assessing Residents' Attitudes toward German Cockroach Infestations in Apartment Buildings
CHANGLU WANG, Amanda Eiden, Chen Zha and Richard Cooper
RUTGERS UNIVERSITY

2:57- 3:15 Molecular Insights Into Invasive Subterranean Termites (*Heterotermes, Coptotermes*) in the Caribbean Region
SUSAN C. JONES and Tyler D. Eaton
THE OHIO STATE UNIVERSITY

SUBMITTED PAPERS: ADDITIONAL TOPICS
TANGLEWOOD/ PINEHURST

1:45- 2:00 Direct Treatment and Residual Efficacy of Fendona TM CS Insecticide on Striped Bark Scorpions, *Centruroides vittatus* (Say)
ROBERT DAVIS and Matthew Lee
BASF P&SS; Entomology Consultants, LLC

2:03- 2:18 Novel Strategies to Explore Insect Attractants and Repellents
EDUARDO HATANO, Ayako Wada-Katsumata, Ahmed M. Saveer and Coby Schal
NORTH CAROLINA STATE UNIVERSITY

2:21- 2:36 Two Hands-on Training Facilities for Pest Management Professionals in Texas
MICHAEL MERCHANT and Robert Puckett
TEXAS A&M AGRILIFE EXTENSION SERVICE

2:39-2:54 The Synergy of Adulticides with IGRs Against Cat Fleas
MICHAEL K. RUST and W.L.H. Hemsarth
UNIVERSITY OF CALIFORNIA, RIVERSIDE; Hartz Mountain Inc.

2:39-2:54 Need Resources—We've Got 'Em
JANET HURLEY
TEXAS A&M AGRILIFE EXTENSION SERVICE

2:57- 3:15 The Lesser Mealworm, Darkling Beetle RNA Sequencing and RNA Interference
JINGJING XU, Sharath Chadra and Subba Reddy Palli
APEX BAIT TECHNOLOGIES, INC; University of Kentucky

3:15-3:30 **BREAK**

SYMPOSIUM: MILLENNIAL COCKROACH MGMNT
BLOWING ROCK
Organizer: Chris Keefer, Syngenta Crop Science

3:30- 3:35 Opening Statements
CHRIS KEEFER
SYNGENTA CROP SCIENCE

3:35- 3:50 A Historical Perspective: Aspects of Resistance Management in German Cockroaches
WILLIAM A. DONAHUE, JR.
SIERRA RESEARCH LABORATORIES, INC.

3:50- 4:05 The X Factor, What are We Missing in German Cockroach Management in Commercial Kitchens?
JUDY BLACK
RENTOKIL STERITECH

4:05- 4:20 Nutrients as Deterrents in Cockroach Baits
COBY SCHAL, Ayako Wada-Katsumata and Jules Silverman
NORTH CAROLINA STATE UNIVERSITY

4:20- 4:35 Symposium Break

4:35- 4:50 Industry Perspective on Resistance and Aversion Programs for Cockroach Management
JASON MEYERS
BASF Professional & Specialty Solutions

4:50- 5:05 Insecticide Application Strategies for Cockroach Management: Not A Simple Subject
ROBERT PUCKETT
TEXAS A&M AGRILIFE EXTENSION SERVICE

5:05- 5:20 Stubby, Precocious, and Sterile? Overcoming IGR Inhibition in Pest Control Technicians
TIM HUSEN
ROLLINS INC.

5:20- 5:25 Closing Statements
CHRIS KEEFER
SYNGENTA CROP SCIENCE

SYMPOSIUM: REAL-WORLD APPLICATIONS OF MOLECULAR RESEARCH IN URBAN ENTOMOLOGY
TANGLEWOOD/ PINEHURST

Organizers: Ameya D. Gondhalekar and Shripat T. Kamble
Purdue University; University of Nebraska, Lincoln

3:30- 3:47 Molecular Responses of the Termite Gut to Toxic Wood Diets
MICHAEL SCHARF
PURDUE UNIVERSITY

3:47- 4:04 Use of a Biodegradable Hydrogel to Deliver Aqueous Bait to Control Argentine Ants (*Hymenoptera: Formicidae*) in Residential Settings
JIA-WEI TAY, Mark Hoddle, Ashok Mulchandani, and Dong-Hwan Choe
UNIVERSITY OF CALIFORNIA, RIVERSIDE

4:04- 4:21 RNAi for Urban Pest Control
SUBBA REDDY PALLI
UNIVERSITY OF KENTUCKY

4:21- 4:38 RNAi Mediated Knockdown of V-ATPases in Bed Bug Decreases Reproduction and Survival
SANJAY BASNET and Shripat Kamble
UNIVERSITY OF NEBRASKA, LINCOLN

4:38- 4:55 Unravelling the Invasion Dynamics of the Bed Bug Using Molecular Tools
WARREN BOOTH[1], Christopher Lawrence[1], Gage Holleman[1], Ondrej Balvin[2], Grant Robison[1], Zachary DeVries[3], Ed Vargo[4] and Coby Schal[3]
1University of Tulsa; 2 Charles University in Pargue; 3North Carolina State University; 4 Texas A&M University

4:55- 5:12 Management of Insecticide Resistance in German Cockroaches (*Blattella germanica* (L.))
MAHSA FARDISI, Ameya Gondhalekar, Aaron Ashbrook, Zachery Wolfe and Michael Scharf
PURDUE UNIVERSITY

5:12- 5:30 Q&A / Discussion

3:30-5:30 **Fire Ant eXtension Meeting**
CAPE HATTERAS

6:00 Buses depart hotel for NC Museum of Natural Sciences
9:30 Buses depart museum for hotel

WEDNESDAY, MAY 23

6:30-8:00 **Breakfast (included with hotel registration)**

8:00-10:00 Concurrent sessions:

SYMPOSIUM: POLICY WORK GROUPS
TANGLEWOOD/ PINEHURST

Organizer: Kyle Jordan, BASF P&SS

8:00- 9:00 Federal Discussion

9:00- 10:00 Break Out Working Groups:
Rodent Policy
Bed Bug Testing Guidelines
Others as needed

SUBMITTED PAPERS: TERMITES
BLOWING ROCK

8:00- 8:15 Soil Termiticide Barriers Work as Oral Toxins
BRIAN T. FORSCHLER
UNIVERSITY OF GEORGIA

8:18- 8:31 Termidor® HPII: Treat Today Like Tomorrow
FREDER MEDINA, Robert Hickman, Robert Davis, Jason Meyers, Kyle Jordan, Barry Furman and Joe Schuh
BASF Professional & Specialty Solutions

8:34- 8:49 Colony-level Effects of Liquid Termiticides and Baits on Subterranean Termites
THOMAS CHOUVENC
UNIVERSITY OF FLORIDA

8:52- 9:07 Building Out Bugs: How the Use of New Building Materials Leads to Sustainable Pest Control
CASSIE S. KREJCI and Roger E. Gold
POLYGUARD BARRIER SYSTEMS; Texas A&M University

9:10- 9:25 Identification of a Queen and King Recognition Pheromone in the Subterranean Termite, *Reticulitermes flavipes*
COLIN FUNARO, Katalin Böröczky, Edward L. Vargo and Coby Schal
NORTH CAROLINA STATE UNIVERSITY; Pennsylvania State University; Texas A&M University; North Carolina State University

9:28- 9:43 Efficacy of Trelona® Compressed Termite Bait for Area-wide Control of Subterranean Termites in Historic Buildings in Mobile, AL
CARRIE COTTONE[1], Kyle Jordan[2], Bob Hickman[2] and Claudia Riegel[1]
1 CITY OF NEW ORLEANS MOSQUITO, TERMITE AND RODENT CONTROL BOARD; 2 BASF Professional & Specialty Solutions

9:45- 10:00 The National Pest Management Association's Tiny Termite House Project
ED FREYTAG[1], Shaun Broadley[1], Jack Leonard[1], Jim Fredericks[2], Jessica Phelan[3], Patricia Stofanak[3], Danielle Corrato[3], Amanda Polyak[3], Logan Yu[3], Sara Deviva[3], Felicia Schwarz[3], Cindy Mannes[4] and Claudia Riegel[1]
1 NEW ORLEANS MOSQUITO, TERMITE AND RODENT CONTROL BOARD; 2 National Pest Management Association; 3 Vault Communications; 4 Professional Pest Management Alliance

10:00-10:30 **BREAK/CHECK OUT**

10:30-11:30 **FINAL BUSINESS MEETING**
CAPE HATTERAS

11:30-12:00 **EXECUTIVE COMMITTEE BUSINESS MEETING**
CAPE HATTERAS

MARK YOUR CALENDARS FOR THE NEXT NCUE!
MAY 2020 IN MOBILE, AL

Past Recipients of the Distinguished Achievement Award in Urban Entomology

1986	Walter Ebeling, James Grayson
1988	John V. Osmun, Eugene Wood
1990	Francis W. Leichleitner
1992	Charles G. Wright
1994	Roger D. Akre, Harry B. Moore, Mary H. Ross
1996	Donald G. Cochran
1998	Gary H. Bennett
2000	Michael K. Rust
2004	Roger E. Gold
2006	Coby Schal
2008	Nan-Yao Su
2010	Don Reierson
2012	Shripat Kamble
2014	Jules Silverman
2016	John Klotz
2018	Brian Forschler

Past Conference Chairs

1986	Patricia A. Zungoli
1988	William H. Robinson
1990	Michael K. Rust
1992	Gary W. Bennett
1994	Roger E. Gold, Judy K. Bertholf
1996	Donald A. Reierson
1998	Brian T. Forschler, Shripat Kamble
2000	Shripat Kamble
2004	Daniel R. Suiter
2006	Dini Miller, Robert Kopanic
2008	Richard Houseman, Bob Cartwright
2010	Karen Vail
2012	Faith Oi
2014	Faith Oi, Grzesiek Buczkowski
2016	Kyle Jordan
2018	Kyle Jordan

2018 NCUE Planning Committee

Conference Chair: KYLE K. JORDAN, BASF

Program Chair: ALLIE ALLEN, NPMA

Awards Co-chair: FAITH OI, University of Florida
Awards Co-chair: DINI MILLER, Virginia Tech

Treasurer: EDWARD L. VARGO, Texas A&M University

Secretary: Molly Keck, Texas AgriLife Extension Service

Local Arrangements: COBY SCHAL, NC State University
Local Arrangements: BARRY FURMAN, BASF

Sponsorship Chair: DANIEL R. SUITER, University of Georgia
Sponsorship Committee: DINI MILLER, Virginia Tech
SHRIPAT KAMBLE, University of Nebraska
GARY BENNETT, Purdue University

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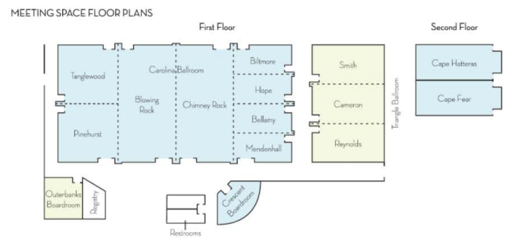

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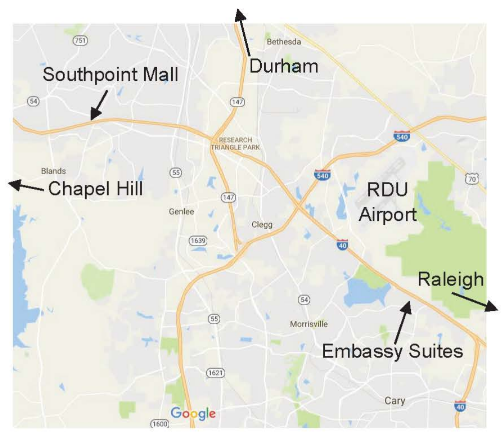
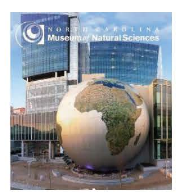
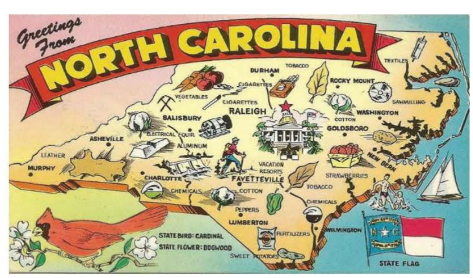


Tuesday night outing:
North Carolina Museum of Natural Sciences
11 W Jones St, Raleigh, NC 27601





NOTES:

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2018 NCUE Planning Committee

Conference Chair: Kyle Jordan (BASF)
Program & Proceedings Chair: Allie Allen (NPMA)
Secretary: Molly Keck (Texas AgriLife Ext)
Awards Co-Chair: Faith Oi (University of Florida)
Awards Co-Chair: Dini Miller (Virginia Tech)
Treasurer: Ed Vargo/Lisa Jordan (Texas A&M University)
Sponsorship Chair: Dan Suiter (UGA)

Local Arrangements Co-Chair: Coby Schal (NC State)
Local Arrangements Co-Chair: Barry Furman (BASF)

2020 NCUE Planning Committee

Conference Chair: Allie Allen (NPMA)
Program & Proceedings Chair: Molly Keck (Texas AgriLife Ext)
Secretary: Carrie Cottone (City of New Orleans Mosquito, Termite & Rodent Control)
Awards Chair: Kyle Jordan (BASF)
Treasurer: Ed Vargo/Lisa Jordan (Texas A&M University)
Sponsorship Chair: Dan Suiter (UGA)

Local Arrangements Co-Chair: Kelly Palmer (Washington County Extension)
Local Arrangements Co-Chair: Fudd Graham (Auburn University)

NCUE Bylaws

BYLAWS

NATIONAL CONFERENCE ON URBAN ENTOMOLOGY

ARTICLE I- NAME
The name of this organization is the National Conference on Urban Entomology.

ARTICLE II-BACKGROUND
In the spring of 1985, individuals representing urban entomology and the pest control industry came together to organize a national conference to be held biennial. The mission of these conferences was to open channels of communication and information between scientists in industry, academia, and government, and to foster interest and research in the general area of urban and structural entomology.

The primary scope of the National Conference is to emphasize innovations and research on household and structural insect pests. It is the intent; however, to provide flexibility to include peripheral topics that pertain to the general discipline of urban entomology. It is anticipated that the scope of the conference could change through time, but the emphasis would be to provide an opportunity for urban entomologist to meet on a regular basis. It is not anticipated that any specific memberships would be required or expected, but that the cost associated with the conference would be met through registration fees and contributions. In the event that funds become available through donations or from the sale of conference proceedings, that these resources will be spent to meet expenses, to pay the expenses for invited speakers, and to provide scholarships to qualified students working in urban entomology. It is the intent of this organization to be non-profit, with financial resources provided to the Conference to be used entirely in support of quality programming and the support of scholarships.

ARTICLE III-OBJECTIVES
The objectives of this organization are:

1. To promote the interest of urban and structural entomology.

2. To provide a forum for the presentation of research, teaching and extension programs related to urban and structural entomology.

3. To prepare a written/electronic proceedings of all invited and accepted papers given or prepared at the biennial meeting.

4. To promote scholarship and the exchange of ideas among urban entomologists.

5. As funds are available, scholarships will be awarded to students pursuing scholastic degrees in urban entomology. Three levels of scholarships will be offered: the first level is for Bachelor students; the second level is for Masters students; and the third level is for Ph.D. candidates. These students must register for, and attend, the conference and present the paper in order to receive funding. These scholarships will be awarded based solely on the merits of the candidates, and the progress that they have made towards completion of their research and scholastic degrees. The student will receive funding only if they are currently enrolled in a university at the time that the conference is held.

6. There may also be first, second, and third place recipients of an onsite student competition for students who are currently involved in their undergraduate or graduate programs. These students can compete for scholarship funds; however, if any student has already been awarded a scholarship for the current meeting, and wishes to participate in this onsite competition, their presentation must be completely separate, and they must be properly registered in advance for this competition.

ARTICLE IV-JURISDICTION

The jurisdiction of this conference is limited to events held within the United States of America; however, we will be supportive of international urban entomology conferences as they are organized and held.

ARTICLE V-MEMBERSHIP

There are no membership requirements associated with this organization except for the payment of registration fees which go to offset the cost of holding the conference, preparation/printing of proceedings and the offering of scholarships. All persons with an interest in urban entomology are invited to attend the conferences and associated events.

ARTICLE VI-OFFICERS

Leadership for the Conference will be provided by the Chair of the Conference Committee. The Executive committee will be composed primarily of representatives from academia, industry and government. There will be seven officers of the Executive Committee and will include the following:

Chair of the Conference Committee
Chair of the Program Committee
Chair of the Awards Committee
Secretary to the Conference
Treasurer to the Conference
Chair of the Sponsorship Committee
Chair of the Local Arrangements Committee

The Chair of the Conference Committee will preside at all Committee meetings, and will be the Executive Officer for the organization, and will preside at meetings. In the absence of the Chair of the Conference Committee, the Chair of the Program Committee may preside. The voting members for executive decisions for the conference will be by a majority vote of a quorum which is here defined as at least five officers.

The duties of the officers are as follows:

Chair of the Conference Committee: To provide overall leadership for the Conference, to establish ad hoc committees as needed, and to solicit nominations for new officers as needed.

Chair of the Program Committee: To coordinate the conference in terms of arranging for invited speakers and scientific presentations as well as oversee the printing of announcements, programs and proceedings.

Chair For Awards: To oversee and administer the Mallis Award, scholarships and other honors or awards as approved by the executive committee.

Secretary: To take notes and provide minutes of meetings.

Treasurer: Provide documentation of expenditures, and the collection and disbursement of funds. To act on behalf of the executive committee in making arrangements with hotels, convention centers and other facilities in which conferences are held.

Chair For Sponsorship: This committee will be involved in fund raising and in seeking sponsorship for various aspects of the conference. It will also contact contributors and potential contributors to seek donations and support for the conference and associated events. It is anticipated that the committee will be composed of at least one member representing academia, and one member representing industry.

Chair For Local Arrangements: To gather information on behalf of the executive committee for hotels, convention centers and other facilities in which the conference is to be held. To arrange for audio/visual equipment, and to oversee the general physical arrangements for the conference.

ARTICLE VII-TERMS OF OFFICE & SUCCESSION OF OFFICERS:
Officers may serve for a maximum of four conference terms (8 years); however, if no new nominations are received, the officers may continue until such time as replacements are identified and installed.
The Awards Chair is the last position to be served, and may be relieved from NCUE officer duties unless asked or willing to serve NCUE in another capacity.
The Conference Chair may serve for one conference after which time they will become the Chair of the Awards Committee.
The Program Chair may serve for one conference term after which time they will become the Conference Chair.
The Secretary may serve for one conference term, after which time they will become the Program Chair.

The Chair for Local Arrangements should change with each conference unless the meetings are held in the same location.
The Chair the Sponsorship Committee (to include both an academic and industry representative) will serve for two conferences.
The Treasurer will serve for two conference cycles, unless reappointed by the Executive Committee.

ARTICLE VIII-NOMINATION OF OFFICERS
Nominations for any of the chair positions may come from any individual, committee, or subcommittee, but must be forwarded to the Chair of the Conference before the final business meeting of each conference. It is further anticipated that individuals may be asked to have their names put into nomination by the Chair of the Conference. In the event that there are no nominations, the existing Chair may remain in office with a majority vote of the Executive Committee for the conference. It is clearly the intent of these provisions that as many new people be included as officers of this organization as is possible, and no one shall be excluded from consideration.

ARTICLE IX-MEETINGS
Conferences of the National Conference on Urban Entomology will be held every two years. Meetings of the officers of this organization will meet at least annually either in direct meetings or by conference calls in order to plan the upcoming conference, and to conduct the business of the organization.

ARTICLE X-FINANCIAL RESPONSIBILITIES
All financial resources of the Conference will be held in a bank under an account named, “National Conference on Urban Entomology", and may be subjected to annual audits. Expenditures may be made in support of the conference, for scholarships and other reasonable costs; however, funds may **not** be used to pay officers’, or their staff’s salaries, or for officers’ travel expenses. In the event that this organization is disbanded, all remaining funds are to be donated to the Endowment Fund of the Entomological Society of America.

ARTICLE XI-FISCAL YEAR
The fiscal year will run from January 1 through December 31 of each year.

ARTICLE XII-AMENDMENTS
The bylaws for this organization may be amended by a two-thirds affirmative vote of the attendees at the business meeting, provided that the proposed amendments are available for review at least 48 hours in advance of the voting.

ARTICLE XIII-INDEMNIFICATION
The National Conference on Urban Entomology shall indemnify any person who is or was a party, or is or was threatened to be made a party to any threatened, pending or completed action, suit or proceeding, whether civil, criminal, administrative or investigative by reason of the fact that such person is or was an officer of the Committee, or a member of any subcommittee or task force, against expenses,

judgments, awards, fines, penalties, and amount paid in settlement actually and reasonably incurred by such persons in connection with such action, suit or proceeding: (I) except with respect to matters as to which it is adjudged in any such suit, action or proceeding that such person is liable to the organization by reason of the fact that such person has been found guilty of the commission of a crime or of gross negligence in the performance of their duties, it being understood that termination of any action, suit or proceeding by judgment, order, settlement, conviction or upon a plea of nolo contendere or its equivalent (whether or not after trial) shall not, of itself, create a presumption or be deemed an adjudication that such person is liable to the organization by reason of the commission of a crime or gross negligence in the performance of their duties; and (II) provided that such person shall have given the organization prompt notice of the threatening or commencement (as appropriate) of any such action, suit or proceeding. Upon notice from any such indemnified person that there is threatened or has been commenced any such action, suit or proceeding, the organization: (a) shall defend such indemnified person through counsel selected by and paid for by the organization and reasonably acceptable to such indemnified person which counsel shall assume control of the defense; and (b) shall reimburse such indemnity in advance of the final disposition of any such action, suit or proceeding, provided that the indemnified person shall agree to repay the organization all amounts so reimbursed, if a court of competent jurisdiction finally determines that such indemnified persons liable to the organization by reason of the fact that such indemnified person has been found guilty of the commission of a crime or of gross negligence in the performance of their duties. The foregoing provision shall be in addition to any and all rights which the persons specified above may otherwise have at any time to indemnification from and/or reimbursement by the organization.

Modified: 5/19/10-passed

Letters Certifying Compliance with IRS Filing Requirements

TDC
THOMPSON, DERRIG & CRAIG, P.C.
Certified Public Accountants

February 13, 2017

National Conference of Urban Entomology
Board of Directors
c/o Texas A&M University
Center for Urban and Structural Entomology
2143 TAMU
College Station, TX 77843-2143

Dear Board of Directors,

The organization's average annual gross receipts for the three-year period of 2014, 2015, and 2016 is $49,368. Therefore a Form 990 is not required. A Form 990-N (the e-Postcard) has been electronically filed with the IRS for the 2016 tax year to notify the IRS that the organization's average annual gross receipts are under the $50,000 threshold.

Sincerely,

Dillard Leverkuhn, CPA

1598 COPPERFIELD PARKWAY, COLLEGE STATON, TX 77845 979.260.9696 F: 979.260.9683 firm@tdccpa.com/www.tdccpa.com

Form **990-N**

Electronic Notice (e-Postcard) for Tax-Exempt Organization Not Required to File Form 990 or 990-EZ

2016

Electronic Filing Only — Do Not Mail

For the 2016 calendar year, or tax year beginning 1/01 **, 2016, ending** 12/31 , 2016

Check if applicable ☐ Termination	**Organization name and address** NATIONAL CONFERENCE OF URBAN ENTOMOLOGY 2143 TAMU, TEXAS A&M UNIVERSITY COLLEGE STATION, TX 77843-2143	**Employer identification number** 57-0802364 **Telephone Number** (979) 845-5855

Other names the organization uses

Website:>

Check > ☒ if the organization's gross receipts are normally not more than $50,000 ($5,000 for a 509(a)(3) supporting organization)

Principal Officer Information	**Name**	LAURA NELSON
	Address	2143 TAMU COLLEGE STATION, TX 77843-2143

Form 990-N, also known as the e-Postcard, must be filed electronically with the Internal Revenue Service. There will be no paper form accepted by the Internal Revenue Service.

Do Not mail this form to the Internal Revenue Service.

TEEL0801L 06/16/16

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Client 60350    - National Conference of Urban E     EIN: 57-0802364
 US:              Even Return...............$0

Activity
________

US - ACCEPTED    02/13  (Current Status)
Submission ID: 7410532017044009eb9n

   Previous Activity
      -  02/13 Sent to the IRS
      -  02/13 Received at Lacerte
      -  02/13 Sent to Lacerte
      -  02/13 Ready To Send
      -  02/13 Passed Validation
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THOMPSON, DERRIG & CRAIG, P.C.
Certified Public Accountants

1598 COPPERFIELD PKWY
COLLEGE STATION, TX 77845-4674
(979) 260-9696

January 31, 2018

National Conference of Urban Entomology
2143 TAMU, Texas A&M University
College Station, TX 77843-2143

Dear Client:

Your 2017 Electronic Notice (e-Postcard) for Tax-Exempt Organizations will be electronically filed with the Internal Revenue Service. No tax is payable with the filing of this return.

Please be sure to call us if you have any questions.

Sincerely,

Dillard Leverkuhn, CPA

Form **990-N**

Electronic Notice (e-Postcard) for Tax-Exempt Organization Not Required to File Form 990 or 990-EZ

2017

Electronic Filing Only– Do Not Mail

For the 2017 calendar year, or tax year beginning 1/01 **, 2017, ending** 12/31 , 2017

Check if applicable

☐ Termination

Organization name and address	**Employer identification number**
NATIONAL CONFERENCE OF URBAN ENTOMOLOGY 2143 TAMU, TEXAS A&M UNIVERSITY COLLEGE STATION, TX 77843-2143	57-0802364 **Telephone Number** (979) 845-5855

Other names the organization uses

Website:>

Check > ☒ if the organization's gross receipts are normally not more than $50,000 ($5,000 for a 509(a)(3) supporting organization)

Principal Officer Information		
	Name	EDWARD VARGO
	Address	2556 F&B RD COLLEGE STATION, TX 77843-2143

Form 990-N, also known as the e-Postcard, must be filed electronically with the Internal Revenue Service. There will be no paper form accepted by the Internal Revenue Service.

Do Not mail this form to the Internal Revenue Service.

TEEL0801L 07/06/17

01/31/2018	2017 e-file Activity Report	Page 1
03:02 PM	Thompson, Derrig & Craig, PC	

Client 60350 - National Conference of Urban E EIN: 57-0802364
US: Even Return...............$0

Activity

US - ACCEPTED 01/31 (Current Status)
Submission ID: 7410532018031002vl68

Previous Activity
- 01/31 Sent to the IRS
- 01/31 Received at Lacerte
- 01/31 Sent to Lacerte
- 01/31 Ready To Send
- 01/31 Passed Validation

THOMPSON, DERRIG & CRAIG, P.C.
Certified Public Accountants

February 1, 2018

National Conference of Urban Entomology
Board of Directors
c/o Texas A&M University
2143 TAMU
College Station, TX 77843-2143

Dear Board of Directors,

The organization's average annual gross receipts for the three-year period of 2015, 2016, and 2017 is $26,298. Therefore a Form 990 is not required. A Form 990-N (the e-Postcard) has been electronically filed with the IRS for the 2017 tax year to notify the IRS that the organization's average annual gross receipts are under the $50,000 threshold.

Sincerely,

Dillard Leverkuhn, CPA

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