The Proceedings of the 2014

National Conference on Urban Entomology

San Antonio, TX

Edited by Dr. Kyle K. Jordan, BASF Professional & Specialty Solutions

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Thank you again!

Introduction

The National Conference on Urban Entomology has become an important forum for sharing ideas and information and for networking with colleagues from around the world. Though these proceedings only include information from those authors who chose to submit, they reflect the diverse and relevant spectrum of research and interests of our community.

Thank you to those of you who took the time to provide material to include in this publication. Except for some formatting and correcting conspicuous errors, changes were not made to the submissions.

See you in New Mexico in 2016!

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May 18-21, 2014
San Antonio, Texas

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School IPM: Moving the ball forward and keeping it sustainable

Floating Unfunded Mandates: Florida's IPM in Schools Program

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The problem: School administrators prioritize resources based on metrics required by law or funding stipulations. Implementing Integrated Pest Management (IPM) in Florida schools is low a priority because there are no laws or rules in place to hold anyone accountable for substandard or ineffective pest control. Although the Department of Education has a mandate to use IPM through the State Requirements for Educational Facilities (SREF 5.E.5, 2012), it is unfunded and not enforced. The Florida Department of Agriculture and Consumer Services (FDACS) maintains the position that it does not have the specific authority to enforce IPM despite an all-encompassing definition for pest control which includes:

"(a)The use of any method or device or the application of any substance to prevent, destroy, repel, mitigate, curb, control, or eradicate any pest in, on, or under a structure, lawn, or ornamental;

(b) The identification of or inspection for infestations or infections in, on, or under a structure, lawn, or ornamental;

(c) The use of any pesticide, economic poison, or mechanical device for preventing, controlling, eradicating, identifying, inspecting for, mitigating, diminishing, or curtailing insects, vermin, rodents, pest birds, bats, or other pests in, on, or under a structure, lawn, or ornamental…"
(Florida Statute 482.021(22))

Enforcing existing pesticide application laws is only a partial solution because:

1) In states that do not have laws requiring IPM, any viable IPM programs would be in place due to school or district policy. In this case, most regulatory agencies do not have authority to dictate school policy.
2) State agencies are not motivated to promote enforcement actions against each other.

3) There is evidence that in some schools no pesticides are used, resulting not only in uncontrolled pest infestations, but also leaving nothing for regulators to enforce given the pesticide-centric position of FDACS, and
4) Pesticides should be a small component of IPM programs. Thus, under the specific authority claimed by FDACS, there would be little action that could be taken. FDACS' position is currently that "education is enforcement" but it will not compel a school district to implement IPM.

In addition to the inherent issues associated with stand-alone IPM programs being a low-priority, there is significant turn-over in schools. Schools intrinsically serve a large transient population: students. Secondly, staff members, particularly those directly responsible for pest control, are generally under-appreciated and under-paid. It is not uncommon for these staff members to move on to better paying jobs, partially because of the IPM training they received. The departure of an enthusiastic IPM implementer can be a devastating set-back in a state without school IPM laws because there is no requirement for the replacement hire to be motivated to continue the IPM program. Significant turn-over means that training and re-training a school population on the principles of IPM becomes an on-going task. Current resource allocation models do not account for this perpetual activity in order to maintain sustainable programs.

There are many approaches to solving the problem of implementing IPM in schools regardless of whether funding and laws exist, including developing partnerships that can strengthen the foundation of all verifiable IPM programs. However, the final solutions must rest in empowering schools to prevent and control pests when they occur. The easy answer to this problem is to not put any effort toward IPM in schools. The result: Children spend many hours a day in facilities that do not have adequate pest control which we now know can have serious health outcomes. In a state where IPM is an unfunded mandate, too many schools have opted to ignore pest control.

Keep the solution simple. How do you float school IPM in a state where schools do not have to use IPM? Find ways to incorporate IPM-related functions into a school's daily operational activities.

1. Select the right people. There are people who are willing to do their part of an IPM program even without a requirement. Hire and reward people who understand the importance of exclusion and pest prevention to overall school health.

2. Select IPM-related functions that can lead to a sustainable program and something that can be accomplished at the school level. We have defined a sustainable program as one where IPM is incorporated into the daily operational activities of the school

community. Keeping recommendations simple and do-able, which often equates to affordable, is important in school IPM programs.

Every school has a building maintenance budget. In 2012, we launched a “Fix the Building Envelope” campaign because deteriorating infrastructure is a significant impediment to pest prevention. In 2013, we focused on simply fixing door sweeps on external doors only. Entering into the 3rd year of our initiative in 2014, we began seeing “success stories” declaring door sweeps a “fifth man” in a four person team with significant decreases in rodent activity in schools. The “Fix the Building Envelope” example also serves to illustrate another important point: Many school IPM programs are funded solely through grants. During a one-year grant cycle, it is usually not possible to see the impacts of even a simple recommendation. However, during a 3 to 5 year horizon, more significant impacts can be seen, as demonstrated above. It is important to adjust expectations for measurable impacts.

3. Emphasize simplicity. Every school has custodial services and the great majority of IPM is sanitation. Simplifying the environment by decreasing clutter will increase custodial efficiency, increase the ability to monitor for pests, and eliminate pest breeding sites.

4. Other IPM-related functions which also decrease pest conducive conditions include keeping landscape trimmed away from buildings and adjusting irrigation heads away from the building walls.

Minimize complexity.
There are many helpful guidance documents such as the “Sensible Steps to Healthier School Environments” (EPA 2012). Statewide coordinators may find these types of comprehensive documents helpful when working with individual school districts or schools to tailor an IPM program. However, finding these types of documents is often the first hurdle. In a 2012 survey of Florida School Plant Management Association session attendees only 22% knew that the “Sensible Steps” document existed. Additionally, only 44% knew that EPA also had a website for school IPM, while 78% knew that the University of Florida maintained a website with material to support school IPM. Even if comprehensive guidance documents are found, they may be perceived as overwhelming and not achievable.

Leverage existing resources.
Leveraging existing resources almost sounds cliché, but there is significant value in using public information and existing data sets. Public information can include high-profile media reports of school kitchens being shut down due to pest problems. In April

2011, Florida's Department of Health closed 22 Orange County Public Schools (OCPS) kitchens in what became a high-profile media event. Orange County Public Schools is the 10th largest school district in the nation with over 180 schools and 180,000 students. The OCPS website contained information for a complete IPM program, but it was clearly not implemented. Once the crisis was managed, the Florida School IPM program offered its assistance and worked with OCPS to develop an IPM program which included providing training to the entire staff via its sister-program at Pest Management University combined with on-site follow-up visits. The OCPS program had become the fastest turn-around of a school district that the Florida school IPM program had documented to date. The OCPS success-story was largely due to the supervisor who was tasked with remediating the pest problem. Once he understood the importance of an IPM approach to pest control in schools, in addition to mandatory training, he was able to identify staff who would work with him in developing and implementing an escalation protocol for pests in kitchens, which included a reporting system, and quality assurance follow-up. In 2013, the supervisor left for a better paying position. Without state requirements in place for an IPM service in schools, it remains to be seen if OCPS will sustain its IPM gains.

Another example of leveraging existing resources is the use of food hygiene inspection reports. Inspections of food handling facilities up to 4 times per year are statutorily required by the Florida Department of Health (FDOH). The date, location and rating ("satisfactory" or "unsatisfactory") for a calendar year, can be accessed from a public website. While the FDOH report mainly emphasizes meat temperature and sanitation, it does have a specific reference to "vermin control." If food handling establishments repeatedly fail the FDOH inspection, we assume it is because of underlying standard operating procedure failures which will likely lead to a pest problem. An arbitrary 15-20% "unsatisfactory" rating over all county inspections rated as "unsatisfactory" was selected as a threshold for determining when a school district might have a pest control problem within a given county.

Food handing inspection data are used this way: In May 2014, 30.2% of all the FDOH inspections done in Orange County were schools (n=540, including up to 4 visits to the same school) out of a total of 1,788 inspections for a calendar year. There were 143 food handling establishments that received an "unsatisfactory" rating in Orange County, which included 11 schools. Thus, 7.7% of all the "unsatisfactory" ratings (n=143) were due to school kitchens. In contrast, Manatee County Public Schools, which has been our model school IPM district, underwent 209 school inspections (including up to 4 visits to the same school) which accounted for 35.6% of all of the inspections done in Manatee County with no schools failing. There have been some counties in Florida where approximately 50% of the “unsatisfactory” FDOH food hygiene reports are schools.

Partnerships and closing thought for more sustainable programs. On September 12-13, 2013, the University of Florida, school IPM implementers from several states, EPA, and the Association of Structural Pest Control Regulatory Officials (ASPCRO) held a “School IPM Partnerships Workshop” in an effort to build more sustainable programs. We did an Advanced IPM training session, followed by two facilitated sessions to tackle the issue of building sustainable programs.

Numerous suggestions and strategies were offered as to how maintain sustainable programs. “More education and training” was a constant theme. However, we would caution that training has to be meaningful. Can training and certification requirements become a hindrance to IPM implementation? Yes. When it is simply another death-by-PowerPoint, bureaucratic step in the process, not geared toward satisfying how to solve the very real pest control problems in schools.

In the same survey done in 2012 with the Florida School Plant Managers, they were asked to complete the following statement: “I learn best by…” 83.3% said that they learned best by hands-on training, 16.7% by PowerPoint lecture, 11.1% by watching training videos, and 0% by webinars. While technological advances may make other learning options more palatable through time, IPM implementers are hands-on learners. As statewide IPM program managers, are we offering hands-on options the primary method of training or do grant reports require high numbers as a measure of impact?

In closing, Mary Scattergood (Collier County Public Schools, Food Services Division) commented that “(t)here is a misconception that schools don’t want to do IPM. They want to do it but need help. They want to do the right thing. They are already spending money on pest control; they just need to spend it a different way.”

References

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IPM and pesticide safety — How Washington has linked the two together.

Carrie R. Foss
Washington State University Puyallup

The WSU Urban IPM and Pesticide Safety Education Program trains 2,300 pesticide applicators each year in western Washington on IPM and pesticide safety education. The majority of the attendees work in public areas, including schools. One day of the two-day trainings focuses on integrated pest management topics while the second day centers on environmental protection and personal safety. In 1999, the WSU Urban IPM Program initiated the WSU IPM Certification Program to acknowledge pesticide applicators for their investment in IPM education. IPM hands-on workshops were added as a curriculum and recertification option. The workshops incorporate pesticide safety education into the curriculum. For example, during the Water Quality and IPM hands-on workshop attendees learned about the impacts of environmental chemicals on salmon at the WSU Puyallup fish lab but also about rain garden plant selection. Pest management professionals who work in schools, multi-family housing, single-family residential, and commercial sites are trained at the WSU Structural Pest IPM Facility. The WSU Urban IPM Program partners with the Washington State Department of Health, EPA, the Washington State Department of Ecology and others to provide science-based information on IPM and pesticide safety.

Who needs to be involved? Using interviews to improve implementation of IPM in schools

Deborah Young[1], Susan Tungate[2], Ryan Davis[1], Esther Chapman[1], and Kristen Carman[1]
[1]Colorado State University, [2]Utah State University

Summary

The objectives of this research were to (1) use stakeholder interviews as a tool to determine community readiness for IPM adoption in schools and (2) understand the skills and knowledge of IPM by school personnel. We conducted one-on-one phone interviews with key staff in Colorado and Utah schools. We assessed responses, using the Community Readiness model, in order to determine what approaches are most effective. Responses were analyzed based on job title and by school district. We found significant differences among groups and are designing educational programs to target each group.

Methods

Successful outreach programs are community specific, culturally relevant, and consistent with the level of readiness of the community to implement change. We conducted key respondent interviews, from a modified Community Readiness Model, to assess improve our understanding of school districts ability to adopt IPM.

Telephone interviews were conducted with 50 school staff (across six school districts, three each in Colorado and Utah. Interview participants represented six targeted stakeholder groups: custodians and facility managers, teachers, principals/ administrators, kitchen/nutrition staff and nurses. Interview questions were adapted from the Community Readiness (CR) model (Plested, Edwards, & Jumper-Thurman, 2006) and sought to elicit participant perspectives across six dimensions of readiness (existing community efforts, knowledge of efforts, leadership, community climate, knowledge of the issue, and resources) to address an identified community issue. The “community” for this project was identified as the school district. Detailed notes from participant responses were taken for each interview; interviews were not audio-recorded.

Researchers, in pairs, rated the interview responses on each dimension using the CR nine-point scale (1 = no awareness; 2 = denial/resistance; 3 = vague awareness; 4 = preplanning; 5 = preparation; 6 – initiation; 7 = stabilization; 8 = confirmation/expansion; 9 = high level of community ownership). When rating differences occurred, the researchers discussed these to gain consensus on the final scores. Ratings were then summed and averaged on each dimension across school districts by role/stakeholder group and within each individual school district. Summed scores were averaged to obtain an overall CR score for each district and for each role/stakeholder group across the districts and states. Additionally, each interview was separately coded to identify key themes and concepts related to decision-making authority and communication, organizational culture and stakeholder group interests and perceptions.

Results

School staff responsible for facilities, both inside and out, were most familiar with IPM and had the highest Community Readiness (CR) scores (4.55 and 4.64, respectively). See Table 1. Pest management was considered more of a concern inside buildings than outside. Grounds personnel said that communication between these two maintenance groups is not very integrated. One comment was that the “outside” grounds staff had implemented IPM for a longer period of time than the “inside” staff.

Facility directors and head custodians (inside buildings) reported some familiarity with the principles, such as to eliminate attractants/environment for pests and minimize pesticides. One person talked about allergens and indoor air quality. Their average CR score shows that the community climate is beginning to acknowledge the issue. One respondent said that you "can't have a school full of kids trying to learn in an environment that is not safe and clean to learn in." Food storage is a concern to custodial staff – in the classrooms and in the kitchen.

Table 1. Average CR scores based on compiled by roles across districts.

Roles	Overall Average Readiness	Overall Readiness Level
Facilities (inside)	4.55	Preplanning
Facilities (outside)	4.62	Preplanning
Kitchen	4.26	Preplanning
Teacher	3.52	Vague Awareness
Administration	3.92	Vague Awareness
Nurse	3.82	Vague Awareness

District support for IPM was generally unknown to custodial staff. There were comments that health and safety is always a concern, that support would follow visible benefits and evidence of district support is volunteering as a pilot school. Some thought that maintenance departments had a good understanding of IPM, but that there was a need to educate the principal and teachers, especially regarding food in the classroom. According to facility staff, principals and teachers assume that maintenance takes care of it and they do not want to know the details.

Custodians said that more training was needed; they mentioned the health department and Extension as sources of information.

Outside facilities and grounds maintenance staff were somewhat familiar with the concept of IPM. Those who participated in a pest assessment "walk-through" had greater awareness. This group said that, while there is district support for IPM, leadership is not knowledgeable about IPM and the priority for leadership is to educate kids. Liability and safety were mentioned; one person referred to a girl in Utah who died because of pesticide exposure.

Respondents indicated that more training is needed. Information sources, such as work orders, records on pesticide use, pest control company records and, in some districts, a computer tracking system, are available. One respondent wanted to be in the pilot program in order to assist with raising awareness among teachers.

Kitchen and nutrition staff were also familiar with IPM; the overall CR score was 4.26. Some said that pest management it is always a concern because it is a health and safety issue; kitchens are subject to health department inspections. Others said that it is not a concern because there are no problems or problems are addressed promptly. Most respondents were not sure about the level of IPM knowledge amongst leadership and did not know whether there was support for IPM in their school district. They did not know about the level of expertise and training among those who work with pest management in their districts/schools.

Most teachers have never heard of IPM. They do not know how much leadership in the district knows about IPM. They have no idea about the level of training or expertise on IPM in the district. The average Community Readiness (CR) score was 3.52, indicating that a few recognize a local problem, but are not motivated to do anything about it.

Administrators (Principals, Assistant Principals, and Risk Management), like teachers, are not familiar with IPM. The average CR score was 3.92, indicating that discussion is beginning, but no real action is taking place. There was more awareness for those who participated in the pest assessment (walk-through) of their building. Principals assessed their school district leadership as not knowledgeable specifically about IPM. They assume that those who need to know (maintenance and facilities management), do. Principals think they have enough information and most thought their current system is working fine. They assume that pesticide use is documented and assume that there is a strict regimen around the safe use of pesticides.

Most nurses and health aides interviewed have never heard of IPM. They have no knowledge of the school district's familiarity with IPM and assume that the school district would support IPM efforts. They do not know how pests are handled, but "I trust that they will handle it." Health personnel do not see any big problems regarding pests. Nurses did not know where to go for information regarding pest management, data regarding incidents or use of pesticides. Respondents speculated that pest management is likely a concern for the school or district because of the importance of health and safety; the average CR score was 3.82.

Facility and custodian staff repeatedly mentioned communication, within the school and the school district, as an important consideration in adopting IPM. We asked each person where he or she would go if there were a pest concern. Most schools use a tiered response, with the majority of pest problems handled at the building level. A large concern would go to the district level, which might involve bringing in an outside contractor to address the problem. Monthly building inspections were mentioned.

• Grounds personnel would go to inside custodial staff, then to maintenance, then to risk management, then to an outside contractor.
• Kitchen would go to the principal, who would contact custodial or the district level facilities management.
• Teachers would go to the principal or the custodian; they assume that the principal would go to custodial.
• Principals would go to the building manager or custodian. There is a lot of autonomy regarding decision-making at the building level and principals said that they know what is going on in their buildings.
• Nurses would turn to the front desk, the school secretary or the principal, who would likely engage the custodial staff. They identified facilities or custodial as the go-to people regarding pest management.

When asked about obstacles to implementing IPM, all respondents mentioned time and money. Custodians mentioned staffing, education and awareness, training, attitudes and cultural change, compliance and follow-through. Grounds staff said that implementing IPM is labor intensive and that staffing resources are limited. Other obstacles included: getting administration on board (they want to be in the loop, but not part of [the effort), training custodians, the size of the district and staffing resources (in the long run it saves money; in the short run it costs money), education of faculty, and funding. Kitchen staff, teachers, principals and nurses were unaware of specific obstacles. Potential obstacles to implementing IPM were change from previous practices and taking ownership (kitchen staff); lack of information or low priority (teachers); lack of understanding (principals); and communication or government red tape (nurses).

References

Plested, B. A., Edwards, R. W., & Jumper-Thurman, P. (2006, April). Community readiness: A handbook for successful change. Tri-Ethnic Center for Prevention Research, Colorado State University. Fort Collins, CO. website: http://www.triethniccenter.colostate.edu/.

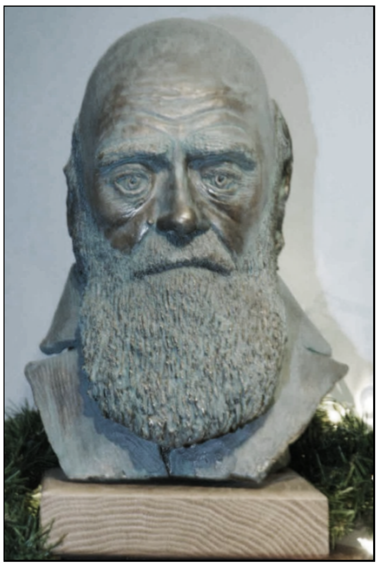
Gene Wood Tribute Lecture

A TRIBUTE TO GENE WOOD

An Extraordinary Friend and Quintessential Extension Entomologist

September 19, 1932 - May 18, 2013

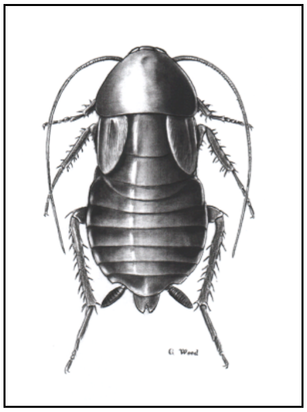
Patricia Zungoli
Clemson University



Many of the people who currently attend the National Conference on Urban Entomology may not have known Gene Wood. I hope to paint for you a vivid picture of the complex, intelligent, sincere man that some of us were fortunate to know well, and to leave you not just with the essence of Gene's personality, but to also provide you with a sense of his contributions to the discipline we share.

Francis Eugene Wood was an eclectic man, an unconventional renaissance man who was a scientist, teacher, mentor, naturalist, poet, listener, scout leader, cabin builder, artist, sculptor, father, grandfather, husband, and friend. Mostly Gene was known in all aspects of his life by the epithet he would often use to refer to people he liked. He was a "solid citizen." His meaning of solid citizen would change, but at the core of it was a fundamental niceness that his wife, Nan Booth, attributed to his mid-western upbringing. As a consummate solid citizen, Gene was a good friend to many people. In fact, after Gene died Nan was astounded by the number of people who told her at the time of his death that Gene was their best friend.

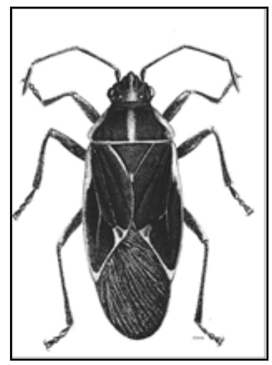
For 36 years Nan was his best friend, ally, partner, and confidant. She has been a good friend to his four children, Nancy, John, Becky, and Joe, and a doting grandmother to Aaron, Josh, and Grace. Nan and Gene shared loving, lasting, and sincere friendships with many multi-faceted, diverse people, and their home was always filled with good conversation and much laughter. Gene had a deep affection for many of the people he encountered in Mathias, West Virginia where in 1974 he purchased 22 acres of land on



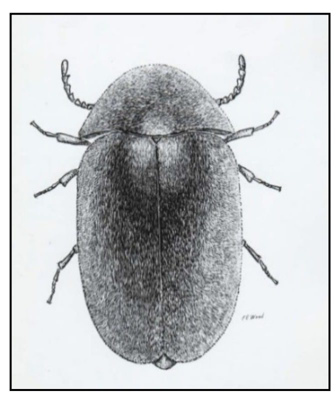
which he and Nan, with the help of many friends, built a log cabin. The conversations and laughter continued in the low light of kerosene lamps and fire from the wood stove.

Born in Jefferson City, MO in the early in the years of the Great Depression, Gene was always grateful for his good fortune in life. He would often talk fondly of his grandparents and his many adventures as a boy scout. Scouting was a stabilizing force in Gene's younger years, and he remained active in scouting throughout most of his adult life eventually being recognized for the leadership he provide by being awarded the distinguished Silver Beaver Award.

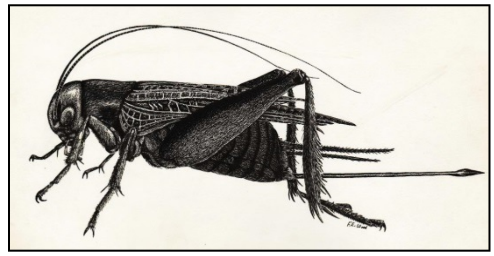
When only 19, Gene joined the 1st Division of the U.S. Marine Corps, and for his actions in Korea he received the Purple Heart. He was proud of his service and always considered the Marine Corps to be a turning point in his life. Leadership skills and the love of camaraderie that came from his experiences were foundational parts of Gene's personality. Armed with VA benefits after completing his service, he was able to pursue an education. With a young family in tow he went to the University of Missouri where he earned B.S. and M.S. degrees, all the while working for the Cooperative Extension Service and as curator of the insect museum. His move to Maryland allowed him to begin work toward a PhD and to continue to hone the craft of insect illustration and his talent for working with diverse groups essential for an effective Extension specialist.



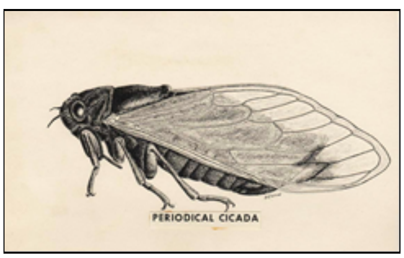
Beyond Gene's love of people, he loved poetry and language. His love of literature was a hallmark of his persona. He had a library of over 3,000 books all of which he had read, many more than once. He was never at a loss for an appropriate quote or passage from a past reading. Gene himself was a creative poet who delighted everyone with his imaginative twist of words, imagery, and rhymes frequently conceived to mark a special occasion.



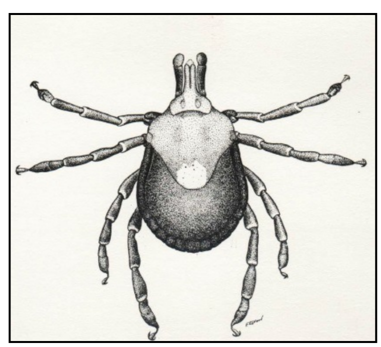
Gene's personal and professional lives were intertwined with his entomological friendships and many shared experiences. His work as an entomologist was one of service to his clientele, who he always found interesting. He felt the help he could offer was a worthwhile endeavor. Gene truly was a quintessential Extension Entomologist who at the early beginnings of what we call urban entomology, had to forge a knowledge path through limited research information, many misconceptions, and endless opportunities to assist his clientele.



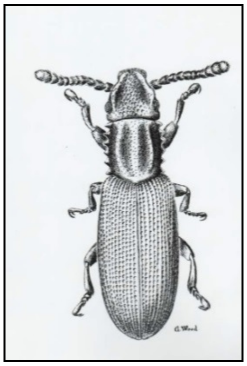
When the Environmental Protection Agency was formed, all of the new licensing requirements placed many pest management professionals (PMPs) in a difficult position. Gene saw a need and created evening courses to teach PMPs the basics of the core manual and category training. He was among the first to adapt agricultural IPM concepts to the urban world. He was profoundly aware that “management” of indoor urban pests may not offer the quality of life that his target audience wanted and deserved, and he set about designing a program for the Baltimore Public Housing Authority with dual goals of reducing insecticide applications and “controlling” German cockroaches. He was a strong proponent of the end goal being control even if the reality would be management. His work in Baltimore is still one of the largest and most ambitious demonstration projects ever launched.



One of Gene’s projects that greatly pleased him, and many others, was when he proved to the Prince Georges County (MD) school system that desegregation does not cause head lice. The 1974 forced busing of school children was a difficult period. When a head louse outbreak occurred in several of the schools, it was immediately blamed on the busing. Gene knew from reading older articles that it was unlikely that the head lice had emanated from the African-American children at the schools, but he knew he had to prove it so he had small wigs woven with different types of ethnic hair. For several weeks he, along with some students, lived with these small wigs in petri dishes with mesh bottoms strapped to their arms all the while collecting data. In the end, he was able to show the school district leaders that the head lice differentially laid eggs on Caucasian hair.



In 1979, Gene began the Interstate Pest Management Conference for PMPs. The conference transformed the industry in Maryland, Northern Virginia, and the District of Columbia. It is still one of the largest, most respected conferences of its kind. In 1986, toward the end of his career, Gene received the Distinguished Service Award for



Extension from Maryland University for his many contributions to the county agents, pest management professionals, and people of the State of Maryland.

Another area of influence that Gene was instrumental in developing was the concept of writing clear and specific contracts between agencies and the pest management firms providing services to them (Wood 1988). His plan was based on awarding contracts based on quality, not just cost. He proposed that announcements for services be handled in the same manner as any grant "request for proposals." While it may seem intuitive now, it was a novel concept to have an agency identify the outcome they expected and to award a contract based on a company's ability to provide the level of expertise and the program needed to meet the expectation instead of awarding contracts to the lowest bidder. His early work with the National Institutes of Health's animal care facilities is a model that has been used repeatedly by government agencies in Washington D.C. where the U.S. General Services Administration insists on outcome based proposals.

Gene was on the inaugural committee to establish the first National Conference on Urban Entomology in 1986. Because it was held at the University of Maryland, Gene served as the primary master of ceremonies and relished in hosting a meeting that had been conceived in countless conversations over many years. The first meeting was dedicated to Drs. Walter Ebeling and James Grayson. After that, Gene had the idea for the Arnold Mallis Memorial lecture to honor pioneers in Urban Entomology, and Gene was one of the early recipients of the award that accompanied that honor.

There was no area in which Gene's personal and professional lives co-mingled more than in his art. Every one of his Extension publications had an original drawing of the subject of the article and most of these were drawn by Gene. It may be difficult now to imagine a time when high quality photographs were not the norm; a time when the masses were still wielding Polaroid and Brownie film cameras and not today's digital Nikons or Cannons. If an early Extension publication was to graphically depict a subject, it was usually in the form of a line drawing. Unfortunately, this has become a rare aspect outside of the world of systematics and even then photography is becoming a frequent replacement for art. There is no true account of all the Extension publications Gene wrote. Like many of his drawings, they are already lost to history. The drawings that are still accessible are beautiful works, and some of them appear at the close of this tribute.

Just prior to retiring, Gene did a sabbatical at the Smithsonian to study under the renowned insect illustrator, George Venable. Gene appreciated and grew as an artist in the time he spent there. Under George's guidance, Gene produced a spectacular drawing of a tiger beetle worthy of any art museum. His sabbatical served to intensify his creativity. He transitioned from insects to the human form, and tried his hand at sculpting. He became part of a group of artists who met regularly to critique each other's work and learn new techniques, and of course, to forge new friendships.

It is difficult to impart the essence of a human being or the importance of their life, and their contributions to the lives of others, but it is even more difficult when the person is incomparable in so many ways. I will close this tribute to Gene with a quote from a close friend of his; Jay Nixon captures what many of would want to say. *"Gene stimulated my thoughts and unconditionally supported me in any way possible. For that I am eternally grateful."*

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Distinguished Achievement Award

Reflections on a career spanning 33 years in industry and academia

Jules Silverman
North Carolina State University

It is with great pride and pleasure that I accept the 2014 Arnold Mallis Distinguished Achievement Award in Urban Entomology. I thank the NCUE Award's Committee for selecting me for this important recognition. I am especially grateful to Coby Schal for nominating me and to Nonggang Bao, Grzesiek Buczkowski, Mike Rust and Ed Vargo for their letters in support of my nomination.

While pondering the topic for the Mallis lecture, it occurred to me that all of the 17 prior award winners had long careers solely in academia. I had spent the first 18 years of my career as an industry urban entomologist, before transitioning to academia. Through a combination of solid academic training, being at the forefront of an exciting and successful new technology, collaboration with highly capable and influential colleagues, plus a degree of serendipity, I've been able to navigate within and enjoy the many challenges inherent to both industry and academia.

After obtaining a Ph.D. at UC Riverside under the guidance of Mike Rust, with critical input from Don Reierson, I joined the Shulton Division of America Cyanamid Co in 1982. As Shulton's first entomologist, I was engaged with formulation chemists in developing the first generation of effective cockroach and ant baits, utilizing hydramethylnon as the active ingredient. A year later Shulton hired Ted Shapas as my boss. Ted was very effective at moving projects to completion while providing an important buffer for me against the demands of upper management, allowing for a considerable degree of research freedom. This afforded me, early in our working relationship, the opportunity to discover secondary kill (Domino Effect) in cockroaches, whereby active hydramethylnon was delivered to insects indirectly via coprophagy. In 1985, Ted did something previously unheard of in the company: he hired Don Bieman to conduct our field efficacy trials, based out of Don's home in Florida. This hiring decision proved key to our discovery of a highly unusual phenomenon responsible for some local bait failures. Don's observations in the field and his keen insights led to our understanding that cockroaches (Blattella germanica) evolved a distaste for a nutrient and bait phagostimulant, glucose: glucose-averse insects rejecting baits eventually dominated field populations. Twenty years later we would learn though the excellent studies conducted by Ayako Katsumata that in glucose-averse cockroaches taste neurons stimulated by bitter substances were also stimulated by glucose.

Another career highlight, while working with Dangsheng Liang at the Clorox Company, was our discovery that nestmate recognition between workers within a colony of Argentine ants was flexible and not entirely genetically based. Quite unexpectedly, when we fed Argentine ants brown-banded cockroaches (Supella longipalpa) workers attacked each other. They had acquired the cuticular hydrocarbons from the cockroach. This altered nestmate discrimination, provoking attack.

I left Clorox Co. for North Carolina State University in 1999. Here I continued our nestmate recognition research along with other Argentine ant projects of basic and applied interest. One notable irony in my career transition was that in industry I confined my efforts to bench level science, resisting temptations to move into management. At NC State I had the responsibility for training the next generation of scientists (graduate students and post-doctoral scholars), and thus my role changed from doing the research to directing the projects. All in all, I have been fortunate to have been engaged in exciting research with a great group of colleagues and students.

Student Award Papers

Masters

Molecular Diagnostic Technique for Identification of the Formosan Subterranean Termite, *Coptotermes formosanus* (Isoptera: Rhinotermitidae) From Other Rhinotermitidae

Mark A. Janowiecki and Allen L. Szalanski
University of Arkansas

The Formosan subterranean termite (FST), *Coptotermes formosanus* Shiraki, is an invasive termite that has rapidly spread throughout the southeastern United States costing more than $1 billion annually in control and damage. Currently, the FST has not been detected in Arkansas, but it has spread into the bordering states of Louisiana, Texas, Mississippi, and Tennessee. Termite identification is very difficult using keys for alates and soldiers, and nearly impossible for the differentiation of only workers. Because of this difficult identification, along with the unfamiliarity of the FST in states that it has not yet invaded, species specific PCR requiring only a single PCR reaction was developed. This method provides molecular identification of FST from other subterranean termites found in the United States in less than four hours. This molecular diagnostic method can augment existing techniques for monitoring the spread of this invasive species in the United States.

Ph.D. AWARD

USING MARK-RELEASE-RECAPTURE TECHNIQUE TO STUDY BED BUG MOVEMENT AND SURVIVAL

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Movement of bed bugs from an infested to an un-infested location occurs through passive and/or active dispersal (Usinger 1966, Reinhardt and Siva-Jothy 2007). Passive dispersal is typically human-mediated and occurs when bed bug infested items are transported from an infested environment to another location. It is also possible for bed bugs to be passively dispersed via birds or bats (Steelman et al. 2008), although the extent to which this occurs is unknown. Active dispersal, on the other hand is mediated by the bug itself, crawling from one location to another. Reinhardt and Siva-Jothy (2007) pointed out that the means by which bed bugs disperse are poorly understood and active dispersal, in particular, is an area of research where the least progress has been made. What is clear is that bed bugs can rapidly spread among apartments within multi-occupancy dwellings resulting in high infestations rates. Doggett and Russell (2008) tracked the spread of bed bugs from 1 to 68 living units in a medical sc hool housing facility over a 26 mo period. Similarly, Wang et al. (2010) reported that 45% of 233 apartments in a high rise building became infested within 41 mo of the first confirmed bed bug introduction and 53% of apartments adjacent to infested apartments had bed bugs. In both studies, over 50% of the infested living units shared a common wall, floor or ceiling with another infested apartment. It seems more likely that clusters of infested units are caused by human-mediated movement of bed bugs between residents visiting one another or through active dispersal of bed bugs crawling out of infested units into neighboring apartments than by independent introductions of bed bugs into the apartment buildings.

The first evidence that active dispersal may be in part responsible for widespread infestations was provided by Wang et al. (2010) who captured bed bugs in interceptor traps located behind the entry door inside of infested apartments as well as in traps located in the hallway just outside of the infested apartments. Despite evidence for active dispersal, absolute proof is still lacking. The close genetic relatedness of bed bugs in neighboring apartments reported by Booth et al. (2012) could be explained by bed bugs actively dispersing, passively dispersing or by a combination of the two dispersal methods.

Understanding the behavioral ecology of bed bugs provides crucial information necessary to advance current management strategies and to reduce the spread of bed bugs within residential communities and into the greater society. We used a mark-release-recapture technique in both vacant and occupied apartments to investigate if active dispersal of bed bugs occurs between an infested apartment and its neighboring apartments. This study also provides additional insight into the longevity of starved bed bugs in the absence of a host.

Materials and Methods

The first mark-release-recapture experiment was conducted in a one bedroom apartment that had become vacant 17 d earlier. The apartment was located in an affordable housing community for the elderly in Newark, NJ. The property management agreed to provide us access to the apartment for 4.5 mo. Bed bugs were hand collected from the apartment and returned to the laboratory to be marked with a small dab of yellow, green or blue acrylic paint on dorsal side of the abdomen. Each color group consisted of 159 bugs represented by 90 4-5th instar nymphs and 69 adults (32 males and 37 females). Approximately 10-20 extra marked bugs of each color were prepared for replacing the dead or unhealthy marked bugs before release. The marked bugs were held in the laboratory for 2 d at room temperature and a 12:12 h (L:D) cycle to examine mortality caused by the marking procedure. Mortality of marked bugs over the 48 h period was not significantly different from that of control bugs.

The bugs were released back into the apartment at three different locations 3-4 days after they were collected. The green bugs were released in the living room, yellow bugs in the bedroom and blue bugs in the bathroom. Because the apartment was vacant, two CO_2 traps mimicking a human host were installed, one in the bedroom where the resident slept and one in the living room where the resident spent time sitting during the day. The CO_2 source was a 5 lb cylinder which was controlled by a timer to release CO_2 between 10 pm-6 am each day. The release rate varied between 200-400 ml/min. Twenty-eight Climbup® interceptors, hereafter referred to as interceptors, were placed along the baseboards throughout the apartment. The interceptors were checked every 1-3 d for the first 30 d and then once per week thereafter for 86 d, and were replaced with clean interceptors at least once per week. A sticky tape barrier was installed across the door threshold inside of the apartment. Interceptors were also installed throughout the neighboring apartments on both sides, beneath and across the hall of the mark-release unit to detect the dispersal of marked bed bugs. The mark-release apartment was on the top floor (5th floor) of the building so there was no unit above the mark-release unit.

Results and Discussion

In the mark-release unit, a total of 2,924 bed bugs were captured from the interceptors and the traps baited with CO_2, of which 213 were marked. The trap catch was recorded daily for the first 12 d and then at 3 d intervals. The overall pattern of the marked bug trap was similar to that of the unmarked bugs (Fig. 1) illustrating that the marked bug catch is representative of the way the population is behaving and can be used to estimate population size. Within the first 24 h, bed bugs of each color had dispersed throughout the apartment (Fig. 2a). The majority of marked bugs were recaptured by 14 d with a similar pattern of dispersal from all three release locations (Fig. 2b). Thus, regardless of the release location, marked bugs dispersed throughout the entire apartment.

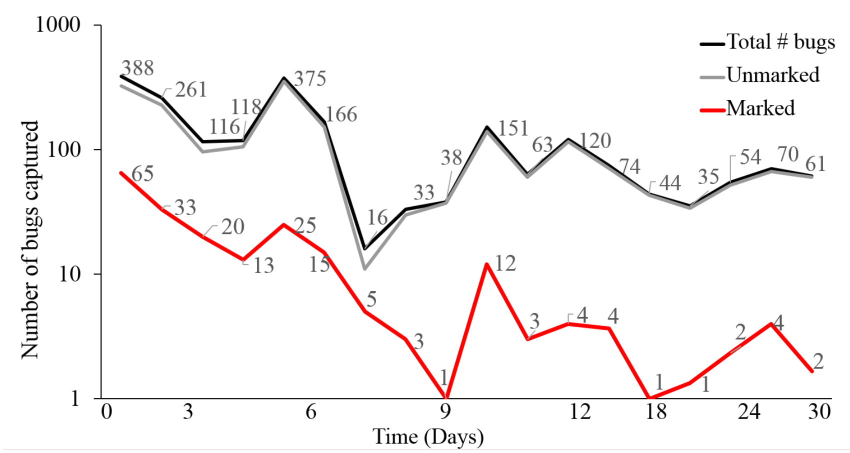

Fig. 1. Dynamics of trap catch after releasing the marked bed bugs.

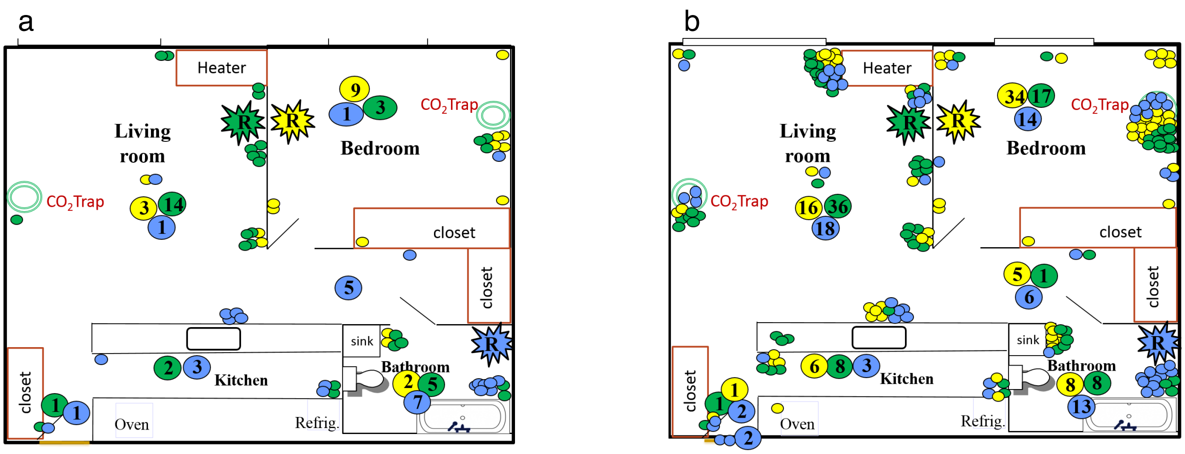

Fig. 2. Number of marked bugs re-captured at: a) 24 h; b) 14 d. Small colored circles represent the location of the recaptured marked bugs of corresponding color. Large circles with a number inside represent the total number of bugs of the corresponding color trapped in the room or region of the apartment.

We recaptured marked late instar nymphs (4th and 5th instar) up to 57 d after the resident had passed away, and adult females and males up to 113 and 134 d, respectively. Unmarked 1st instar nymphs were still being captured at 134 d. Unmarked late instar nymphs as well as adult females and males were still being captured at the conclusion of the study (155 d), demonstrating that these bugs were able to survive at least 5 mo in the absence of a host. The survival times observed are significantly longer than those observed under laboratory conditions by Polanco et al. (2011) who reported maximum survival times of ≤ 80 d for starved resistant strain bed bugs.

A marked bed bug was first recaptured in a neighboring unit 3 d post release. A total of 12 marked bed bugs were recaptured in the four neighboring apartments over the course of 25 d, with 11 of them recovered within the first 14 d after release (Fig. 3). All four neighboring apartments were infested with bed bugs, suggesting that the infestation in the mark-release unit was contributing to the infestations in the

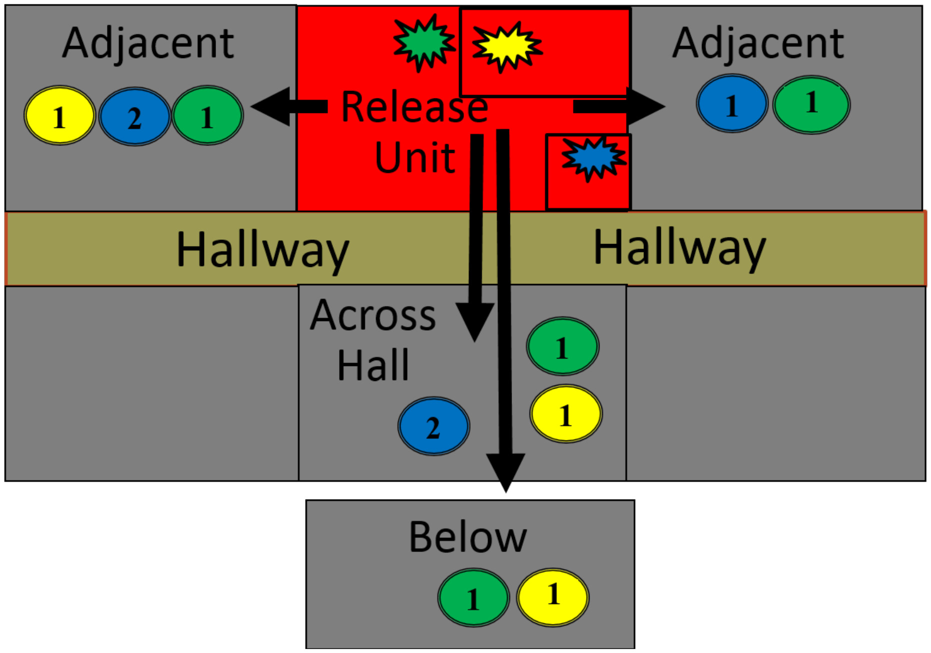

Fig. 3. Number of marked bugs re-captured in neighboring apartments. Colored circles with a number inside represent the total number of bugs of the corresponding color trapped in the neighboring apartment.

neighboring apartments and may have in fact been the source of infestation in some or all of the units. The results support the assertions made by Booth et al. (2012) and Saenz et al. (2012), who suggested that wide-spread infestations in apartment buildings are likely to be the result of a single, or several introductions.

This study demonstrates that the mark-release-recapture method can be used effectively to study the behavioral ecology of bed bugs under field conditions as well as to estimate population size. Using this method, we showed that active dispersal occurs between infested and neighboring apartments. We also documented survival times for both nymphs and adults, of at least 4.5 mo in the absence of a host. These results fill in the gap in our understanding of the ecology of bed bugs and provide important information needed in the development and implementation of bed bug eradication programs.

Acknowledgements

This project was supported by a grant from Norm Ehmann Urban Pest Management Award. The authors would like to thank Boyd Gonnerman and Marcus Kwasek for their assistance during the field inspections. A special thank you goes out to the residents and property management firms that cooperated in the study. This study was approved by Rutgers Institutional Review Board (IRB #E11-766).

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Student Paper Competition, Morning

Differential Gene Expression Analysis in Bed Bug Fed With 0.08% Blood Alcohol Concentration

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Recent resurgence in the common bed bugs (*Cimex lectularius*) infestations worldwide has created a need for renewed research in bed bug biology, behavior and control methods. Majority of the research at present is focused on bed bug infestations, distribution, insecticide resistance and control tactics, while a small percent focus on molecular levels, particularly at gene expression. Alcohol consumed by humans is circulated and stored in blood, and transferred to bed bugs during feeding. The authors previously reported the impact of alcohol in reconstituted human blood (RHB) on bed bugs feeding and fecundity. Current data provide new information of genes expression in bed bugs that were fed on alcohol based RHB. Total RNA was extracted and sequenced, RNA-seq. reads were mapped to the genome and read counts obtained. The read counts were then analyzed using Bioconductor software (DESeq and edgeR) to identify differentially expressed genes. Then BLASTx and BLAST2GO were used to identify the functional annotation of the novel sequence data from the differentially expression analysis. There were 2013 genes identified as significantly (padj <0.05) regulated by DESeq, while edgeR identified (FDR <0.05) 2503 genes. When comparing the two analysis programs 1923 genes were common, with 1113 up; 810 down regulated. Of the 1923 genes identified, 85% return BLAST hits with similarity to genes in BLAST nr database. Metabolic, cellular and single-organism processes accounts for greater than 50% of biological functions, while binding and catalytic activities accounts for greater than 75% of the molecular functions. qRT-PCR gene expression validation analysis for the genes tested agrees with the results obtained from the RNA-seq. analysis. Some of the genes significantly regulated were genes expected to respond that way, for example detoxification enzymes, such as cytochrome P450s, transferases, and hydrolases were up regulated, while stress, such as, heat shock proteins (hsp), hsp70 and hsp20 and reproduction enzymes (vitellogenin) were down regulated.

Genetic variation of the drywood termite *Incisitermes schwarzi* (Isoptera: Kalotermitidae)

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Incisitermes schwarzi (Banks) (Isoptera: Kalotermitidae) is a drywood termite found from extreme southern Florida to South America. Seventeen samples were collected from Florida, Barbados, Belize, Columbia, Panama, Jamaica, Honduras, Mexico, Venezuela, Grenada, Trinidad-Tobago, Bahamas, and the Dominican Republic. Both 16S and COII mitochondrial DNA segments were amplified and sequenced. Genetic variation ranged from 0.3 to 9.1% for 16S, and 0.6 to 10.0% for COII. Molecular phylogenetic analysis was conducted using both maximum parsimony and Bayesian methods to determine relationships among the DNA sequences.

Evaluating the impact of temperature on the tunneling performance of two invasive ants, *Nylanderia fulva* (Mayr) and *Solenopsis invicta* (Buren)

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Biological invasions by numerous plants and animals pose a significant threat to non-native environments by negatively impacting biodiversity and fundamentally altering ecosystems (Pimentel et al. 2000). Invasive ants are among the most damaging biological invaders, capable of diminishing native species abundance and diversity (Holway 1999). Many invasive ant species exhibit subterranean tunneling behavior that can be important for foraging, nest construction, and thermoregulation (Sudd 1969).

Solenopsis invicta (Buren), the red imported fire ant, is an invasive tunneling ant species native to South America that is established throughout the southeastern United States. This mound-building ant species constructs elaborate subterranean tunnel systems that can extend horizontally to territorial boundaries as well as reach vertically below ground (Markin et al. 1975, Penick and Tschinkel 2008). Horizontal subterranean tunnels provide *S. invicta* ready access to its foraging territory, even during poor climactic conditions such as rain or extreme temperatures (Markin et al. 1975). Deep subterranean nests provide *S. invicta* with stable moisture and temperature conditions and aid in thermoregulation (Jones and Oldroyd 2007).

Nylanderia fulva (Mayr), also known as the tawny crazy ant, is another invasive pest ant native to South America that, like *S. invicta*, has established in Florida and several other southeastern U.S. states. This species generates large polygynous and polydomous colonies commonly located in shallow littoral debris (Zenner-Polania 1990). In non-native ranges, large N. fulva populations have reduced species abundance, even displacing another invasive ant, Solenopsis invicta (Buren) (LeBrun et al. 2013). In North Florida, N. fulva populations survive winter temperatures (≤ 15° C) not typically experienced across their native South American range. Shallow littoral debris utilized by N. fulva offer little insulation to brood and reproductives when exposed to these winter temperatures in Central and Northern Florida. Alternative cold avoidance strategies for N. fulva have not yet been evaluated.

Field populations of *N. fulva* in North Florida were observed exhibiting subterranean tunneling behavior. Other invasive ant species utilize subterranean tunneling as a means of nest thermoregulation when temperatures above ground are unfavorable

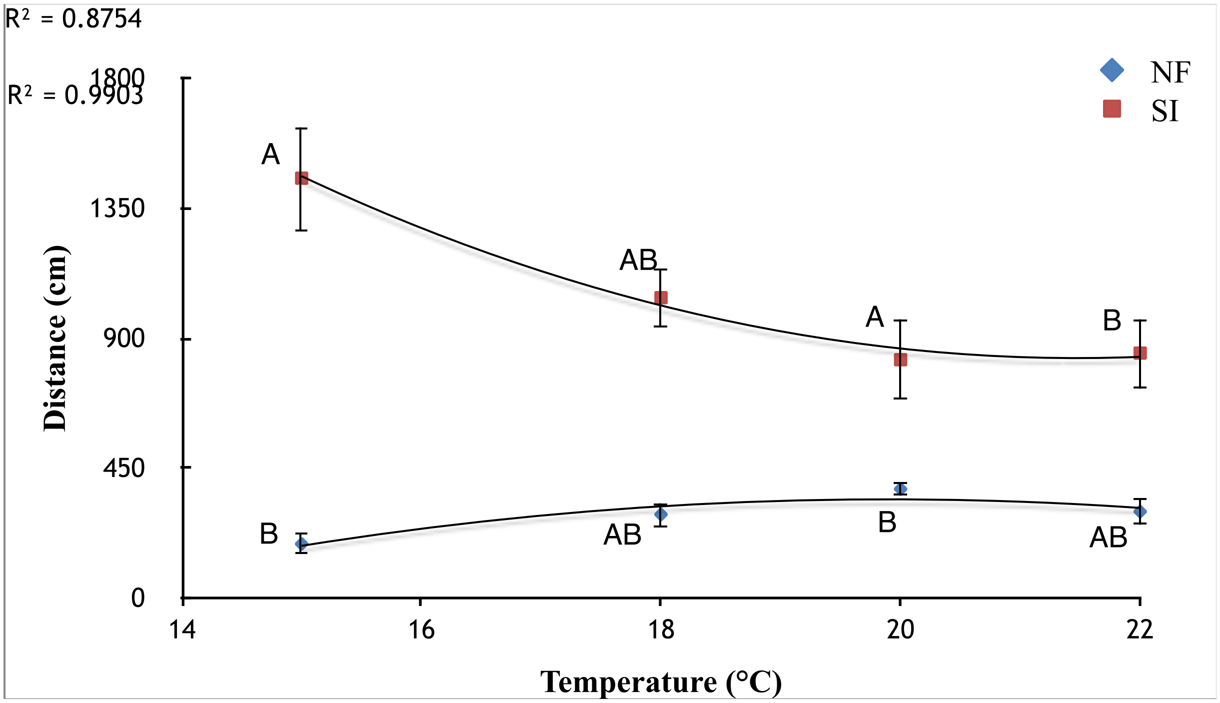

Fig. 1. Mean total (± SE) tunneling distances (cm) per temperature for *Nylanderia fulva* (NF) and *Solenopsis invicta* (SI). Mean values within species not sharing the same letter are significantly different ($P < 0.05$, Tukey-Kramer HSD standardized test [JMP 9.0.2 2010]).

(Jones and Oldroyd 2007). We hypothesized that subterranean tunneling may serve a similar function for *N. fulva*, and may be an important cold avoidance strategy. However, no data exists regarding *N. fulva*'s tunneling performance or the potential impact of temperature on *N. fulva*'s tunneling behavior. Thus, our objective was to evaluate the effect of temperature on *N. fulva*'s tunneling performance and compare it to *S. invicta*, another invasive ant that tunnels extensively.

To evaluate the tunneling performance of *N. fulva* and *S. invicta*, eight Plexiglas tunneling arenas (61.0 x 61.0 cm) were constructed with an interior width of 0.50 cm, and filled with sand (QUICKRETE®, Atlanta, GA). Colony fragments (≈ 1,000 workers, 2 queens, ≈ 1 ml mix of brood and eggs) from a single colony of *N. fulva* or from a single colony of *S. invicta* were used. Colony fragments and tunneling arenas were separately held in incubators set at 15.0, 18.0, 20.0, or 22.0°C and allowed to equilibrate for 24 h. This temperature range was selected based upon previous studies indicating *S. invicta* and *N. fulva*'s lower thresholds for activity to be approximately 15°C, with increased activity observed at temperatures above 21°C (Porter and Tschinkel 1987, Zenner-Polania 1990). Colony fragments were then introduced into their respective tunneling arenas and allowed to tunnel for seven days. Every other day, ants were provided termites as a protein source through a re-sealable opening in the jar in addition to replacing test tubes containing deionized water and 20% sucrose solution as needed.

The experimental design was a randomized complete block, blocking on colony, and consisting of one colony fragment of each species per treatment. In total, four seven-day trials were repeated through time.

Overall, *N. fulva* tunneled less than *S. invicta* at all temperatures evaluated (Fig. 1). Given *N. fulva*'s comparatively low tunneling performance, it is unlikely this pest ant relies on tunneling as a primary means of foraging or deep subterranean nest construction, as does *S. invicta*. However, *N. fulva*'s demonstrated tunneling potential across a narrow range of temperatures supports the hypothesis that *N. fulva* is capable of constructing subterranean tunnels. Like other ant species, *N. fulva* colonies could rely on shallow subterranean tunnels to aid in thermoregulation, and may be important to *N. fulva*'s survival during seasonal cold temperatures experienced in North Florida. *Nylanderia fulva*'s demonstrated tunneling potential may also improve seasonal monitoring and treatment programs. Current inspection and treatment strategies for *N. fulva* primarily target the littoral debris commonly associated with this species. Our results may suggest that *N. fulva* are located further below littoral debris, possibly even at sub-soil levels. Therefore, seasonal monitoring and control programs that utilize sub-soil inspections and treatments may encounter a greater number of *N. fulva* nest sites thus improving their management success.

The fundamental relationship between temperature and tunneling performance differed between *N. fulva* and *S. invicta*. *Nylanderia fulva* tunneled least at cooler temperatures and farthest at warmer temperatures indicating a positive relationship between temperature and tunneling activity. Inversely, *S. invicta* tunneled farthest at cooler temperatures and least at warmer temperatures indicating a negative relationship between temperature and tunneling activity. The positive relationship between *N. fulva*'s tunneling performance and temperature was consistent with previous studies evaluating the behavior of ectotherms in response to temperature (Porter and Tschinkel 1987, Dreistadt and Dahlsten 1990). *Solenopsis invicta*'s negative relationship between temperature and tunneling behavior may be associated with *S. invicta*'s reliance on tunneling for thermoregulation. *Solenopsis invicta* excavates deep subterranean nests that allow it to survive seasonal cold air temperatures due to the temperature-buffering properties of the surrounding soil. When temperatures become undesirable, *S. invicta* will vertically shift to a more preferred temperate region within the subterranean nest (Pranschke and Hooper-Bùi 2003). Therefore, during our study *S. invicta* may have recorded the greatest tunneling distance at 15.0°C as a result of an increase in tunneling activity to minimize exposure to an undesirable temperature.

While this study was the first to evaluate the impacts of temperature on the tunneling performance of *S. invicta* and *N. fulva*, it estimated tunneling performance across a narrow range of temperatures. Further evaluation of the upper and lower thermal limits of *S. invicta* and *N. fulva*'s tunneling performance are needed to better understand the impact of temperature on tunneling performance.

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Student Paper Competition, Afternoon

Investigations into the vector capacity of bed bugs: feeding and defecation behaviors

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The bed bug, *Cimex lectularius* (Hemiptera: Cimicidae), is a significant public health pest, causing economic, physical, and mental distress. Bed bugs have been reported to harbor more than 40 human pathogens, including hepatitis B virus, the human immunodeficiency virus (HIV) (Goddard and deShazo 2009), and various bacteria (Lowe and Romney 2011, Cockburn et al. 2013). However, this insect's potential for pathogen transmission remains poorly understood. Little research has been done to examine bed bug vector competence, which is an organism's ability to acquire, support and transmit a pathogen. Vector competence includes innate characteristics of the vector, such as its behavior (Klempner et al. 2007).

Triatomine bugs (Reduviidae) are closely related hemipterans that are known vectors of Trypanosoma cruzi, the pathogen that causes Chagas disease. During or soon after a blood meal, infected triatomines defecate on their host, shedding trypanosomes in their feces.Transmission occurs when the host rubs fecal material into the bite wound or a mucous membrane (CDC 2013). We suggest that the behavioral mechanism of pathogen transmission in triatomine bugs is also plausible for bed bugs, and hence requires investigation. The objective of this laboratory study was to characterize bed bug feeding and defecation behaviors as potential facilitative processes for pathogen transmission.

Adult bugs were chosen from Harlan and EPM populations, which have differing lengths of time in laboratory culture (40+ and 4 years, respectively). Individual bugs were fed on the Hemotek 5W1 system (Discovery Workshops, Accrington, England) with defribrinated rabbit blood. We recorded pre- and post-weights, feeding and defecation times, and linear distances from the feeding site to fecal deposition. Data indicated that once bed bugs removed their mouthparts from the blood source, they defecated very quickly (median time of 3 seconds) and within 0.5-0.9 inches of their attachment site. These data suggest that bed bugs are extremely likely to remain in sufficiently close proximity to the feeding site to defecate at least once on the host. Females ingested larger blood meals than males (means of 9.5 and 5.8 mg, respectively) and took longer to feed than males (means of 5.3 and 3.7 minutes, respectively). Our data suggest that under laboratory conditions bed bug feeding and defecation behaviors are similar to those of triatomine bugs and could potentially allow for pathogen transmission. As a behavioral comparison, we plan to repeat this study with rats as live hosts.

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Reduced Cuticular Penetration in the Common Bed Bug (*Cimex lectularius* L.): a Mechanism of Insecticide Resistance

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The common bed bug *Cimex lectularius* has been increasing their population dramatically in the U.S. over the past fifteen years. One of the contributing factors to this sudden increase is speculated to be the high levels of insecticide resistance to pyrethroid insecticides. Several mechanisms of the bed bug pyrethroid resistance have been investigated and reported, however reduced cuticular penetration has not been studied extensively in bed bugs. The insect cuticle is composed of diverse cuticular proteins covalently cross-linked with chitin. Our recently published trascriptomic analysis data showed increased levels of transcription in many of the putative cuticle protein-like genes in bed bugs that we have identified based on the presence of chitin-binding 4 domain (Pfam00379) and the Rebers and Riddiford (R&R) consensus. In this study, we extracted and identified bed bug cuticular proteins from 5th instars bed bug molted skins. Trypsin, Glu-C, and acetic acid were used to hydrolyze and extract the cuticle proteins after a series of washing, and peptides were identified using nano-HPLC, MALDI-TOF/TOF tandem mass-spectrometry, and ESI. The proteins were identified using Scaffold, Mascot, and ProteinPilotTM protein identification software. We have identified 51 putative cuticle genes and 25 cuticle proteins. Quantification of the proteins between pyrethroid-resistant and susceptible strains is currently being investigated.

Effects of salinity on the aggressiveness and venom production of the red imported fire ant, *Solenopsis invicta*

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Red imported fire ants (RIFA), *Solenopsis invicta*, are an invasive species that brings large economic cost both in damages and population management. The ultimate solution to the RIFA endemic is eradication, which seems unlikely any time soon. In the interim, continued entomological research may ultimately lead to environmental control and prevention of continued infestation. Our research purpose was to remove the gap in knowledge about venom volume of *S. invicta* flooded in saline conditions versus those flooded in non-saline conditions. Previous research has shown that flooded fire ants are more aggressive and have more venom available for stings than unflooded fire ants; however, research has not been done on different saline conditions as happens in storm surge. An understanding of RIFA venom volume will be valuable tool to predict the implications of coastal fire ants thrust inland following a storm surge and safety of people in floodwaters following hurricanes and tropical storms. We established control colonies, which were flooded with a non-saline solution. Further sets of colonies were flooded with a range of saline solutions reflecting RIFA interaction with Gulf of Mexico tidal waters, storm surge, and deep ocean tidal waters - as would happen during hurricane storm surge. Flooded ants were dissected to ascertain the saline solutions effect on the volume of RIFA venom sacs. Our results based on venom-sac volume indicate that flooding of coastal ants with salt water does not increase the venom sac volume. This indicates that their sacs are not as plastic as inland ants. It is hypothesized that coastal ant venom sacs contain a more concentrated venom as compared to inland ants causing them to be regarded as more aggressive.

Behavior of Asian needle ant, *Pachycondyla chinensis* (Emery) workers during nest emigration.

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Ant colonies emigrate in response to nest disturbances, climate fluctuations, and resource availability. Recruitment of workers during emigration is vital to ensuring that colony members are relocated to a new nest site. As a form of recruitment during emigration, a worker ant may singly or in combination use chemical trail following, tandem running, or physical adult transport. In a laboratory study, we investigated the recruitment behavior of the invasive Asian needle ant, *Pachycondyla chinensis* (Emery) during nest emigration. During emigration trials, colony subsets of 200 workers showed worker ants were ten times (39.2 transports/trial) more likely to participate in adult transport during nest emigration when compared to control colonies (4.1 transports/trial). In addition to transport, we observed that *P. chinensis* workers organize into groups before and during emigration. The groups include the queen's retinula, brood

tenders, adult transporters, and scouts. Marking of individual ants also was conducted to evaluate behavioral plasticity during emigration. Further investigation of task allocation during emigration can elucidate if all ants participate in adult transport or if carrying is a non-specific behavior conducted by all ants. In the current study, task allocation of specific worker ants during nest emigration was observed and recorded. Preliminary results suggest that a select number of individuals are involved as transporters during emigration.

Submitted Papers
ENTOMOLOGY
LITERACY IN
GRADUATE STUDENT TRAINING

Significance of Science and Entomology Literacy in Graduate Student Training – Mentoring: Mentor and Mentee

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Abstract

A symposium on science and entomology literacy in graduate student training focused on crucial topics including mentoring-mentor and mentee, essential coursework, modern research techniques, fundamentals of conducting research, research ethics, preparation of publications, training for success in academia, manufacturing industry and professional pest management companies. These topics provided the baseline ingredients for the successful career in urban entomology.

Introduction

The concept of science and entomology literacy is not new but it is perpetually evolving with invariable innovations in science and technology. Therefore, the scholars of science and entomology need to continually transform their paradigm. Recently, the Agricultural Act of 2014 was signed by U.S. president on February 7, 2014 which is known as “Farm Bill” and the U.S. Agricultural Secretary announced the implementation of this bill under jurisdiction of the U.S. Department of Agriculture’s Research, Education and Economic (USDA-REE) action plan. Among many goals, the USDA-REE delineated the goal #6 for education and science literacy.

In a recent publication, Anelli (2011) has eloquently elucidated the historical overview of science literacy. In early beginning of science era, Huxley (1882) insinuated for inclusion of science training into the British education system and Huxley’s proposal was reiterated by Snow (1959). Later, Dewey (1934) alerted educators in the United States of America (USA) to train students with scientific thinking. With new developments in science and technology, several articles related to emphasis on science literacy (Rutherford et al. 1991, National Academy of Science 1996, Wright 2005, Raloff 2010 and Feinstein 2011) were published.

The objective of this article is to highlight the indispensable components in science and entomology literacy for graduate student training.

Materials and Methods

Training entomology graduate students requires certain degree of virtue and imminent thinking. Mentoring is a thought-provoking process and requires many pieces to solve the puzzle. Therefore, a symposium on “significance of science and entomology literacy in graduate training was organized. This symposium included nine topics as follows: 1) Mentoring – mentor and mentee by Shripat Kamble, Department of Entomology, University of Nebraska, Lincoln, NE; 2) Coursework in science, entomology and other supporting sciences by Michael Scharf, Department of Entomology, Purdue University, West Lafayette, IN; 3) Fundamentals of planning and conducting scientific research by Coby Schal, Department of Entomology, North Carolina State University, Raleigh, NC; 4) Ethics in scientific research by Roger Gold, Department of Entomology, Texas A&M University, College Station, TX; 5) Student’s perspective in graduate training by Brittany Peterson, Department of Entomology, Purdue University, West Lafayette, IN; 6) Mechanics of preparing successful refereed publications by Michael Rust, University of California, Riverside, CA; 7) Graduate student training for success in industry by Joseph Schuh, BASF Corp., Research Triangle Park, NC; 8) Graduate training for success in academia by Dini Miller, Department of Entomology, Virginia Polytechnic and State University, Blacksburg, VA; and 9) Hiring candidates with science training for the national and international pest management companies by Ronald Harrison, Orkin Pest Management Company, Atlanta, GA.

The article presented here is focused on mentoring which involves mentor and mentee.

Results and Discussion

Mentoring is an interaction between mentor and mentee for successful outcomes.

Mentor: It is essential that the mentor must have good broad background in biology and entomology. It is equally important for a mentor to recognize the importance of supporting sciences such as molecular biology, biochemistry, genetics, soil chemistry, statistics, bioinformatics, etc. A mentor should be able to handle all type of students. Many indigenous students come from various geographic regions with different work history. The international students come from different ethnic backgrounds and cultures. It takes different thinking with sound understanding to deal with these students. Inadvertently, international students arrive from a long distance and sometime they have to deal with issue of loneliness, adapting to a different culture, different food products, language barrier, local transportation systems and unforeseen family issues. A mentor should be able to work well with male and female students. At times, there is also a difference in interacting with recent graduate and older graduate students. Recent graduates are more likely to be technology savvy when compare with older graduates. However, older graduate students have several years of work experience, much more matured and focused to accomplish the task. Mentor also needs to recognize the interest of mentee when it comes to field and laboratory research projects. Not all mentees have similar interest. Mentor must offer time for instrumentation training, learning modern research techniques, learning local government regulations and safety training. The program is successful when mentor serves as a role model and passes on his/her knowledge. Writing and publishing scientific articles contribute to overall success. The mentors with publications in eminent journals earn high regards from their mentee. Publishing books is another way of passing on the knowledge. We have well known urban entomologists who have been highly respected for their publications (Kofoid et al. 1934, Snyder 1954, Weesner 1965, Cornwell 1968, Ebeling 1975, Rust et al. 1995, Bennett et al. 2003, Robinson 2005, and Bignell et al. 2011).

Mentee: It is equally important for a mentee to accept responsibilities for his/her success. Mentee must acquire a thorough science and entomology background. Moreover, it is very beneficial for mentee to gain additional background in instrumentation, modern research techniques, molecular biology, genetics, biochemistry and statistics and other subjects that deem to be necessary. Mentee must develop clear goals, research focus and positive attitude. Mentee should have productive interaction with his/her mentor. If misunderstanding occurs, a mentee should take an initiative to resolve it as soon as possible. Professional development by following good role models adds another dimension to the success of mentee. Mentee must learn the critical thinking in conducting research, data collection, analysis, and the manuscript preparation. Good writing and oral presentation skills serve as an asset to mentee for professional success. It is highly suggested that mentee should interact with professional colleagues and potential employers. When needed, it is always beneficial for mentee to seek advice and counseling from his/her mentor or other colleagues.

Conclusions

The science and entomology literacy can be concluded with following outcomes:

- Be a science and entomology literate;
- Use literacy to make sound decisions;
- Share your knowledge; and
- Serve as a role model.

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Ethics in Scientific Research

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Introduction

It is always challenging to talk about ethics in scientific meetings, because this topic is usually more of a discussion topic than for a short paper. This particular talk is part of the Symposium: Significance of Science and Entomology Literacy in Graduate Student Training. I am pleased that some credence is being given to “ethics” in this venue because little is generally done during graduate education to address these concepts. While I continue to believe that most student scientists adhere to ethical principles in their research and writing, there are sometimes areas of misunderstanding from which we can all learn.

Most of us would agree that “science” is an unbiased approach to determining the “truth” about a situation, observation, event, or claim. The process of conducting the “scientific method” has been time tested, but did not develop from one individual or group of individuals. Many generations of philosophers, observers, experimenters, mathematicians, physicists, and biologists have contributed to the development and acceptance of a linear approach to determining the truth. Most would agree it starts with an observation or a question, which eventually morphs into a hypothesis which is then tested. The results are then analyzed with statistical tests which should led to acceptance or rejection (or failure to accept) of the hypothesis. There are certain limitations to science in that the processes involved must produce measurable results. If it cannot be measured, then it falls into areas of philosophic discussions. In addition to the limitations that exist in the scientific method, there are different levels, or weights, for results such as: observation, hypothesis, theory, and law. With a Law, it is generally accepted that with all the replicated testing that has, or will be done, there will never be an exception to the conclusions. As an example, Newton's Law of Gravity, has no exceptions while on planet earth. Regardless to the veracity that is given to scientific outcomes, we all must be open to the concept that with new technologies and the ability to measure more closely, certain hypotheses or theories may change in the future, but the large caveat that results must be reproducible by any scientist who uses the same methods and procedures.

While science is generally understood by most graduate students and researchers, the concept of ethics may be somewhat more esoteric. Stated simply, "ethics is doing the right thing" regardless of the consequences. Different cultures have stated it different ways, such as "do unto others as you would have them do unto you", "do no harm", "do good rather than evil", and "love one another". Ethics is restricted to human behavior, but only when those individuals have the intellectual capacity to understand the consequences of their behavior. There are areas of science that examine human behavior including anthropology, psychology, and sociology. These particular sciences determine "how people behave", while ethics emphasizes "how people ought to behave". In general, ethical principles are the rules derived from ethical values such as: honesty, trust worthiness, consistency, fairness and justice. To learn more about ethical principles in science consider Arrington (1998), Nash (1996) and Reagan (1971).

While there are many rubrics which emphasize ethical behavior, one that is very straight forward and easy for me to understand is the Rotary International "Four-way Test". This approach asks the following four questions: is it the truth; is it fair to all concerned; will it build good will and better friendships; and will it be beneficial to all concerned? Hopefully the answers to these questions will be "yes". My personal belief is that all of us have the intrinsic ability to tell the difference between right and wrong, but all of us need to determine how we will respond in advance of having to make difficult ethical decisions.

After many years in the classroom and in research laboratories there are certain phrases which should be an alert that ethical behavior is being challenged including:

1. What do you want it to be;
2. No one will ever know;
3. The chances of getting caught are zero;
4. I will make it right later;

5. It doesn't matter, it works well enough; and
6. We have always done it that way.

Conclusions

We are all expected to be ethical in our research relationships. We need to develop hypotheses and test them in appropriate ways, and accept the results without prejudice or bias. When we use the ideas or work of others, cite their work and provide credit. There may be a cost for ethical behavior, but the positive outcomes will be richer and more satisfying in the long term of our careers. We must expect the best of ourselves as well as from others, and everything we do must be done under the "cruel light of discovery", because someone knows what was done, even if it is only you. Consider the poem "Myself" by Edgar Guest, it has challenged me to do better work, and perhaps it will help you.

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A Student's Perspective on Graduate Training

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To discuss graduate student training I think it is important to first remember why students enroll in graduate school to begin with. For many of us, the motivation to go to graduate school not only comes from a deep passion for science and learning, but also because meeting our career goals requires advanced degrees. It is vital that students get practical, marketable training during their tenure in graduate school because the job market, both in industry and academia, is extremely competitive. In fact, the National Science Foundation recently released a study of recent doctoral graduates showing that only about 65% of life science graduates have a job commitment at the time of graduation (NSF 2014). So here I will give my perspective on how can we prepare students for success in graduate school and their future endeavors in any field.

In an effort to make this subject matter more objective, I surveyed the graduate students currently enrolled in the Urban Entomology program at Purdue University. This group consists of nine individuals: male and female, international and domestic, pursuing Master's or Doctoral degrees in Entomology at Purdue. These students responded that who their advisor *was* (i.e. tenure status, age, publication record etc.) was not as important as *how* he/she mentored and advised students (unpublished). Additionally, the two key aspects of the graduate student-advisor relationship that students were most concerned about were (1) communication and (2) preparation/career development. From a student's perspective communication skills and proper preparation in a few areas are especially important for a productive graduate career.

Communication: Crucial for Progress in Graduate School

Communication can be broken down into three main areas: 1) communication with mentors, 2) communication with scientific audiences, and 3) communication with non-specialist audiences. Each of these areas requires a specific set of skills and will contribute to the successful progression of a student through their graduate training.

Student-Advisor relationships hinge on good communication. Both parties have implied their commitment to the progress of the student through the program and research required to obtain the degree in question, but this is something that may need to be revisited as a student progresses. The research objectives of the student and advisor must be explicitly stated to ensure their agreement. It is also important for the student to share their career objectives and the mentor to make note of them to help highlight important career development opportunities throughout the student's time in the lab. Regular one-on-one meetings are important to monitor the progress of students and provide them opportunities to communicate roadblocks, successes, and other issues with their advisors. This outlet provides an important flow of information which may help circumvent or minimize misunderstandings especially when it comes to research avenues, and facilitate the balance between guiding graduate students and encouraging independent thought. These meetings will look and proceed differently for every student-advisor relationship, but the practice is important for open lines of communication.

Apart from the traditional student-advisor relationship, it is important to consider other mentoring relationships available to students. Everyone can be a mentor given the right opportunity. The hierarchical stratification of a lab lends itself nicely to a nested mentor network. Post-doctoral researchers can serve as mentors to graduate students, more senior graduate students can serve as important troubleshooting sounding board for more junior lab members, and graduate students can help guide and mentor undergraduates working in the lab. These relationships help to foster a collaborative lab environment and may also make lab management more efficient.

Communicating research in a scientific setting is a skill that is essential for graduate student success. In order to graduate, students must write, review, and defend a thesis/ dissertation all of which require this skill. However, the time to develop these skills is not in the months or weeks before graduation. Opportunities to present and develop research ideas present themselves throughout a graduate student's career. Department-wide poster presentations, paper presentations at national meetings, writing for grants, publishing, reading and editing papers all help to hone skills that are necessary for success in graduate school. These concepts; i.e., presenting, writing, and reviewing science topics, are also essential for students after graduation.

Non-specialist audiences pose a different set of challenges when communicating science. As such, graduate students also benefit from explaining scientific principles in extension, outreach, and teaching settings. Each of these situations requires communication with minimal jargon. I liken this experience to a physician's bedside manner; students must learn effective ways of communicating important information in an non-intimidating, practical way.

By developing communication skills in mentoring relationships, with scientific audiences, and with non-specialists, graduate students will be equipped to be successful during graduate school. As effective communication is a staple for success in nearly all post-graduate endeavors, promoting the development of these abilities during graduate training will also prepare the student for their future career.

Preparing Graduate Students for Future Successes

In addition to developing great communication skills, graduate students can also use their time and training in graduate school to prepare them for success in their future. By preparing 1) in the classroom, 2) with practical experiences, and 3) by capitalizing on stepping stones, students can be prepared for the career of their choosing.

The classroom is a logical place to begin preparing a student for success. Graduate students in urban entomology come from diverse backgrounds, so the first classes they take should make up any deficiencies. With a Bachelor's degree in Microbiology, I needed to take an insect biology course to learn basic insect identification and the like before I was prepared for graduate level classes in insect physiology and biochemistry. This aspect of a graduate student's curriculum should be considered on a case-by-case basis. Students should also bolster existing expertise if the opportunity presents itself. For example, if a student has a knack for statistics and an advanced data management class is offered, this may be a chance for the student to set him/herself apart. Finally, graduate students need to have knowledge and skills that are on the cutting edge. If a course in a novel technique or up-and-coming bioinformatics software is offered, students should be encouraged to learn these new, marketable skills.

Outside of the classroom, it is important for graduate students to develop practical skills that can be applied in their careers. One aspect previously discussed, experience with extension and outreach, is important for learning how to communicate with the general public, something that is likely to be required often in their profession. As we prepare students to be the future leaders of the field, it is critical that we provide them with practical leadership experience. Involvement in professional societies, student organizations, or even within the context of a lab environment can help to strengthen leadership and mentoring skills students will need throughout their careers. Workshops and webinars also provide channels for graduate students to learn about new ideas and develop their toolkit for success.

The final aspect of preparing graduate students for future successes that I will address is in defense of the Master's degree. A recent trend in the life sciences has been to move away from Master's programs and instead accept students holding Bachelor's degrees straight into Doctoral programs. Personally, I think this is incredibly unfortunate. A Master's degree lays an experience-based foundation in experimental design, time management, scientific communication, navigating the logistics of academe, etc. In addition, a Master's degree often has a more defined time parameter. This gives a student an opportunity to acquire advanced knowledge, gain important skills, and do advisor-guided research before diving straight into a more independent Doctoral program. By getting a couple of years of research, classes, and training under their belts, I feel graduate students can be more successful in Ph.D. programs, and beyond. Though I am not implying that a Master's degree is absolutely necessary for every student; I do not believe a Master's degree is detrimental to anyone.

Conclusion

Everyone has their own philosophy on how to best train graduate students to be successful researchers, independent thinkers, and leaders in the field. My aim was to provide a student's perspective on this process. By focusing graduate training on developing communication skills and preparation for future success, I think graduate students will emerge into the professional world better equipped. It is important to remember that this process is gradual and sometimes progress may seem slow and incremental, and indeed, every student is different. I like to think of graduate students as being analogous to hemimetabolous insects. They will go through several stages during their training that will eventually lead to success. However, instead of the traditional, linear sense of the word (like cockroaches), maybe graduate students are more like termites, which have complex and plastic developmental trajectories. There are several transformations and stages to go through on their path to success, and success for each student is specific to their goals.

Acknowledgements

I would like to thank the Urban Entomology graduate students at Purdue University for participating in the survey that inspired this perspective. I would also like to thank all of my past and present mentors for opportunities, skills, and experience I have learned under their guidance that were incorporated into this presentation.

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(NSF) National Science Foundation. 2014. Doctorate recipients from U.S. Universities: 2012. Special Report NSF 14-305. NSF, Arlington, VA.

Mechanics of Preparing Successful Refereed Publications

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The preparation, submission, and acceptance of a refereed publication is the climax of the student's research thesis or dissertation. There are many possible avenues to approaching that task, but the ultimate goal is to prepare a clear and compelling story. As Katrina Kelner (2007) writes, "I see that the most successful papers are those that present innovative research. But the best papers also present their story in a clear and logical way. The thinking behind the paper is clear, so the writing is clear. Writing research papers with all these qualities can require a bit of strategic thinking, practice, and know-how." Hopefully, the student will find some of the following suggestions, comments, and opinions helpful in obtaining that goal.

Selecting the best journal to submit an article can be a daunting task. In recent years the journal impact factor has drawn considerable attention, especially as a tool to evaluate the importance of the research. However, there has been a widespread abuse of the journal impact factor in evaluating research, especially because of technical and conceptual issues when comparing across different scientific fields (Zupanc 2014). The author should strive to find the outlet with the most appropriate audience. Zupanc (2014) states, "An author's decision regarding the suitability of a scholarly journal for publication, therefore, be based on the impact that this journal makes in the field of research, rather than on the journal impact factor."

Many journals have the following elements in their publications: Title, Keywords, Abstract, Introduction, Methods and Materials, Results, Discussion, and References. Most editors probably spend a limited amount of time with each manuscript and thus, it is important to stimulate the editor's curiosity. When hundreds of articles are published every month, it is not possible to read all of them and most readers browse the literature with the aid of various search engines available in digital libraries. Consequently, the reader only views the title, keywords, and abstract. Thus, it is important to spend the necessary time to insure that the title and abstract will attract your audiences' attention. An editor of *Science* observes (Nancekivell 2004), "Your title may be the only part of your paper that gets read –first by the journal editor, later by your readers. So make its every word count."

In recent years, many journals now allow for supplemental information to be published. The following information is provided by the Entomological Society of America regarding supplemental materials (ESA 2014). Such material often consists of large tables, data sets, or videos which normally are not possible or convenient to present in print media. Supplemental Material represents substantive information to be posted on the ESA journal website that enhances and enriches the information presented in the main body of a paper. In the future, this electronic storage of data, video files, and information will become even more important.

Many journals provide the authors with checklists to aid in the preparation of manuscripts. Nancekivell (2004) provides an excellent list of questions for the author to consider and these are summarized in Table 1.

Table 1. A checklist for authors compiled from Nancekivell (2004).

Title

Does your title summarize the main point of your paper?

Abstract

Is the significance of your study clear?

Does your Abstract have a clear statement of purpose?

Is all the information in the Abstract consistent with the information in the rest of the paper?

Have you stated your main conclusion?

Introduction

Have you reviewed the relevant literature in your Introduction?

Is the significance of your study clear from your Introduction?

Have you stated the specific purpose of your paper at the end of your Introduction?

A good rule of thumb is to focus your literature review on key terms drawn from your purpose statement

Methods

Have you described the selection process for the subjects in your study?

Have you described all the methods you used?

Results

> ***Have you stated the overall answer to the purpose of the study in Results?***
>
> ***Are the Results logically organized?***
>
> ***Have you presented your findings in only the Results?***
>
> ***Have you omitted all interpretation of the data?***

Discussion

> ***Is the answer to the study question clear and not buried somewhere in the Discussion?***
>
> ***Have you explained the meaning and significance of your results rather than merely repeating them?***

Some of the common problems encountered in editing manuscripts are as follows:

- ➢ the authors fail to comply with the journal format, the text references don't match the references cited,
- ➢ the figures and tables are repetitive,
- ➢ the authors fail to describe the statistics used,
- ➢ and authors fail to critically review citations used in the paper.

Often these mistakes occur because the manuscript has been reviewed and altered several times leading to omissions and potential errors in the references. One last careful review can catch most of these types of mistakes in the manuscript.

The author has several responsibilities to the reader and editor. The most important responsibility is to insure the accuracy of the data and paper. Once the paper has been reviewed and re-submitted, the author should provide the editor with a detailed explanation of the changes incorporated in to the manuscript, thereby decreasing the time required for a second review. A little extra effort from the author saves valuable time and decreases the time to publication.

The impact and creditability of journals depends upon the peer review system. Once the student has authored a peer reviewed paper, the student now has a responsibility to also serve as a reviewer. Serving as a peer reviewer is just as important as authoring papers and is essential if we are to maintain high quality scientific journals.

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Submitted Papers
BED BUGS

Dealing with bed bugs in New York City

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Abstract

Bed bugs are a public health nuisance, difficult and costly to eradicate. If left untreated, they can spread quickly and become a serious issue especially in multi-residential housing. By closely working with the public, owners, tenants and other stakeholders, New York City has begun to curb the resurgence of bed bugs and the emotional strains associated with them. In 2012 and 2013, the City received significantly fewer bed bug infestation reports than preceding year. In 2013, there was a 19% decline in bed bug complaints received and 17% decline in bed bug violations issued by the City. The reduction in these parameters occurred across the City and throughout the year. This success is because of productive partnerships between city agencies, private businesses and the general public.

Introduction

The common bed bug, *Cimex lectularius* L., is a blood feeding parasite of humans. This species is widely distributed frequently found in the northern temperate climates of North America, including New York City (NYC). Bed bugs can affect our physical, mental and social wellbeing. While they do not transmit disease, their bites can cause itching and discomfort (Doggett 2012), and their presence can be disturbing to the occupants of the affected environment. Common health effects of bed bug bites may include dermatitis and secondary dermal infections (Doggett 2012, Pritchard and Hwang, 2009). Their presence in the home may cause stress, anxiety, depression, and lack of sleep (Goddard and deShazo 2009, Rieder *et al.* 2012). In addition, a lot of time and expense is required to manage these bugs successfully.

After a virtual absence for decades, bed bugs have re-emerged in NYC and other metropolises across the globe. With the use of residual insecticides (such as DDT) in 1950s, bed bug infestations practically disappeared from most industrialized countries. Since the late 1990s, the United States, Canada, Australia and several European countries have noticed a comeback of bed bugs in places such as apartment buildings, single family homes, hotels, student hostels, hospitals, offices, libraries, retail-stores and even movie theaters (Potter *et al.* 2010, Potter 2011). Several factors, including changes in pest management practices, pesticide resistance, increased global travel and commerce, lack of public awareness, and difficulty in detecting early infestation, have been suggested as likely reasons of the recurrence (Boase 2008, Davies 2012, Gangloff-Kaufman *et al.* 2006, Romero *et al.* 2007).

In April 2010, NYC Bed Bug Advisory Board (BBAB) published a report on the growing problem of bed bugs in private multiple-residential buildings- approximately 2.5 times increase in infestation from 2006 to 2009. The board observed that the spread of bed bug infestation in the City was a burden on its residents, property owners, health establishments, and social services providers. The board suggested raising public awareness and endorsing early detection of bed bugs as the two key elements for quality management and minimization of bed bug spread/infestation in the City. In 2009 and 2011, the NYC Department of Health and Mental Hygiene (DOHMH) conducted citywide Community Health Surveys and asked the public if during the past 12 months they had a problem with bed bugs in their home that required an exterminator. Of those surveyed, 6.7% and 7.4%, respectively, answered affirmatively. In 2011, affirmative responses ranged from 0.6% to 20.3% (Fig.1).

2009 **2011**

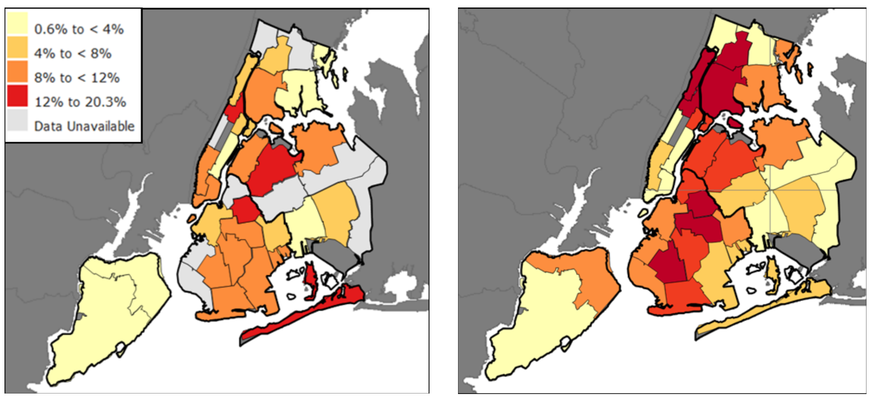


Fig. 1. Bed bug prevalence in NYC (DOHMH Environmental Public Health Tracking).

Bed Bug Management Practices and Procedures

Bed bugs are difficult to abate; their management requires approaches and resources that are different than most other urban pests. It is important to ensure that sound bed bug management principles, relevant to diverse scenarios and environments, are widely known and practiced. New York City's bed bug management protocols and procedures are available at nyc.gov/bedbugs. This website helps the public learn how bed bugs thrive, how to recognize and inspect for their presence, steps to take to prevent them from infesting homes, how to safely rid bed bugs if they do occur, and also how to select and work with a pest management professional. An excerpt of strategies and procedures on the bed bug management for urban areas is given in the Figure 2.

NYC Pest Management Laws

Several city laws regulate management of pests (including bed bugs) in the City. Local health and housing codes require that property owners address pest infestations promptly. NYC Health Code §151.02 and Housing Code § 27-2005 ensures that the owner of a multiple dwelling keeps the (rental) premises free from household pests and conditions favorable for their multiplication. Health Code §151.02 authorizes the Health

Department to issue orders to property owners to write and execute pest management plans and employ appropriate pest management strategies to eliminate household pests. NYC Sanitation Code § 1-04.1 requires that the bed bug infested material must be enclosed and securely sealed in suitable plastic bag before the items are placed outside for pick up by Sanitation Department. NYC Bed Bug Disclosure Law (Administrative Code § 27-2018.1) mandates that new residential tenants in New York City be given a one-year bed bug infestation.

If You Believe that You Have Bed Bugs
- And live in a multi-residential building, immediately report the matter to your landlord
- And live in a single-family residence, consult a pest professional
- At the office where you work, immediately report the matter to your supervisor
- Know that there is NO EVIDENCE THAT BED BUGS SPREAD DISEASE
- DO NOT PANIC
- Know that bed bugs CAN BE CONTROLLED

The Resident Should …
- Inspect regularly - report possible bed bug sightings immediately
- Encase the mattress and box springs. Launder bedding regularly.
- Vacuum – remove the used vacuum bag immediately, seal in a plastic bag, freeze for 24-hours then discard
- Use plastic bags/wrap when transporting infested items
- Don't bring home furniture found on the street
- Cooperate with the building management and pest management professional - follow preparation instructions

The Resident Should NOT …
- Attempt any type of "do-it-yourself" pesticide application program
  Use insect bombs (individually or by a pest professional. They lack effectiveness and are dangerous (exposure and fire hazard)
- May cause bed bugs to disperse
- Discard perfectly good furniture (unless pest professional instructs the discarding)
- Purchase gimmicks such as ultrasonic devices

Landlords/Building Management Should…
- Not blame anyone for a bed bug infestation – generally landlord is responsible for bed bug control – depends on contract with resident.
- Treat tenants, staff and pest professional as partners
- Treat each "case" as indicative of potential wider infestation
- Respond quickly and thoroughly
- Cooperate with the pest professional

Building Maintenance Should …
- Educate residents regarding bed bugs
- Inspect and clean
- Repair cracks, gaps and holes in walls, floors and ceilings
- Seal any openings where pipes, wires or other utilities come into the structure
- Pay special attention to walls that are shared with other apartments/rooms
- Glue loosened wall paper
- Secure moldings
- Inspect the laundry room weekly – will need a flashlight and spatula

The Pest Professional Should …
- Thoroughly inspect the infested and adjacent areas
- Provide preparation and follow-up instructions
- Utilize the principles of Integrated Pest Management, including non-pesticidal alternatives
- Follow the precautions and directions on the pesticide label
- Return in as necessary to look for and treat emerging nymphs.

Hiring a Pest Professional
- Hire only licensed pest professionals
- Check their training and experience
- Inquire about all possible non-chemical approaches
- Insist on an Integrated Pest Management (IPM) service
- Agree on a service plan and cost – the cheapest services are rarely the best.
- Two or more visits likely will be required

How New York City Handles Bed Bug Complaints from the Public?

Complaints from public and private housing are handled differently. For public housing, the NYC Housing Authority (NYCHA) receives complaints via its hotline, inspects and mitigates as appropriate. When a complaint is made to 311 (nonemergency hotline) about bed bugs in a private residential building, a housing inspector from the Department of Housing Preservation and Development (HPD) may conduct an inspection. The inspector examines places where bed bugs are commonly found, such as on and around mattresses, beds and head boards, as well as other potentially infested areas as directed by the tenant. If the HPD inspector finds bed bugs, the

property owner is issued an HPD Notice of Violation ordering that the condition be abated. Commissioner's Order to Abate (COTA) is issued by DOHMH instructing the property owners what must be done. For example, owners must hire a licensed pest management professional (exterminator) to treat the infestation. Property owners must notify HPD when the problem has been corrected.
If a property owner has repeatedly failed to comply with Housing and Health Codes, and/or if bed bugs persist or occur in multiple apartments in the same building, DOHMH issues a second COTA requiring that property owners take additional steps such as, develop and distribute to tenants a building-wide Pest Management Plan to correct problems, to notify tenants that bed bugs have been found in the building, and to provide guidance on how to prevent and control infestations. To prove that bed bug infestations have been treated, owners must have their licensed exterminator complete an "Affidavit of Correction of Pest Infestation". Owners that fail to provide these documents will be issued a Notice of Violation and will be required to appear before the City's Environmental Control Board where fines may be levied.

Public Reporting of Bed Bug Infestation

In the past two years the City has observed downward trends in public reporting of bed bug infestations (Fig 4 - 6). In 2013, there were approx. 8,500 bed bug complaints received, which represents a 19% decline from 2012 when approx. 10,500 bed bug complaints were received. In 2013, there were approx. 2,900 bed bug violations issued by HPD; this represents a 17% decline from 2012 when 3,400 bed bug violations were issued (Fig. 6). The reduction in the reporting has been seen in all boroughs of the City and throughout the year (Fig. 4-6).

Bed Bug Infestations in Non-Residential Buildings

DOHMH identifies potential bed bug specimens for NYC agencies. Figure 7 shows average number of specimens received per month from non-residential buildings mainly offices, court houses, libraries, etc. Sixty-three percent of the 747 specimens received during 2011-2013 were identified to be bed bugs. These specimens were found as live insects walking on people, personal items, ground, walls, or furniture in areas frequented by visitors. Since a single (and even a few) bed bugs does not constitute an infestation, their presence in office settings is generally incidental and rarely justifies treatment.

Summary

The best way to fight bed bugs is to prevent them from ever entering and establishing in our homes, businesses and places of work. Once they have been discovered, a prompt measured and competent abatement response is necessary. In New York City, various government agencies play a key role in the fight against bed bugs through new initiatives, education, and outreach. Complaints from public and private housing are handled differently. For public housing, the NYC Housing Authority receives complaints via its

Fig. 4. Bed Bug Complaints and Violation, 2004 – 2012

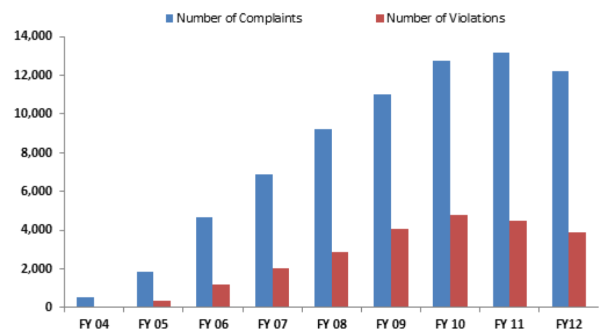


Fig. 5. Continuous Decrease in Bed Bug Complaints (2012 -2014)

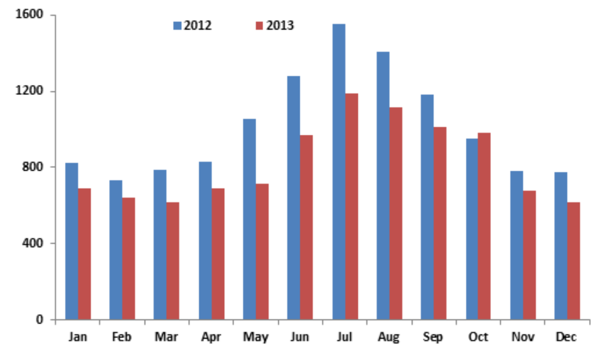


Fig. 6. Borough-wide Bed Bug Violations

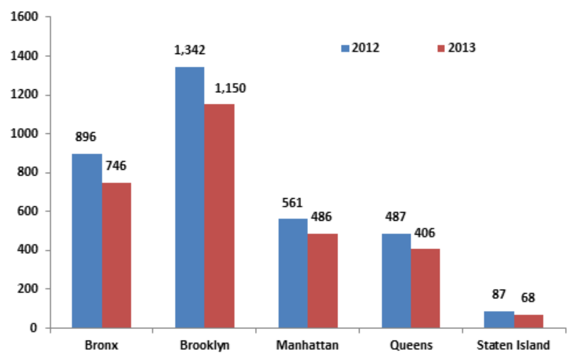
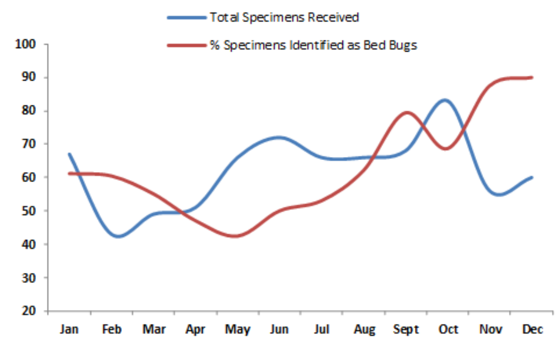


Fig. 7. Specimens Submission for Identification, 2011 -2014



hotline, inspects and mitigates as appropriate. For private housing, a complaint is received via 311 and is forwarded to Housing Preservation and Development (HPD) who inspects the premise for bed bugs. If bed bugs are observed, a “Notice of Violation” (NOV) is issued and a “Commissioner’s Order to Abate” (COTA) is issued by Department of Health and Mental Hygiene (DOHMH) instructing the property owners what must be done to correct the situation. The property owner must notify HPD that the problem has been corrected. In situations where the problem is not adequately corrected, DOHMH will issue a second COTA requiring property owners take additional steps. Once treatment is complete, owners must have their licensed pest management professional (exterminator) complete an “Affidavit of Correction of Pest Infestation”. By closely working with the public, owners, tenants, and other stakeholders, NYC has begun to curb the resurgence of bed bugs and the emotional strains associated with them. In 2012 and 2013, the City received significantly fewer bed bug infestation reports than the preceding year. In 2013, there was a 19% decline in bed bug complaints received and 17% decline in bed bud violations issued by the City. The reduction in these parameters occurred across the City and throughout the year.

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Can we detect bed bugs in occupied multifamily housing apartments using four or fewer monitors?

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Three inexpensive passive bed bug (*Cimex lectularius* L.) detection devices were evaluated to determine the effects of type (BlackOut Bedbug Detector, Black ClimbUp Insect Interceptor and Catchmaster BDS Bedbug Detection System) and number (1,2 or 4), as well as area of placement, on catch when placed in Knoxville multifamily housing apartments with potentially low numbers of bed bugs. The number of bed bugs caught was recorded at two week intervals through 8 weeks. Most bed bug first-finds occurred at two weeks after device placement. The BDS was less effective in detecting bed bugs than the BlackOut or Black ClimbUp when the dependent variables of weeks to first find and percentage of apartments with bed bugs caught were used in the analyses. Our study used two to six times fewer BDS per apartment than recommended which may have contributed to its lack of success. Device number did not significantly impact catch success. On the date bed bugs were first detected, they were more commonly found under bed/sleeping furniture than in the living room area, under the couch/chair or in the bedroom area. Two BlackOuts or Black ClimbUps placed where the resident spends most of their time should be adequate to detect low numbers of bed bugs.

Attracting Bed Bugs Using Sugar-Yeast and a Bed Bug Lure

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Passive bed bug monitors are used extensively for bed bug monitoring. However, drawbacks of passive monitors include heavy lifting of furniture, multiple visits to confirm the presence of bed bugs, and reduced effectiveness in non-occupied environments. As a result, there has been continued interest in developing active monitors that use carbon dioxide (CO_2), chemical lure, and/or heat for attracting bed bugs in both occupied and non-occupied environments.

CO_2 release rate is an important determining factor in the efficacy of an active bed bug monitor. Singh et al. (2013) reported a distinct positive relationship between the CO_2 release rates and bed bug trap catches. Most of the available active monitors are either expensive or generate very low CO_2 release rates and are therefore ineffective. Dry ice (Wang et al. 2011) and a sugar-yeast fermenting mixture (Smallegange et al. 2010) have been used as an economical source of CO_2 for surveillance of bed bugs and different species of mosquitoes, respectively. Dry ice can be difficult to obtain, transport, store, and can pose a hazard during handling and use. On the other hand, the sugar-yeast fermentation method is convenient, cheap, and all of the materials are readily available. Sugar-yeast fermentation seems to have great potential as a CO_2 delivery system in bed bug monitors. In addition, a chemical lure with proven field efficacy may further maximize trap efficacy. The objectives of this study were: a) to determine if Sugar-yeast and Dry ice traps are equally effective for attracting bed bugs, and b) to determine if adding a chemical lure can significantly increase the effectiveness of bed bug monitors.

Materials and Methods

All experiments were conducted in occupied one-bedroom or studio apartments located in Irvington, NJ. The first experiment was conducted to compare Sugar-yeast and Dry ice traps. The Sugar-yeast trap consisted of a 5 gallon bucket filled with a mixture of 150 g yeast, 750 g sugar, and 3 L warm water (Fig. 1a). The dry ice trap consisted of a 1.2 L insulated jug containing 400 g dry ice (Fig. 1b). Both traps generate an average of 400 mL/min CO_2 for 8 h after placement. Two pitfall traps described by Singh et al. (2013) were placed under the bucket containing the fermenting materials. In the case of a Dry ice trap, two pitfall traps were deployed in a similar fashion as the Sugar-yeast trap with a jug of dry ice placed on one of the two pitfall traps, the second remained non-baited. In addition to CO_2, a chemical lure containing nonanal, L-lactic acid, 1-octen-3-ol, and spearmint oil was placed in one of the two pitfall traps. Thirteen medium to high level bed bug infested rooms were used. Traps were placed near sleeping areas of the residents where bed bugs were likely to be present.

The second experiment was conducted to determine if adding a chemical lure can significantly increase the effectiveness of the Sugar-yeast trap. The Sugar-yeast trap and chemical lure were used in a similar manner as in Experiment 1. Chemical lure was placed in one of the two pitfall traps under each bucket. The other pitfall trap was used as non-baited control (Fig 1a). A total of nine monitors were placed in six high level infested apartments for one night.

Fig. 1. Field set up of: a) Sugar-yeast trap, and b) Dry ice trap.

Results and Discussion

Field testing in apartments showed no significant differences in trap counts between the Sugar-yeast trap and the Dry ice trap (t = 0.65, df = 12, P = 0.52). Sugar-yeast and Dry ice traps caught an average of 109.0 ± 30.1 and 85.5 ± 24.5 bed bugs, respectively, during a one night trapping period. Our results demonstrate the Sugar-yeast trap is equally effective as the Dry ice trap. Pitfall traps baited with chemical lure caught 7.2 times more bed bugs than those without lure (t = 5.3, df = 8, P = 0.0008). Traps baited with chemical lure (nonanal, 1-octen-3-ol, spearmint oil, and coriander Egyptian oil) were found to be 2.2 times more attractive than their corresponding non-baited controls in a field study (Singh et al. 2013). Since then, we improved the lure formula by replacing coriander Egyptian oil with L-lactic acid. This field study showed a dramatic increase in trap catch when sugar-yeast was used as CO_2 source and proved the value of adding the chemical lure for monitoring bed bugs. The results indicate the chemical lure is very effective for improving the trap catch in a monitor that uses CO_2 as a long range attractant. The Sugar-yeast trap with an attractive bed bug lure delivers an affordable, safe, and effective solution for monitoring bed bugs. This monitor is affordable compared to existing active monitors. There is initial cost of $10 for buying a container and two pitfall traps and then the operating cost (sugar, yeast and lure) is only $1.7 per trap.

Acknowledgements

We thank the management and staff of a private property management group in Irvington, NJ for allowing us to conduct field experiments in their facility. This project was funded by a grant from the U.S. Department of Urban and Housing Development Healthy Homes Technical Studies grant program.

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Bed bug IPM in high-rise apartment buildings using pyrethroid and neonicotinoid mixtures

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Control of the common bed bug, *Cimex lectularius* L., continues to be a serious challenge for the pest management industry. Eradicating multiple bed bug infestations in high-rise apartment buildings is especially difficult because of the ability of bed bugs to actively and/or passively disperse within and between different units (Wang et al. 2014). Previous research has clearly shown that integrated pest management (IPM) programs that include the use of chemical (insecticides) and non-chemical methods are very effective in controlling bed bug infestations. However, active bed bug dispersal following application of pyrethroid-based insecticide mixtures and hot steam treatment is a cause of concern for successful deployment of IPM programs. In the current study we compared the utility of pyrethroid + neonicotinoid mixture products *viz*., Tandem™, Temprid™ and Transport™ for use in bed bug IPM programs in high-rise apartment buildings. The non-chemical control strategies included use of Climbup™ interceptor traps, hot steam treatment and use of mattress encasements. Results indicated that all insecticide mixture products provided satisfactory (> 82% population reduction) control. Moreover, active bed bug dispersal following insecticide application was not observed; however, bed bug dispersal was evident within certain apartment units after the use of hot steam treatment. Laboratory data on repellency of pyrethroid + neonicotinoid mixtures corroborated with field results. In conclusion, pyrethroid-based insecticide mixtures can be effectively used in a bed bug IPM program.

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Submitted Papers
ANTS

Modifying Perimeter Sprays for Ant Control to Reduce Pesticide Runoff into Urban Waterways

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Pesticide runoff in to urban water ways has become a major problem throughout the U.S. A 10-year survey of runoff studies of urban areas in CA found that bifenthrin and fipronil were present in 69% and 19% of sediment samples and 64% and 39% of water samples, respectively (CASQA 2013). Pyrethroids were commonly found at levels lethal to sensitive aquatic organisms. Similarly, sediments from 59% of 20 urban sites in Illinois were toxic to the amphipod *Hyalella azteca* and pyrethroids were detected in 95% of the samples (Ding et al. 2010). In Texas, 66% of the 18 urban sites sampled had levels of pesticides great enough to kill aquatic organisms (Hintzen et al. 2009). This runoff has been attributed to the outdoor applications of pesticides to control ants.

The objectives of this research were to develop and evaluate low-impact treatment strategies that reduced the amount of pesticides applied and incorporated recent label directions that prohibit the treatment of impervious surfaces such as concrete and asphalt. Two different low-impact strategies were conducted by collaborating pest management professionals (PMPs). The residences were monitored to determine the efficacy of the treatments and the pesticide runoff for the entire ant season.

Methods and Materials

Estimating ant numbers. To evaluate ant populations, the numbers of ants around homes were monitored using vials containing 13 ml of 25% sucrose water (Klotz et al. 2009). Ten vials were placed on the ground around the exterior foundation (“house”), and 10 additional vials were placed out in the yard about 5 m from the structure (“yard”). The vials were then reweighed to measure the amount of sucrose water consumed by the ants. Post-treatment evaluations of ant numbers were done at 1, 2, 4, 8, 10, and 14 wks.

Treatment protocols. We collaborated with two large pest management companies. Ten homeowners, 5 for each company, volunteered their homes for these summer trials.

Protocol 1. The first company (PMP 1) scheduled bimonthly treatments (July and September). Each house was treated with an average of 1.9 L of 0.06% fipronil spray (Termidor® SC, BASF, Research Triangle Park, NC), 3.8 L of 0.1% cyfluthrin (Cy-Kick® CS, Whitmire Micro-Gen, St. Louis, MO), and 409 g of 0.2% bifenthrin granules

(Talstar® PL, FMC, Philadelphia, PA). In July, the fipronil spray was applied with a Birchmeier Flox 10 L backpack sprayer with an adjustable cone nozzle. It was applied as a narrow band approx. 5.1 cm up and 5.1 cm out from the house foundation at the grade/wall junction. At the garage door/driveway interface (but not specifically into the expansion joint) the spray was applied as a pin stream with the applicator tip held about 0.6 m away from the surface. PMP 1 supplemented the fipronil spray with bifenthrin granules applied with a 14 oz CentroBulb Duster around landscaped areas such as bushes and trees and decorative walls and borders. Any granules that landed on impervious surfaces (driveway and walks) were swept to nearby soil or grass. On day 63 the granular bifenthrin was applied as described above and a 20 cm band of cyfluthrin spray was also around the house foundation, except for the driveway or other impervious surfaces in the backyard. A pin stream of cyfluthrin was applied to the driveway at the garage door, as well as the edges of the lawn next to the driveway.

Protocol 2. The company (PMP 2) scheduled monthly home service from July through October. Each house was treated with an average of 1.9 L 0.06% fipronil, 2.3 L of 0.1% cyfluthrin, and 11.3 L of a botanical pesticide, 0.025% EcoPCO® WP-X WP (Prentiss Inc., Alpharetta, GA). Using a B&G handheld tank sprayer and adjustable cone tip they sprayed the fipronil band 30 cm up and 30 cm out from the grade/wall junction. At the garage door/driveway expansion joint, a crack and crevice application was used with the applicator tip right up against the expansion joint. On the 1st visit the fipronil was supplemented with a cyfluthrin spray applied as a spot treatment around the edge of the lawn and fence lines. They also used the cyfluthrin along the edge of the lawn next to the driveway as a crack and crevice or spot treatment. After the initial treatment, the company used a 10-cm fan spray of the EcoPCO® WP-X, around all areas of the house foundation, driveway, tree trunks, fence lines, and shrubs during the monthly visits.

Measurement of insecticide runoff. We flushed the driveway from the garage door to the street with 76 L of water as measured by a water meter (AbsolutelyNew Water Saver™ Usage Meter, San Francisco, CA) attached to a hose nozzle. At the curb 1 L of water was collected by making a dam consisting of a U-shaped block of Styrofoam inside a plastic bag. Water collected in the dam was collected with a glass pipette and put into a 1 L amber glass bottle. These samples were kept at 4°C until analyzed for insecticide residues. Samples were collected 1, 28, 65, and 98 d after the initial treatments, and usually within a couple of days of a treatment. There were no significant rain events during this period. Samples were analyzed for bifenthrin, cyfluthrin, and fipronil. Techniques for analyzing botanicals are not readily available at this time and were therefore not measured.

Pesticide analysis. Pesticides were identified using a procedure outlined by Greenberg et al. (2010). Water samples (1000 mL) were extracted with 40 mL methylene chloride three consecutive times using glass separatory funnels. For analysis of fipronil and its metabolites, the residue was recovered in petroleum ether + acetone (70 + 30 by volume; 1.0 mL) and subjected to a further cleanup. The extract (1.0 mL) was then passed through the conditioned cartridge and eluted with petroleum ether + acetone (70+30 by volume; 10mL) at a flow rate of 0.5 mL min^{-1}. The concentrations of target compounds in the final extracts were analyzed using an Agilent 6890 series GC equipped with a Ni63 microelectron capture detector (ECD; Agilent Technologies, Wilmington, DE). An HP-5MS column (30 m×0.25mm×0.25 µm; Agilent Technologies) was employed for separation. The typical retention times for desulfinyl fipronil, fipronil sulfide, fipronil, and fipronil sulfone under these conditions were 10.7, 12.9, 13.1, 15.2 and 17.8 min, respectively. A preliminary experiment showed that the method detection limits for the analytes were 0.001 µg L^{-1}. The recoveries of spiked analytes were higher than 85% using the above extraction and analysis steps.

Statistics. We computed the percent reduction in ant numbers compared to the pretreatment numbers as determined by our sugar water monitoring. Repeated measure (RM) ANOVAs were done on the arcsine-transformed proportions, where “subjects” were houses sampled over time. We did the RM ANOVA over the first 10 wks as well as for each consecutive shorter time period down to weeks 1 and 2. As a follow-up to the RM ANOVAs we did simple ANOVAs at each monitoring date to compare the two protocols. Similar RM ANOVAs for runoff data for fipronil and a simple ANOVA for cyfluthrin were done to compare Protocols 1 and 2. All analyses were done with Systat (2009).

Results

Ant numbers. The RM ANOVAs between the two protocols did not show any significant differences either at the house foundation or yard (F=2.5, df=1,8, P=0.15), and (F=3.3, df=1,8, P=0.10). For wks 2 through 10 there were significantly more ants in the yard than at the house foundation for both Protocols 1 and 2 (RM ANOVA, F=51.3, df=1,8, P<0.001), and (F=13.1, df=1,8, P=0.007), respectively.

Insecticide runoff. Protocol 1. The concentration of bifenthrin from driveway runoff from the granules was near or at the *Ceriodaphnia* EC_{50}. The spot treatments of cyfluthrin for a call back in August and the bimonthly treatments in September resulted in cyfluthrin runoff levels above the *Ceriodaphnia* EC_{50} for days 65 and 98. The concentration of fipronil in the runoff was orders of magnitude below the fipronil EC_{50}, except for day 1, when it slightly exceeded it.

Insecticide Runoff. Protocol 2. The concentration of cyfluthrin in the runoff was below the *Ceriodaphnia* EC_{50} except for the day 1. The concentration of fipronil in the runoff was orders of magnitude below the *Ceriodaphnia* EC_{50} for all samples.

Both companies used the same volume of 0.06% fipronil for treatments on day 0. Analysis of the water samples showed that Protocol 1 had higher concentration of fipronil in the runoff than Protocol 2, but not significantly so over the entire time period (RM ANOVA, F=4.3, df=1,8, P=0.07).

Discussion

Two strategies were tested in these trials. PMP 1 used a more traditional approach, consisting of an initial fipronil foundation treatment supplemented by pyrethroids. In place of a pyrethroid spray the company used bifenthrin granules applied away from impervious surfaces. For their second treatment they did spot treatments with cyfluthrin sprays plus bifenthrin granules where ants were seen. To reduce the amount of insecticides used, this company treated bimonthly instead of monthly. PMP 2 relied more heavily on botanicals on a monthly schedule. Even though the initial treatment was done with fipronil spray and spot treatments with cyfluthrin, PMP 2 used only EcoPCO WP-X, a liquid spray containing 2-phenethyl propionate and other botanical oils (thyme oil and pyrethrins) for all their subsequent monthly treatments.

With respect to ant control, the bimonthly use of more traditional insecticides controlled ants at about the same level as the monthly applications of botanicals. For the first two weeks the Protocol 1 combination of fipronil plus granular bifenthrin gave better control than did the Protocol 2 treatment of fipronil plus cyfluthrin. Thereafter the differences were slight.

The initial bifenthrin runoff in Protocol 1 from the granular product was approx. 150 ppt. This result is similar to an earlier report of about 300 ppt (Greenberg et al. 2010). We have seen pyrethroid runoff this low only with the granular product. By way of comparison, that same article (Greenberg et al. 2010) reported the initial runoff from bifenthrin barrier sprays at about 9,000 ppt.

Both companies used the cyfluthrin spray along the edges of the lawn next to the driveway and around the foundation. It is likely that most of the runoff results from treatments was from the cracks and crevices adjacent to the driveway, which would be in contact with water moving down the driveway. Although the new labeling for pyrethroids prohibits their use on impervious surfaces, elimination of crack and crevice treatments adjacent to the driveway and sidewalk may further reduce pesticide runoff.

Traditional PMP practices included widespread use of pyrethroids in the yards to control ants there. Due to sensitivities about pyrethroid runoff, both companies in this study limited the use of pyrethroids in the yards. Not surprisingly, the level of ant control in the yards was significantly lower than that at the house foundation. Homeowners may be tolerant of the higher numbers in the yard, so long as the ants do not invade the structure. However, if the high number of ants in the yard becomes problematic as some ants invade the structure, then other strategies, such as bait stations and botanicals, could be considered.

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Comparison of two community wide programs targeted to manage red imported fire ants, *Solenopsis invicta* (Buren)

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Community wide fire ant management programs can help reduce red imported fire ant populations and reduce pesticide costs for community residents. By forming community wide programs for neighborhoods, fire ant re-infestation can be reduced or delayed. Two Central Texas neighborhoods have ongoing red imported fire ant community-wide management programs in place. The programs bait for fire ants in spring and fall of each year with residents treating fire ant mounds with the method of their choice between those times. Both neighborhoods are monitored four times a year, before and after each baiting period. The community wide management programs have been developed and carried out in different ways- one hired a pest management company while the other sent an email to residents with a reminder to bait. The neighborhood with professional baiting shows greater reduction in red imported fire ant populations with an increase in other ant genera.

Food Lure Preferences of *Brachymyrmex patagonicus* Mayr (Hymenoptera: Formicidae)

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Laboratory and field trials were initiated to investigate the food lure preference of *Brachymyrmex patagonicus*. Multiple food lures were offered to ants in laboratory assays to determine food preferences of *B. patagonicus* under constant environmental conditions. All food lures were replicated a minimum of five times in both the laboratory

and field. Observations of food lure attractiveness and ant recruitment (measured by counts of ants on food lures and differences in pre and post-study weight) were made. The top five preferred food lures in the laboratory assays were then deployed in the field trials to determine *B. patagonicus* food preferences under field conditions. Seasonal data was collected in the field trials.

In the laboratory study, photographs were taken six times daily (3 am and 3 pm photographs) over a 5 d period. *B. patagonicus* foragers chose the honey spread and the pancake syrup over the other eight food lures based on number of ants and the weights pre and post-study. There were approximately 110 ants and 80 ants at the honey spread and the pancake syrup, respectively, followed by pineapple preserves, tuna, and sweet and sour sauce.

Those five food lures were then deployed to the field seasonally in manicured lawns near known areas of established *B. patagonicus* colonies to determine the preference of foragers. Photographs were taken starting at 6:00 am and hourly until 10:00 am, then at 5:00 pm and hourly through 10:00 pm. Based on the number of ants documented at each food lure and the differences in weight pre and post-study, foragers preferred the following lures seasonally: Winter-pineapple preserves; Spring-honey spread; and, Fall-tuna.

Submitted Papers FLIES & COCKROACHES

Laboratory Screening and Field Evaluation of Four Commercially Available Scatter Baits and One Novel Bait Against *Musca domestica* and *Fannia canicularis*

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Toxic fly baits are commonly used for fly control on California animal operations. However, resistance development has been a problem. Comprehensive laboratory and field studies were conducted to test currently available commercial baits (imidacloprid, methomyl, dinotefuran, spinosad) and one novel cyantraniliprole bait (Zyrox®). Cyantraniliprole is a novel insecticide that belongs to the anthranilic diamide class of insecticides. The novel mode of action of cyantraniliprole depletes calcium from insect muscle, affecting muscle contraction, causing paralysis and eventually death. In this study, a susceptible *Musca domestica* strain was compared with a wild-type strain in the laboratory, as well as *Fannia canicularis*, in bait choice/no-choice laboratory tests. Field visitation to baits and both short and longer-term mortality were documented.

Susceptible *Musca* suffered high 3d mortality with all baits in choice and no-choice tests. Wild-type *Musca* mortality was more variable and higher in no-choice tests (due to behavioral resistance or dilution effects). *Fannia* were most susceptible to spinosad > dinotefuran= cyantraniliprole > methomyl = imidacloprid. Field *Musca* were attracted to spinosad > cyantraniliprole > dinotefuran > sugar > methomyl > imidacloprid. Eventual mortality from bait-fed field flies (captured and held with untreated food and water for 3d) was ranked spinosad > cyantraniliprole > dinotefuran = methomyl > imidacloprid > sugar.

Behavioral resistance to imidacloprid and methomyl persists. Spinosad and cyantraniliprole baits performed best. Speed of action may be a factor in use and abuse of baits. For insecticide resistance management, cyantraniliprole fly bait will be a valuable tool for rotation with neonicotinoids and carbamates.

Recent findings from insecticide resistance studies in German cockroaches

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Insecticide resistance has been a significant barrier to insecticide-based pest management for over 60 years. German cockroaches were one of the first insect pests with documented resistance (Keller et al. 1956); and in the ~60 years since this, they have repeatedly developed resistance to nearly all insecticide classes used against them (Bennett & Spink 1968, Cochran 1989, Scharf et al. 1997, 1998; Wang et al. 2004, 2006). Recent incidences of resistance re-emphasize the evolutionary adaptability of cockroaches (Chai & Lee 2010), and also that present-day insecticides are not immune from resistance evolution. Diligence by pest managers thus remains essential. The overall goal of our research on this topic is to provide information that helps the pest management industry to better preserve existing cockroach control products, while at the same time, consistently achieving satisfactory control. General topics covered in this talk included (1) development of a proactive resistance monitoring program (Gondhalekar et al. 2011, 2013) and (2) findings from basic research programs investigating resistance evolution, mechanisms and management in this important pest species (Gondhalekar et al. 2012, Gondhalekar & Scharf 2013).

Three strategies for resistance management are considered viable at the present time. These include insecticide rotations, insecticide mixtures, and an integrated, mostly non-chemical approach (Gondhalekar & Scharf 2013). However, regarding the first two options of rotations and mixtures, there is presently no information available regarding how to most effectively deploy either approach, and which might be more effective. Research is clearly needed to define rotation and mixture parameters that would best delay the onset of resistance-associated control failures.

Thus, our recommendation for cockroach resistance management at the present time remains *active ingredient (AI) rotation* over exclusive reliance on *AI mixtures*. However, mixtures still have utility for resistance management, provided they are, at least initially, rotated with other products in ways that prevent the kinds of selection pressures that lead to rapid resistance evolution and impending control failures.

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Sexual behavior of the resurgent Turkestan cockroach, *Blatta lateralis* (Dictyoptera: Blattidae)

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The Turkestan cockroach, *Blatta lateralis* (Walker) is a peridomestic urban pest that has resurged in the Southwestern of United States. Despite the high prevalence of this cockroach in urban and rural areas, there is little information on their biology and behavior. We used a video tracking software (Ethovision ®) to characterize mating and calling sexual behavior of this species. Virgin adult females exhibit a characteristic calling posture in which the female stretches her hind legs and rubs several times the 3 thoracic segments against a surface. Calling occurred more in photophase than scotophase. The onset of calling activity in the scotophase commenced three hours after lights-off and the percentage of calling females remained low during this period. In the transition from dark to light, most of the females showed a sudden increase in calling activity, but this rapidly decrease during the photophase. We did not examine whether a pheromone is actively released during calling, as describe in other species. However, we hypothesize that calling behavior serves to attract males as well as to potentiate responses to putative contact sex pheromone.

Laboratory Efficacy Studies of TEKKO™ PRO (Novaluron 1.3% + Pyriproxyfen 1.3%) for the Control of *Blatella germanic a* (Blattodea: Blattellidae)

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Initial dose response bioassays were conducted with combinations of pyriproxyfen and novaluron concentrations on selected substrates to identify effective dosages interfering with cockroach molting, metamorphosis and reproduction. The combination of two IGRs demonstrated that the dual action of pyriproxyfen and novaluron prevented normal molting, metamorphosis and reproduction at concentrations tested for the selected substrates.

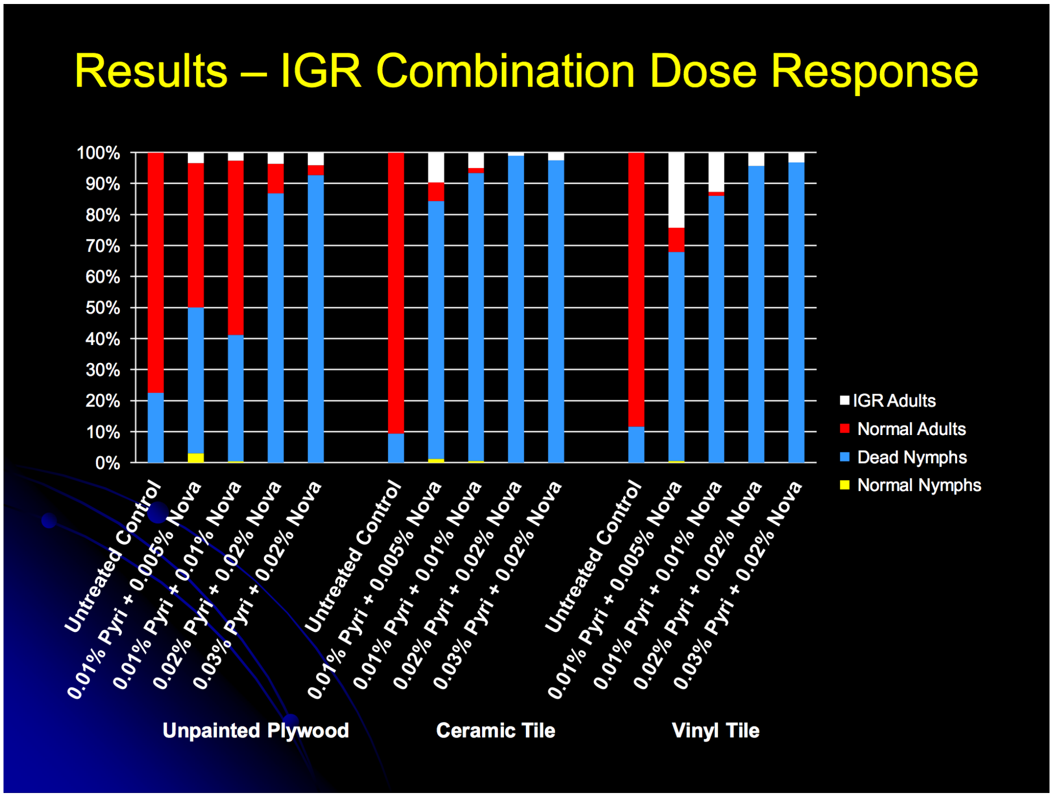
A second experiment was initiated to evaluate novaluron (0.02%) and pyriproxyfen (0.02%), individually and in combination, against German cockroaches on plywood, vinyl tile and ceramic tile in the laboratory. The cockroaches were mid-instar nymphs, 35 per replicate placed in plastic shoeboxes with food, water and harborage. The test containers were placed in an environmental chamber until all the control groups had adult cockroaches and reproduction.

Results showed molting abnormalities of mid-instar cockroaches on all three substrates in the novaluron only test groups and the combination novaluron + pyriproxyfen test groups. These cockroaches were dead prior to molt and comprised 45-82% of the test populations. Morphological characteristics of juvenile hormone analog (JHA) activity were observed in the pyriproxyfen only test groups and pyriproxyfen + novaluron test groups. These effects were most notably twisted wings and darkened cuticle with individuals alive in these treatment groups. The untreated control groups showed normal molting and metamorphosis to the adult stage with some females producing ootheca.

0.02% Pyriproxyfen + 0.02% Novaluron were the optimum concentrations for German cockroach control.

Unfinished plywood was the most challenging substrate when compared with vinyl and ceramic tile.

Tekko™ Pro was effective by reducing the reproductive potential and breaking the life cycle of German cockroaches.


Results – IGR Combination Dose Response
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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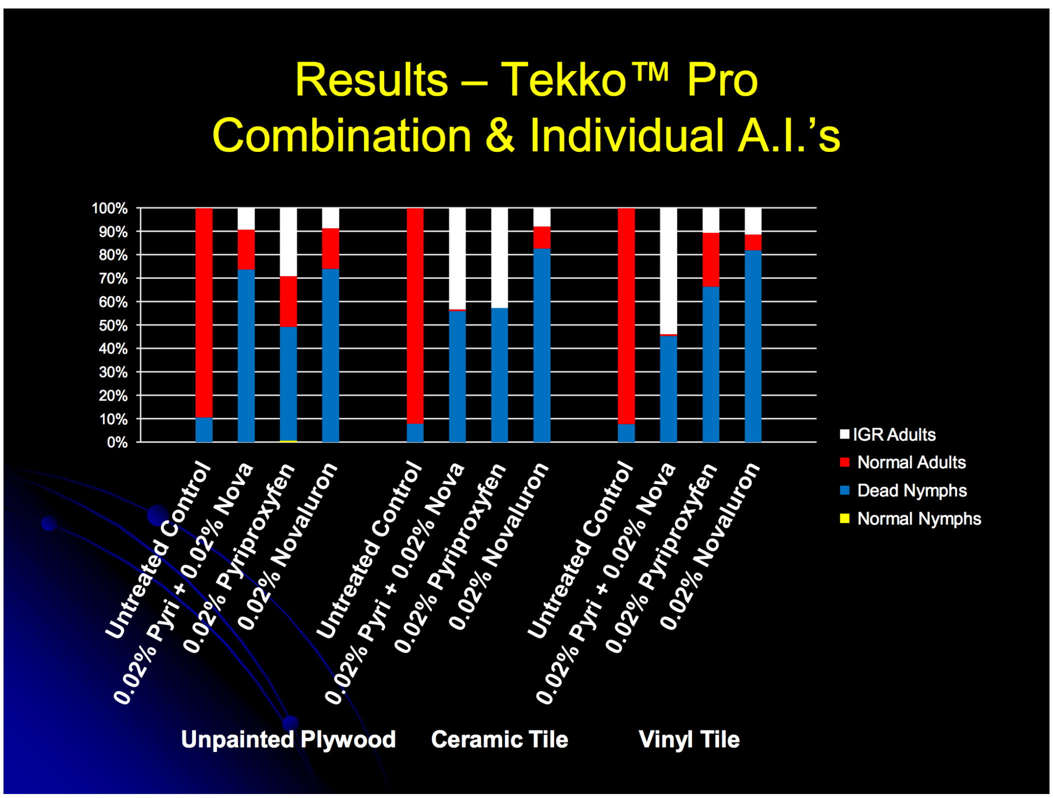
Untreated Control
0.01% Pyri + 0.005% Nova
0.01% Pyri + 0.01% Nova
0.02% Pyri + 0.02% Nova
0.03% Pyri + 0.02% Nova
Unpainted Plywood
Ceramic Tile
Vinyl Tile
IGR Adults
Normal Adults
Dead Nymphs
Normal Nymphs


Results – Tekko™ Pro
Combination & Individual A.I.'s
100%
90%
80%
70%
60%
50%
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20%
10%
0%
Untreated Control
0.02% Pyri + 0.02% Nova
0.02% Pyriproxyfen
0.02% Novaluron
Unpainted Plywood
Ceramic Tile
Vinyl Tile
IGR Adults
Normal Adults
Dead Nymphs
Normal Nymphs

Submitted Papers
IPM SUCCESSES

A+ Schools – Getting Everyone Involved in the IPM Program

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Integrated pest management (IPM) is a process that requires cooperation among all school staff members, which includes faculty and students, within a school district as well as the pest management professionals. IPM is a strategy of managing pests using multiple control tactics that provide the best control with the least cost and environmental impact. IPM is based on thorough knowledge of the pests and the technologies used to control them, and can be performed by anyone with proper training. A good IPM program attempts to make schools less hospitable to pests by modifying the environment and by using the lowest impact pesticides necessary. Managing risks from pests and risks from the pesticides used to control them are top priorities under an IPM program.

Having a sustainable IPM program takes time, effort, and people. Simply adopting IPM tenets and practices is part of the solution, but having a well thought out program takes some effort. Each school or district should have a designated IPM coordinator ("The Bug Stops Here" person). All reports and complaints should be directed to the coordinator's office. The IPM coordinator should be viewed as an important part of the overall environmental quality team for the school or district. When it comes to IPM, cooperation is the key to successful operation. The IPM Coordinator for the school system needs to be an individual that can work with upper administration, principals, teachers, custodians, food service, and maintenance. The IPM Coordinator needs to have the ability to request work orders and have some input as to how repairs are made. This individual also needs to be able to request that custodial crews undertake deep cleaning projects when necessary, that many not be on a normal routine basis. The coordinator also needs to be able to work with food service staff on ongoing maintenance and implementation of IPM practices in order to make these areas less pest friendly. The coordinator must also have the ability to work with campus teachers and principals to change practices that could affect the IPM program through conducive conditions for pests.

IPM is information intensive; the coordinator should have time to attend conferences, and other educational programs so that he/she can keep up with all the trends on pests and their treatments. The coordinator must also be able to communicate well with others; this includes composing emails and newsletters to district staff during certain periods of the school year when certain pest problems are common.
In addition, the program should have these additional components:

- Pesticide treatments should be conducted only when there is just cause. Every visit by a pest control technician should consist of careful inspections and corrective actions. Staff and administrators should be trained to understand that a successful pest control service involves investigation, analysis, and education, and does not necessarily involve the application of pesticides.

- Pest control service should include use of monitoring devices such as sticky cards (for insects), glue boards, non-toxic bait blocks and non-toxic tracking powder (for rodent inspections) and accurate reports that detail sanitation needs and pests observed.
- Recordkeeping is an essential part of an IPM program. Each campus should have records of all pesticide applications, IPM service reports, labels, and Safety Data Sheets for every pesticide use on campus. Outdoor applications should include information about pesticides used, time of day applications were made and weather conditions including wind speed and direction.
- Educate, educate, educate. Not only pesticide applicators need training. Teachers, principals, school nurses and other staff need to be informed about the goals and directions of the pest control program. In schools, it is especially important to get everyone on board to make IPM work.
- Assemble an environmental SWAT team. Start small. Get four to five interested people involved. Staff suggestions should include employees from the maintenance and purchasing departments. Together these people will generally know how much time and money it will take to fix a problem. Other team members can include teachers, office staff, custodians, principals, nurses, and even parents.
- Keep parents informed! Every year parents should be notified, via a student handbook or handout, about the IPM program. Provide a number to call if they have questions, and post notices in the entryways and offices before any pest control service.

Overall functions of the IPM Coordinator and IPM program

Inspections: The backbone of an exemplary IPM program is the ability to inspect school campuses for conducive conditions for pests. These inspections can be done in conjunction with other environmental inspections; however, to understand where pests are coming from, inspecting buildings thinking like a cockroach or mouse, will expose many areas that need sealing up. Having the IPM coordinator or their designee assigned to this task will point out many areas that will also help with student safety, indoor air quality and energy efficiency as well.

To assist schools with this function, Texas A&M AgriLife Extension developed the IPM Risk Calculator (http://ipmcalculator.com) has 92 questions that now allow IPM Coordinators, pest management professionals, and Extension Specialists to inspect a school building and determine an overall pest risk based on observations of the presence/absence of 18 pests and the condition of 37 building features. Building features used in the calculator are those thought most likely to influence the likelihood and severity of a pest infestation. The risk calculator gives a weight to the importance and severity of each pest to calculate an estimated overall risk to students, teachers, and others.

In addition to user observations, the IPM Risk Calculator uses school location, based on zip code, to determine likely pest pressure for each pest. For example, northern zip codes would have a low risk for fire ants. Southern zip codes would raise the risk of fire ants, even if the user does not record fire ant mounds.

Sanitation: Sanitation is often more important, than any pesticide application. Cleaning up storage rooms, eliminating clutter, and keeping food items in plastic storage containers can greatly reduce the need for insecticide applications. All principals and teachers need to learn the importance of maintaining clutter free zones. Not only will this aid with the IPM program, but it will also help with indoor air quality issues, including asthma and allergy triggers.

Exclusion: The premise behind the IPM program is to prevent pest problems before they become a problem. One of easiest tasks the district can do is to maintain pest entryways so that mice, rats, cockroaches and other pests have difficulty entering a building structure.

Interior and Exterior IPM Strategies:
School Interiors:

- All food storage areas should have products stored on industrial grade, stainless steel wire shelving, at least 6 inches from walls and 12 inches from floor.
- No foods should be stored in classrooms without being stored in re-sealable containers (i.e. plastic storage containers, metal tins, etc.).
- Seal all cracks and crevices around windows, doors, bathroom fixtures, moldings, water fountains, utility lines, bulletin boards, and blackboards attached to walls.
- Keep clutter in classrooms and custodial closets to a minimum. Cardboard is great harborage for cockroaches, ants, and mice.
- Eating in classrooms should be kept to a minimum and classrooms should be cleaned thoroughly after food consumption to prevent insect and mice activity.
    - Breakfast in classroom is understandable in the elementary campuses, but there needs to be a plan in place to help custodial understand if there has been a food spillage or special attention needs to be made to classroom after the students have left for the day.
- All food prep areas should be cleaned and disinfected on a daily basis; this includes moping of floors and cleaning of floor drains on a regular basis.

School Exterior:

- Any openings larger than ¼ inch should be sealed. This means that door sweeps, kick plates, and doorsills should be maintained and regularly repaired to prevent rodent entry.
- Holes around all pipes and soffits must be sealed using a durable sealant.
- Cracks in walls and foundations must be sealed.
- All exterior doors must be kept closed at all times, and not used for added ventilation.
- Garbage cans and exterior dumpsters should not be maintained too close to the school. It is recommended that dumpsters be at least 10 feet from the entryways and when possible 50 feet away.

- Shrubs and trees must be trimmed so they are not in contact to exterior walls or rooflines. Recommended distance from buildings is one (1) foot.
- Exterior lighting must be non-attractant. Replace halogen bulbs with low-pressure sodium vapor lights over entry areas. (This is extremely important to keep crickets down so that spiders do not follow)
- Seal all cracks and crevices around doors, windows, and walls with an appropriate sealant.
- All metal overhangs and roof edges must be tight and sealed to avoid nesting of wasps, hornets, other stinging insects, bats, and/or birds.

Coordination of Grounds, Athletics and IPM: Often the athletic department or grounds department are removed from the IPM program. In order to have an exemplary IPM program there needs to be communication and cohesiveness between the indoor IPM program and what goes on outdoors. Athletic staff, including coaches needs to understand their role in the IPM program. Too often locker rooms are considered outside the program until there is a pest problem. The coordinator needs to work with these groups to understand what the department roles are and how they can assist with the IPM program so that every part of the school campus is pest free.

Training for staff: Everyone within the school district has a role in IPM. All custodial staff, food service personnel, and maintenance personnel should be trained to look for hidden problems. Teachers, principals, and coaches should be educated on when a pest problem is significant to warrant a pesticide treatment versus when a pest problem needs exclusion or sanitation remediation. Within the IPM program it is everyone's responsibility to help maintain the "health and well-being" of the school building. By training everyone, especially teachers, as to why pests favor school buildings, what steps can be taken to keep ants and roaches out of classrooms, the overall IPM program will be received favorably. Most people do not understand that everyone has a role in the IPM program, from teachers and staff having food in their desks/classrooms, to custodial practices, to the need to seal up holes, to reporting broken door sweeps. If everyone in the district understood the need and reported properly, your pest complaints would decrease and the use of pesticides would decrease.

Roles of other staff in the IPM Program:

School Administrators: Administrators should be aware of state laws about IPM in schools, pesticide use in schools, any other regulations addressing pest management and the district's IPM policy. The IPM program needs administrative support for sustainability and effectiveness. The IPM Coordinator should communicate with school administrators on a regular basis. The most important responsibilities of administrators are to:

- Adopt and maintain an IPM policy.
- Include IPM as part of your health and/or safety committee(s)
    - SHAC (School Health Advisory Councils)
- Designate and train a competent IPM Coordinator.

- Support priorities for maintenance and sanitation, as identified by the IPM Coordinator.
- Encourage faculty and staff understanding and full participation in the IPM program.

School Nurses: Should be aware of the IPM Policy, IPM Plan, and pesticides on school property. Be familiar with the signs and symptoms of pesticide poisoning. They should also be aware of signs of pest exposure including head lice, fire ants, bed bugs, asthma, rabies and mosquito and tick-borne diseases present in the region. The nurse should be able to communicate with the IPM Coordinator about such concerns. A nurse should:

- Be aware of any children or staff with asthma, chemical sensitivities, or allergies to stinging insects.
- Have information on IPM strategies for pests that can affect student health.
- Keep a list of students who have serious reactions to stinging insects. And communicate this information to the IPM Coordinator

Students and Teachers: Need to be trained on how to report pest sightings. Using pest sighting logs and/or a work order system allows teachers report their concerns to the IPM coordinator. The teacher can act as the liaison from the student to the IPM coordinator. Students and teachers must also understand the necessity of keeping facilities clean:

- Leaving NO food in lockers, classrooms, and common areas
- NO eating or drinking in areas not designated for food consumption.
- NO clutter, which can provide shelter and makes inspection and cleaning difficult

Parents: Parent support of IPM can motivate and reinforces school staff efforts to provide effective, low risk pest control. Parent support for IPM can strengthen the districts IPM program more than anything else.

- Express concerns to IPM Coordinator, PTO, or school administrator about pest or pesticide issues.
- Notify administration of chemically sensitive child.
- Use IPM practices in their homes to extend the benefits of IPM.

Maintaining a healthy school building is the ultimate goal of IPM for schools. Children and teachers spend more than eight hours a day inside these structures. Not having to worry about pests or routine application of pesticides allows the building occupants a safe place to learn, share, and grow. For IPM to be successful, everyone has a role to keep the school pest free.

http://www.extension.org/urban_integrated_pest_management
School IPM 2015 Pest Management Strategic Plan

Submitted Papers
SPECIAL INTERESTS

Deposition of Fluoride on Inert Surfaces during Fumigation with Vikane® gas fumigant (sulfuryl fluoride)

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A number of structures, including residences, schools, museums, laboratories, and manufacturing, medical and veterinary facilities, are fumigated with sulfuryl fluoride sold as Vikane® gas fumigant (99.8% sulfuryl fluoride, Dow AgroSciences, Indianapolis, IN). Occupants, employees, and managers of these buildings often request documentation that deposition of fluoride on inert surfaces, such as stainless steel, glass and ceramic, does not occur during fumigation with sulfuryl fluoride (SF). The chemical properties of SF would indicate fluoride deposition on these inert surfaces would not occur. Dow AgroSciences in collaboration with the American Council for Food Safety & Quality evaluated fluoride (F-) residues on glass, stainless steel and ceramic surfaces before and after exposure to Vikane.

Samples were fumigated for 24 h at 35°C at the maximum dosage rate of (1500 g-h/m^3). The fumigation treatment was replicated three times, with two samples of each surface type in each replicate. After fumigation, each treated and untreated sample was wiped following a standard process. A template with a 10x10 cm opening was adhered to the sample surface and wiped with a laboratory wipe pre-moistened with a specified amount of deionized water. Samples were wiped once and then wiped a second time with a new pre-moistened wipe. Wipes were placed in separate labeled containers and held for extraction.

A standard extraction method for determining fluoride residues on fumigated commodities was followed with slight modifications to allow for the use of laboratory wipes. F-residues for each surface replicate were measured with a Denver Instrument Model 225 pH/mV/ion meter with an F- Combination Electrode using a validated procedure.

No significant differences could be detected between treated and control samples of the same surface type (α=0.01). A comparison of fluoride levels across all control samples found no statistical differences between surface types (P=0.1699). Likewise, no significant differences in F- levels could be detected between surface types of non-fumigated samples (P=0.457). Residue values for all fumigated samples were combined and compared to levels of all non-fumigated control samples. No significant difference (P=0.1025) could be detected between untreated control and fumigated samples. Based on these results, F- residues recovered from glass, stainless steel and ceramic surfaces following fumigation with Vikane are from exposure to naturally occurring fluoride in the environment and not from exposure to sulfuryl fluoride.

Effifcay of mosquito adulticiding in reducing incidence of West Nile virus in New York City

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Introduction

During the epidemics of mosquito-borne diseases such as West Nile (WN) virus, mosquito adulticiding (space spraying for adult mosquito control) is often used to interrupt pathogen transmission to humans by reducing the number of infected mosquitoes (Bond 2012, Peterson et al. 2006). Such reduction makes this intervention a valuable tool for the protection of public health in the urban areas. In New York City (NYC, City), adulticiding is performed by truck-mounted ultra-low-volume (ULV) applications of insecticides (adulticides) against the flying adult mosquitoes. ULV applications generate fine aerosol droplets and are timed for late evening and night hours to coincide with flight activity of the vectors (*Culex pipiens*, *Cx. restuans* and *Cx. salinarius*) and to avoid the flight activity of non-target insects such as bees, butterflies and dragonflies. This application method and timing ensure minimal human-health risks from residential exposure to the adulticide (Bond 2012, Currier *et al*. 2005, Karpati *et al.* 2004, O'Sullivan *et al.* 2005; U.S. EPA 2012).

NYC Department of Health and Mental Hygiene (DOHMH) uses near real-time mosquito surveillance and infection rates to determine risk of WN virus transmission and to decide when to spray in the selected areas of NYC. The transmission risk is determined based on the extent and level of virus activity, density of vector mosquitoes and likely effect of forecasted weather on the mosquito activity in the area.

In this paper, we have presented results of analyses of West Nile virus surveillance data for spray operations conducted during 2007-2012 WN virus seasons. These results indicate that reduction in population and/or infection-rates of vectors of WN virus would result in a decrease in the number of infective bites received by the human population and would consequently impact the transmission of WN virus.

West Nile Virus Control in NYC

In the late 1999 summer, WN virus was confirmed for the first time in the United States in the City of NYC. This discovery caused immediate and critical concern because of the unknown and possibly deadly risk of the spread of WN virus, especially in a densely and heavily populated city. DOHMH rapidly developed a plan and program to deal with this situation. The initial strategy in preventing WN virus focused on surveying and testing dead birds. If a WN virus positive bird was identified, an area within a radius of one-mile around the positive bird would be adulticided. Since the identity of WN virus was confirmed late (late August, 1999) in the "mosquito" season, there was a short period to deal with a potentially catastrophic situation.

Beginning in the 2000 WN virus season, DOHMH developed a workable and comprehensive surveillance program for humans, mosquitoes and dead birds. Human cases were reported to and investigated by the DOHMH's Bureau of Communicable Diseases. Mosquitoes were collected, identified, pooled by species, and tested for WN virus by the Office of Vector Surveillance and Control (OVSC). Dead birds were sent to the

New York State Department of Environmental Conservation for testing. Positive birds were considered during the decision making process, but were not a driving component in determining whether or not to adulticide. Later, OVSC started using algorithms/decision trees to assess its human and mosquito surveillance data and determine the need for adulticiding an affected area.

Use of Spray Algorithms

Our adulticiding criteria are based on assessment of "WN virus transmission risk" in an area considering the following:

1. Human case(s) with evidence of local transmission of WN virus
   or
2. WN virus activity in mosquito populations plus the following four essentials:
   a) Evidence of persistent virus activity, which refers to the ongoing presence of WN virus in the trapped mosquitos from an area.
   b) Successive weeks of increasing mosquito populations testing positive for WN virus in the area, or with mosquito counts exceeding 100 per trap per night.
   c) The mosquito species with WN virus must be known to be those that bite humans, feed on birds, or are opportunist and feed on anything. Only mosquitoes that feed on both birds and humans are capable of transmitting the disease to humans.
   d) The weather conditions must be favorable for mosquito activities and viral transmission.

The "Positive Human Case Algorithm" (Figure 1) and the "Positive Mosquito Pool Algorithm" (Figure 2) are used to accurately and consistently determine if above-mentioned criteria are met to adulticide selected areas based on WN virus positive mosquitoes pools collected during mosquito surveillance and/or WN virus positive human cases reported to the department. Both algorithms have been updated as appropriate.
The "Positive Human Case Algorithm" is driven by:

- Presence of human case(s), and
- Presence of WN virus infected mosquito(es) in the area.

Rationale - A human case(s) and the presence of a WN virus positive mosquito(es) indicate a meaningful risk to the people in the defined geographical area. However, a single human case in an area without supporting evidence of local transmission would not trigger the need to adulticide. The
"Positive Mosquito Pool Algorithm" is driven by:

- Presence of WN virus in mosquito pools
- Persistence of WN virus in locations
- Proficiency of mosquito species in transmitting WN virus
- Propensity of WN virus positive mosquito to bite humans
- (Human) Population density in the area where WN virus activity [positive mosquito(es)] was detected.

Rationale - The presence of a positive mosquito pool(s) that is of a human biter and a competent vector of WN virus near a high human density poses a significant enough risk to justify adulticiding. Typically, infected mosquitoes signal the presence of local WN virus activity, and occur three weeks or more prior to human transmission.

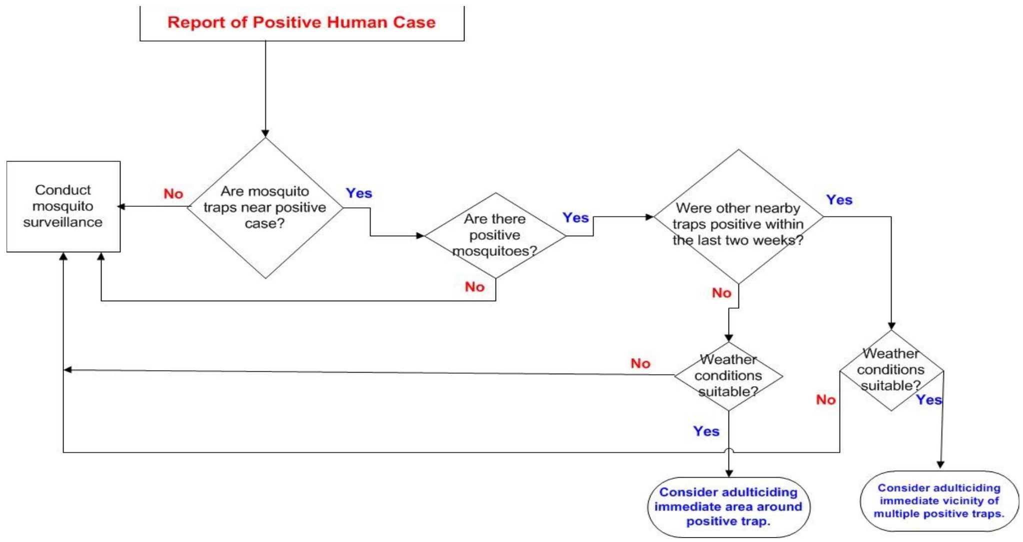
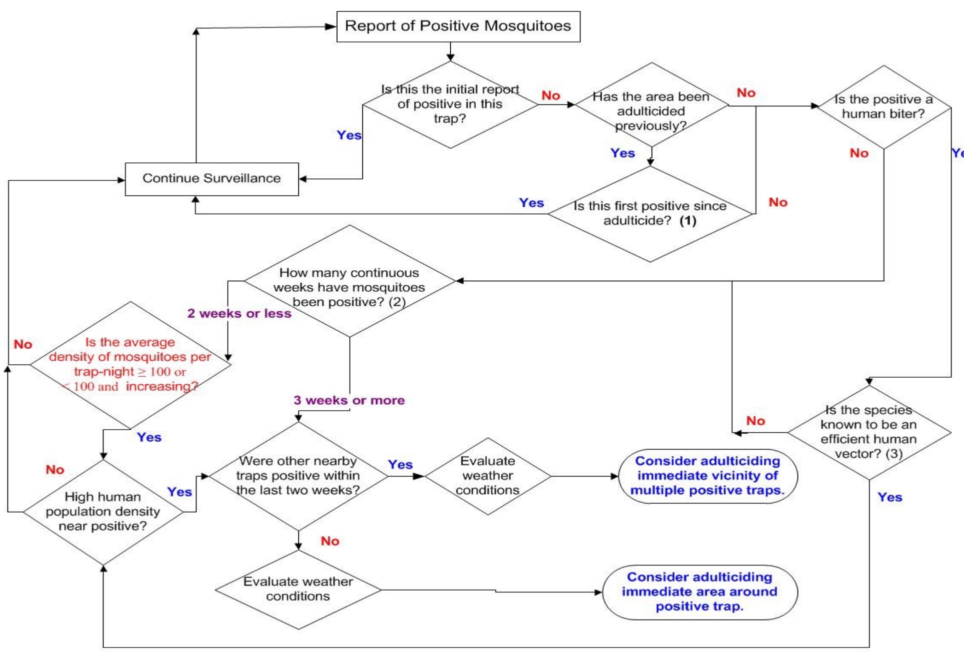


Figure 1: Positive Human Case Algorithm



1: Must consider how recent the spray event was. 2: Must consider total number of positive mosquitoes in the trap 3: Must consider other species specific factors such as flight range.

Figure 2: Positive Mosquito Pool Algorithm

The "Positive Mosquito Pool Algorithm" has the following different pathways to justify adulticiding to reduce the risk of WN virus:

1. Positive mosquito pool(s) is a human biter
2. Positive mosquito pool(s) is a competent vector of WN virus
3. High human population near the positive pool(s)

Table 1. Results of adulticiding in New York City- Normal (2007 - 2008) versus epidemic (2010 - 2012) years

Year	Spray Events*			Human Cases				Odds of Human Infection (Untreated/ Treated)		Mosquitoes	
	Total Events	Acres Treated	Traps No.	Total	Untreated Areas[1]	Treated Areas < 14 days[2]	Treated Areas > 14 days[3]	< 14 days	> 14 days	Population Reduction	Infection-Rate Reduction
2007	6	7,222	44	18	18	0	0	-	-	46.8	91.6
2008	10	19,252	96	15	15	0	0	-	-	56.8	80.8
2010	18	34,200	86	42	33	2	9	16.50	3.67	55.6	71.7
2012	23	57,606	108	41	33	3	5	11.00	6.60	59.7	76.0

[1] Human cases outside spray zones or inside the spray zones but with the onset of illness before spraying

[2] Human cases within spray zones and the onset of illness < or = 14 days after spray

[3] Human cases within adulticiding spray zones and the onset of illness >14 days after spray

* All adulticiding events were conducted using truck-mounted ULV sprayers and only when the weather conditions were compatible (temperature > 60°F, wind speed: < 10 MPH, precipitation: 0 inch). If any of these conditions were not met, the adulticiding event was delayed to an alternate date. If criteria were not met for the alternated date, the event was reconsidered base on new surveillance data.

Persistence of positive mosquito pools:

1. One week meets the criteria for adulticiding, if:
   i) Positive mosquito pool is that of a human biter and a bridge vector
   ii) Positive mosquito pool is that of a competent vector of WN virus
   iii) High human population near the positive pool

Rationale – The presence of a positive mosquito pool(s) that is of a bridge vector and a competent vector of WN virus near a high human population poses a significant enough risk to justify adulticiding.

2. Two consecutive weeks meets criteria for adulticiding, if:
   i) Positive mosquito pool is that of a non-human biter or a human biter but a non-competent vector of WN virus
   ii) Average density of mosquitoes is ≥100 mosquitoes/trap night or ≤100 mosquitoes/trap night and increasing
   iii) High human population near the positive pool

Rationale – Two consecutive weeks of positive mosquitoes within a density of ≥100/trap night or ≤100/trap night and increasing near a high human population poses a significant enough risk to justify adulticiding.

3. Three consecutive weeks meets the criteria for adulticiding.

Rationale – Three consecutive weeks of positive mosquitoes demonstrates a continuing perseverance of virus activity that poses a significant enough risk to justify adulticiding.

Results and Discussion

In Table 1, we compared the number of human WN cases within treated areas with the untreated area of the City. When we adjusted for an average incubation period of the virus from infection to onset of symptoms (3-14 days), no or very few new cases were reported in the treated areas after adulticiding. During an average WN virus activity seasons (2007/2008), no human case was detected in the treated area any time after adulticiding. During the epidemic years (2010 & 2012), the odds of human infections in the untreated compared with treated areas were 11.0 - 16.5X higher within one weeks after spraying and 3.7 - 6.6X higher more than two weeks after spraying. The overall odds of human infection after spraying were 13.75X higher in the untreated area than in treated areas. We observed 46.8 – 59.7% reduction in mosquito densities and 71.7 – 91.6 % reduction in infected mosquitoes 24 hours after spray. These results indicate that the treatments successfully disrupted the WN virus transmission cycle and adulticiding was effective in reducing human illness and potential death from WN virus infection in the congested urban areas such as NYC.

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Submitted Papers
TERMITES

Development of Baiting as a Method to Control Subterranean Termites

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As early as the 1960's a "bait method of control" for subterranean termites was discussed in scientific literature. The concept described at the time was to use toxicant-impregnated wood blocks to suppress populations of pest termite species in the field. In the years since then, considerable research has been conducted to investigate potential active ingredients for termite bait, including pathogenic fungi, metabolic inhibitors such as sulfluramid, chitin-synthesis inhibitors such as diflubenzuron, lufenuron, and hexaflumuron, and even fipronil and encapsulated permethrin. Additional work has been published on associated stations, matrices, sensors and attractants. Focused research efforts resulted in the first termite baiting system being commercially introduced in 1995. Termite baiting systems now represent a substantial portion of the termite control market in the USA and a growing proportion of the termite control market globally, with research continuing to refine many of the elements earlier defined.

Ecological niche separation between the Formosan and Asian subterranean termites in Taiwan

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The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, and the Asian subterranean termite, *C. gestroi* (Wasmann), are the two major pests of wooden structures and wood products in Taiwan. Both species are responsible for >87% termite infestations in urban area. *C. formosanus* is a native species of Taiwan, and *C. gestroi* is an introduced species. So far, *C. formosanus* occurs in all 15 prefectures of Taiwan, and *C. gestroi* have been found in seven prefectures of southwestern area. In the seven prefectures, the number of reported infestation cases of the two species were not significantly different. These two wood-feeding species were also found in trees and logs in natural environment such as national parks, ecological reserves, and botanical gardens. In order to compare the ecological niche of the two termite species with limited influence of human activity, termite survey were conducted in the Kenting National Park. In 137 survey sites, *C. formosanus* and *C. gestroi* were found in 20 and 11 locations, respectively. Only at one location, the two species were collected together. The four environmental factors of the collection sites of *C. gestroi* and *C. formosanus* were significant different, including minimum temperature in winter (16.7 and 16.2 °C), annual

precipitation (2,474.8 and 2,782.3 mm), evapotranspiration (1,099.6 and 1,153.5 mm), and aridity index (1.93 and 2.18), respectively. The results showed their habitats in southern tip of Taiwan were quite similar, but *C. gestroi* was found at significantly warmer and drier areas than *C. formosanus*.

Overview of Studies Conducted in the Development of Recruit® HD

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Continuous innovation has been a strategic objective ensuring the success of the Sentricon® System. Dow AgroSciences has invested in R&D for Sentricon development since the early 1990's to optimize system performance, minimize component costs, reduce labor for servicing and to build increased customer satisfaction. Over the last 20 years advances in the Sentricon System have included improvements in bait station designs, termite monitoring devices, active ingredient and bait matrices. The Sentricon System with Always Active™ technology is the most recent advancement and utilizes the breakthrough bait matrix Recruit® HD that is installed in all stations from day one, thereby eliminating the need to first monitor with wood and follow up with bait when termites locate the stations. Recruit HD has been proven to be long lasting, remain palatable to termites over time and efficacy data support an annual servicing label.

A thorough and detailed plan of studies was conducted by Dow AgroSciences in the development of Recruit HD. Studies included; lab characterization of consumption and efficacy to key termite species, lab durability when exposed to brown and white rot fungi, long term field durability and termite acceptance of field aged baits, field hit rate and palatability, Termiticide Scientific Review Panel (TSRP) approved protocol for national performance evaluation including 136 test structures across the U.S., improved bait extractor testing and evaluation of acceptance of previous fed on baits by new invading colonies.

Overall conclusions presented were:

1. Recruit HD Termite Bait is readily consumed by all key U.S. termite species.
2. Recruit HD is highly toxic to all key U.S. termite species.
3. Recruit HD is durable and remains palatable and effective after field aging and fungal exposure.
    a. Recruit HD aged 6 years in the field remains highly palatable and has efficacy equal to non-aged fresh bait.
4. Recruit HD is extremely effective at colony elimination.
    a. Excellent TSRP Protocol results across U.S.

5. Recruit HD matrix was readily accepted and effective in eliminating subterranean termite colonies when placed in AG stations.
6. New invading colonies will readily feed on previously consumed Recruit HD baits.

Genetic diversity of Caribbean *Heterotermes* (Isoptera: Rhinotermitidae) revealed by phylogenetic analyses of mitochondrial and nuclear genetic markers

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Heterotermes is a genus of subterranean termites that is found in all major tropical and subtropical locations around the world (Constantino 2000). In the Americas, *Heterotermes* is found in arid regions of South America, Central America, the Caribbean, Mexico, and the southwestern United States. *Heterotermes* species are structural pests, as well as agricultural pests on a variety of tropical crops (Sands 1973). As a structural pest, *Heterotermes* can cause severe wood damage that is characterized by a dry, shredded appearance (Scheffrahn and Su 2000).

Given the pest status of *Heterotermes*, there is a need to understand the diversity of the genus. One method of examining diversity involves phylogenetic studies using DNA sequence data. Previous phylogenetic studies of Caribbean *Heterotermes* have analyzed DNA sequence data from only the 16S rRNA mitochondrial gene (Szalanski et al. 2004). In our study, Dr. Susan Jones collected *Heterotermes* samples from various locations across the Caribbean at various time periods, and a subset was analyzed. We used sequence data from the mitochondrial and nuclear genomes to examine the diversity of *Heterotermes* in the Caribbean. The mitochondrial genetic markers included sequence data of the 16S rRNA gene and the cytochrome oxidase II gene. The nuclear genetic marker consisted of sequence data of the ITS array, which includes the internal transcribed spacer I, the 5.8S rRNA gene, and the internal transcribed spacer II.

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Submitted Papers
TRADE GLOBALIZATION

The Legacy of Trade Globalization from the Perspective of Urban Arthropod Pests: "I've always wanted to have a neighbor just like you”

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The Columbian Exchange was the widespread exchange of animals, plants, culture, people, communicable diseases, and technology between the American and Afro-Eurasian hemispheres following the voyage to the Americas by Christopher Columbus in 1492 (Crosby 1972). This global exchange included urban arthropod pests, an exchange which continues today.

The establishment of arthropod pests has been enhanced by urbanization. Urbanization intensely modifies the habitat to meet the narrow needs of one species – humans (McKinney 2006). Arthropod species adapted to this human-modified habitat thrive and have been described by various terms, including urbanophilic, synanthropic, commensal, and/or peridomestic.

Urban habitats provide reliable food and shelter. Urban habitats support generalist feeders, such as cockroaches, “tramp” ant species (Silverman 2005), and honey bees, which are efficient at harvesting diverse resources. Urban environments can also favor specialized feeders with an abundant food source, such as termites which feed on dead wood used in building construction and furnishings, and common bed bugs which feed on people and their pets.

Urban habitats can also diminish predators and competing species. Social insects have been very successful at establishing in urban habitats. These insects demonstrate reproductive strategies which can result in extremely large and/or dense colonies with enhanced foraging efficiency compared to other insects. One strategy is to form multiple queen (polygyne) colonies. In red imported fire ants (*Solenopsis invicta),* polygyne colonies have 2-fold the density of worker ants compared to single queen colonies (Macom and Porter 1996). Ant species with polygyne colonies can become locally abundant and dominate native ant communities (Silverman 2005).

Numerous arthropod species have been adapting for a long time to live with humans. The common bed bug (*Cimex lectularius*) is thought to have evolved from bat bugs when humans co-habited caves (Cooper and Harlan 2004). Numerous species nearly exclusively infest human structures, such as the German cockroach (*Blattella germanica*), Pharaoh ant (*Monomorium pharaonis*), and the West Indian drywood termite (*Cryptotermes brevis*). *C. brevis* is only found in structural wood in the non-

Asian tropics, except Chile where it infests dead wood from vegetation in the coastal, high altitude deserts. The global distribution of this termite species likely began about 500 years ago by the Spanish after they colonized Chile (Scheffrahn et al.2009).

Non-native species have been intentionally distributed by humans. Honey bees (*Apis mellifera*), called "English flies" by native Americans, were intentionally introduced by early European colonists in 1638 in Plymouth, Massachusetts to pollinate garden plants and obtain honey and wax. Nonetheless, most urban arthropods pests are unintentionally distributed by humans. Many house-dwelling arthropods transported all over the world by "house to house" jump dispersal as humans move, resulting in disjunct distribution. An example is the Brown widow spider (*Lactrodectus geometricus*), which is thought to have evolved in Africa but first described from S. America in 1841. This species has been more recently introduced to Hawaii, Japan, Australia, and Southern California (Garb et al. 2004).

Urban arthropod pests have been transported by human commerce to continents and islands where the organisms would not have naturally immigrated. Ships were the first mode of transport, as described in the above example with *C. brevis*. Ships, including recreational boats, continue to be an important method for translocating arthropods. In Florida, 59 interceptions of six non-native termite species were found in recreational boats from 1986-2009 (Scheffrahn and Crowe 2011). Passenger baggage, particularly from airline travel, has become an important method for distributing arthropod pests. Data from 1984-2000 show that passenger baggage represented 62% of all pest interceptions in the United States, with the remainder from cargo (30%) and plant propagative material (7%) (McCullough et al. 2006). During this same time period in the United States, of all pests intercepted in baggage, 85% were from airlines, 14% from border crossings, and 1% from maritime (Liebhold et al. 2006).

There are numerous challenges in minimizing importation and distribution of urban pest arthropods. Current quarantine inspection methods and regulations focus on finding agricultural pests, not structure-infesting pests, and only a fraction of incoming baggage and cargo is inspected (McCullough et al. 2006, Scheffrahn and Crowe 2011). Stow-away urban pests can be very small and hardy, such as the common bed bug. Bed bug eggs are the size of a pinhead. Bed bugs easily hide in typical items carried while traveling; luggage, backpacks, wallets, purses, and hand-held electronics such as cell phones and tablet devices. Bed bugs are tolerant to a wide range of temperatures and can survive for months without a blood meal (Cooper and Harlan 2004). DNA evidence indicates that bed bugs have been reintroduced repeatedly into the United States from countries including Canada and Australia, suggesting international travel has been the source for resurgence of bed bugs globally (Saenz et al 2012, Szalanski et al. 2008). DNA evidence indicates multiple reintroductions of other urban arthropod species, including the red imported fire ant and German cockroach.

Another challenge in minimizing the distribution of non-native urban arthropod pests is the lack of funding to detect and eliminate newly found infestations. In 2002, the first documented breeding infestation Chilean recluse spider, *Loxosceles laeta,* was found in one single-family residence in Winter Haven, Florida (Edwards and Skelley 2002). The Chilean recluse is larger than brown recluse spider and its venom is reported to be more toxic. Recluse venom can cause necrosis, hemolysis, renal failure or kidney damage (Edwards 2001). In spite of the spider's health threat, Florida Department of Agriculture and Consumer Services (FDACS) had no funding to eradicate the infestation. Dow AgroSciences donated Vikane® gas fumigant (sulfuryl fluoride) to eradicate the spiders from the residence (Thoms 2004).

In May 2001, an established population of *Nasutitermes corniger* was discovered in Dania Beach, Florida (Scheffrahn et al. 2002). This represented the first documented establishment of a non-native termitid termite. The termite was likely introduced by recreational boats, since focal point for the infestation was a marina. Again, FDACS had no funding to eradicate the infestation which covered 50 acres of commercial, residential and wooded properties. A Tree Termite Task Force was organized in 2002 and coordinated area-wide treatment program which began in April 2003 (Anonymous 2003). The insecticides and labor for treatments were donated by the industry. Two infested boats and two infested buildings were fumigated with Vikane (Thoms 2004). Ca. 830 gallons of termiticide (fipronil and imidacloprid) were applied to identified nests and foraging tubes in the 50 acres. In subsequent years, with ongoing surveys and termiticide treatments, *N. corniger* was thought to be eradicated; however, a new infestation area was discovered in 2012. According to an FDACS chief economist, the cost for treatments to control *N. corniger* could exceed $32 million over the next 10 years (NPMA 2014). After the rediscovery of *N. corniger* in 2012, FDACS finally obtained $200,000 in state funding for personnel and vehicles to conduct an area-wide treatment program to control this termite. This program includes public education about the termite, property inspections, and treatment infestations in yards (not in structures) free of charge to residents (M. Page, personal communication).

Urban arthropod pests are well adapted to live with humans. Their widespread dispersal is human-mediated and will continue. Dedicated funding is required for research, detection and elimination of incipient infestations of these pests.

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What's happening with the Florida Department of Agriculture and Consumer Services' invasive conehead termite (*Nasutitermes corniger*) eradication effort?

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Nasutitermes corniger (Motchulsky) (Isoptera; Termitidae), an exotic termite native to the Neotropics, was first discovered infesting trees and structures in a marina in Dania Beach, Florida in May, 2001. In 2003 the Florida Department of Agriculture and Consumer Services ("Department") launched an effort to eradicate the arboreal termite, common name now the conehead termite, with cooperation from Broward County, the City of Dania Beach, the University of Florida, and pest management professionals. Hundreds of gallons of pesticides were used to treat nest, structures, and infested landscape. This invasive population of conehead termites was thought to have been eradicated until it was found infesting a large commercial structure in Dania Beach in July 2011. Surveys of natural areas and neighborhoods near that building and infested adjacent wetlands revealed three additional areas of conehead termite activity within a ½ mile radius. The Department reignited aggressive containment and control efforts, however since the termite had moved into residential neighborhoods and structures, the eradication program was modified to employ Integrated Pest Management interventions. This paper summarizes strategies used to treat this destructive pest, including comparison of different products and novel approaches used to locate and eliminate nests and activity in property landscapes.

2003 Eradication Effort

The Department led a large collaborative effort in April 2003 that included Pest Management Professionals (PMP), product Registrants, Extension Specialists, and City and County officials. Registrants and PMPs donated pesticides and personnel, City and County cooperation assisted with obtaining proper permitting and Extension Specialists provided information on conehead termite biology and behavior. Surveys of the marina and areas immediately surrounding the marina were conducted to identify and locate nests, tunneling and foraging activity. The primary site contained a large natural area within a commercial marina containing native and invasive trees and vegetation that was substantially infested.

All nests and active areas were recorded using GPS and the infested area was divided into 10 treatment zones. Premise® 2 Insecticide (Bayer) and Termidor® SC (BASF) were used at the highest label rate (0.1% and 0.125%, respectively) and treatment follow up inspections were performed to assess treatment efficacy of both products. A Florida Experimental Use Permit was issued for each product, with use directions for application to the termite nests and forage areas. Large areas of the marina were surface sprayed with finished product containing a chemical dye to mark treated areas. Table 1. lists the total number of pounds of active ingredient and the total gallons of finished product used to treat the marina and surrounding areas.

Table 1. Insecticides Used in the 2003 Eradication Effort.

Product	Total Concentrate	Total AI (lbs)	Total Finished Dilution (Gals)
Premise® 2 Insecticide	6,080 mL (205 fl oz)	3.211	380
Termidor® SC	20,760 mL (702 fl. oz.)	4.388	450

Surveys, monitoring for conehead termite activity, were conducted between 2003 and 2011 by Extension Specialists from the University of Florida’s Institute of Food and Agriculture Sciences (IFAS). The Department awarded small annual grants to IFAS personnel through 2007. Annual reports indicated a decline in number of nests found up to that time period and surveys in some of the surrounding areas were discontinued after 2007. Between 2007 and 2010 no conehead nests or signs of activity were found.

2012 Eradication Effort

In July 2011, the International Game Fish Association (IGFA) discovered dark tunnels climbing up to the second floor of the IGFA museum. IGFA personnel immediately contacted their PMP who quickly confirmed the infestation as conehead termites. A survey of the IGFA property indicated extensive conehead activity in the property's manmade wetlands area located just north of the infested structure. Additional surveys of the surrounding natural, residential, and commercial areas were performed by IFAS and Department personnel. Three additional areas located west of I-95 had infestations. These areas included single family homes in established neighborhoods with a large number of rental properties and some infested structures that were vacant, abandoned, or foreclosed. Table 2 documents the extent of the properties found with conehead termite activity and the area of the infestation.

Table 2. Extent of Affected Areas.

Location	Number of Properties Affected	Total Acres
Area 1*	IGFA Museum wetlands	3.5
Area 2* Woodlot	22	10.5
Area 3	17	4.0
Area 4	11	3.5
Totals	**51**	**21.5**

*Contained Reservoir Area.

The eradication strategy was amended by the Department's Commissioner to accommodate concerns for human and environmental exposure to pesticides. Two products were utilized: Termidor® SC, because of its superior performance during the 2003 campaign and Termidor® DRY Termiticide, a crystalline product that allowed direct treatment of the active ingredient into tunnels. Consent was required to access properties and treatments were restricted to include only nests and active foraging tunnels. Nest treatment required penetrating into its center and treating with an appropriate amount of finished product (based on the size of the nest). No surface spraying of nests or tunnels was performed. Tunnels were nicked at 5 ft. intervals and Termidor® Dry was "puffed" directly into the tunnel. Only active nests and tunnels in the IGFA wetlands and neighborhood landscapes were treated when located. If an infestation was found in or on a structure, a local PMP was contacted to treat. The total amount of Termidor® SC used in May and June 2012 was 33.15 gallons (finished product) and 49.5 grams of Termidor® DRY Termiticide, representing greater than a twenty five-fold factor reduction of product use.

2013 Eradication Effort

Further revisions of the Department's treatment protocol were made. Lessons learned from the previous year indicated more severe actions would be needed if eradication of the exotic termite was going to be achievable. An IPM strategy based on nest removal and destruction proved helpful in keeping within the constraints placed on the eradication team to minimize the potential of exposure to humans and the environment. Removing and destroying nests accomplished several things: maintain a limited use of pesticides, severely diminish a colony's reproductive capacity by eliminating the nest's queen(s), king(s), eggs, juvenile termites, and many alates (swarmers) depending on season. Nest destruction also suppresses dispersal flights. This strategy of removing the nest as growth center 'heart' of a colony, then treating the 'footprint' under the removed nest (including openings into wood that had been enclosed by the nest) as well as perimeter of tree that it was associated with (although some nests are isolated from trees) has suppressed nest production. The areas identified as "reservoirs" (Area 1 and 2) continue to harbor conehead activity that has been difficult to find due to extensive overgrowth and large quantities of dead cellulose.

In addition to removing and destroying nests, we endeavored to enhance our ability to survey for conehead termite activity by adding a scent dog to the inspection team. In addition, landscaping interventions such as clearing vegetative debris and mowing dense underbrush obstructing our surveys have proven helpful.

Conclusions

Use of large volumes of pesticides in the 2003 campaign (25X that used in 2012) was insufficient to eradicate the invasive conehead termite infestation spreading from a marina in Dania Beach, Florida. Although surveys were performed for several years following the initial applications, discontinuing routine surveys allowed the coneheads to gain a foothold in new areas of Dania Beach.

The discovery of conehead termites in the IGFA wetlands was the result of discontinuing surveys of this site after 2007 when it was believed the area did not harbor any activity. This was a contributing factor in resurgence of the coneheads because colonies grew undisturbed and likely launched dispersal flights over several years.

The current IPM-based strategy employing the tactic of removing nests and spot treating small areas has helped the Department suppress and gain limited control in some of the infested areas of Dania Beach. Continued monitoring is an essential part of this eradication effort. Even more aggressive measures will be necessary to contain and, hopefully eradicate, this challenging pest.

Unwelcome House Guests - Introduced Heteroptera as Urban Pests in North America

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The Heteroptera as a group are not typically thought of as major urban pests. The one exception that has attracted a lot of attention recently is the common bed bug *Cimex lectularius* L. The Handbook of Pest Control (Mallis et al. 2011) classifies urban heteropteran pests into two categories, ectoparasites (bed bugs and kissing bugs, families Cimicidae and Reduviidae, respectively), and occasional invaders and overwintering pests (numerous families). The latter group contains bugs that are attracted to water or lights and bite (Belostomatidae, Nepidae, Corixidae, Notonectidae, Miridae and several other families), turf pests (chinch bugs, Lygaeidae), and bugs that invade homes, primarily for overwintering, (aboxelder bugs and other Rhopalidae; stink bugs, family Pentatomidae; and leaf-footed bugs, family Coreidae). Almost all of these are native species, the exception being the common bed bug, tropical bed bug (*C. hemipterus* Fabricius) and the home invading brown marmorated stink bug *Halyomorpha halys* (Stål). In addition, there is a recent invader in the southeastern US, the bean plataspid or kudzu bug *Megacopta cribraria* (Fabricius) that was not included in Mallis et al. (2011) and is an overwintering home invader. Thus, we have only four introduced heteropteran urban pests in North America.

The common bed bug is cosmopolitan in distribution and found throughout North America while the tropical bed bug is rare, being found only in isolated parts of Florida (Harlan et al. 2008). Potter (2011) provides an interesting history of bed bugs. They were probably associated with bats in the Mediterranean region and moved to humans that shared caves with the bats. By the 13th century, bed bugs had spread throughout continental Europe and probably accompanied some of the first Europeans to the New World. Early control methods included destruction of bedding or treatment with a number of toxic materials such as arsenic or mercury compounds mixed with alcohol or turpentine. DDT provided control in the 1950's and any resistant populations were controlled with organophosphate insecticides. As a result, bedbugs were all but eliminated as pests in North America. In the late 1990's bed bugs began to reappear as pests and have become a major problem due to loss of effective insecticides, ineffective application methods, and the rapid spread through air travel. There are currently more than 300 registered products for control of bed bugs (United States Environmental Protection Agency 2014), but they continue to spread and attract a great deal of attention.

The brown marmorated stink bug was first found in Allentown, PA in 1998 (Hoebeke and Carter 2003). The native range of this species is primarily in Asia where it is a pest of tree fruits and soybeans and an occasional home invader (Hamilton 2009). In North America, this species is a major pest of agricultural crops. It has spread extensively in the northeastern US and has been found on the west coast of the US and in Europe (Zhu et al. 2012). It can be recognized by a combination of large size (15 mm), smooth anterolateral pronotal margins, white banded antennae, and a triangular pale area on the lateral margins of the abdomen. Although it may be controlled by a number of insecticides, the best option for controlling this bug in dwellings is probably exclusion. This bug is attracted to light in large numbers and it may enter homes after being attracted to lights.

Large numbers of the bean plataspid or kudzu bug were found invading homes in northeastern Georgia in 2009 (Eger et al. 2010, Suiter et al. 2010). It belongs to the family Plataspidae (Pentatomoidea), an exclusively Old World family until the introduction of this species in North America. It was introduced from Asia, probably from Japan (Jenkins and Eaton 2011), where it feeds on kudzu (*Pueraria montana* var. *lobata* (Willd.) Ohwi) and soybeans, but is rarely a problem as a home invader. This bug is unusual in that while it is a pest of soybeans and a home invading urban pest, it also has potential as a beneficial biological control agent of kudzu, reducing biomass of this invasive weed by about 30% (Zhang et al. 2012). It is easily recognized by the relatively small size (3.5 - 6.0 mm), two segmented tarsi, scutellum enlarged and wider than long, truncate posteriorly and with an elongate transverse area on the base of the scutellum that is outlined by an impressed line. Since its introduction, the kudzu bug has spread to at least 9 southeastern states and has been found in shipments of various commodities to Central America (Gardner et al. 2013). As with the brown marmorated stink bug, there are insecticides with activity against this pest, but control in urban areas is probably best accomplished by the use of exclusion techniques.

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Good Invaders Come in Small Packages: Introduced Ants of the Southeastern U.S.

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The mild climate, warm temperatures, abundant rainfall, and numerous ports of entry, both commercial and private, dominating the Southeastern United States (U.S.) provides conditions conducive for the establishment of exotic species, including ants. A review of the website Ants of the Southeastern U.S. (MacGown, J. Ants (Formicidae) of the Southeastern United States. http://mississippientomologicalmuseum.org.msstate.edu/Researchtaxapages/Formicidaehome.html#.U8O317HLLdU) lists 74 species of exotic ants in the Southeastern U.S. (**Table 1**), and includes many hyper-invasive/tramp species typically encountered by pest management professionals in the urban and suburban environment in the Southeast (**Table 2**). Predictably, states bordering the Gulf of Mexico exhibit greater exotic ant species diversity than non-coastal states; moreover, Florida's exotic ant diversity is at least twice that of other Southeastern states.

Tawny Crazy Ant, *Nylanderia fulva*, in Georgia. The first find of the tawny crazy ant (TCA) in Georgia was in August 2013, in Albany, GA (southwest GA) (**Figure 1**). Until this find, the TCA was known from just a few counties in Mississippi, Louisiana, and Alabama, but was widely-distributed in Texas and Florida (MacGown website). The TCA is an invasive ant species from South America with widespread distribution in Texas and Florida. The TCA's visual appearance, to the untrained eye, is similar to that of another South American invasive ant species common in Georgia, the Argentine ant, *Linepithema humile*. While the TCA was detected in Georgia in 2013, the Argentine ant has been established in the Southeast for more than 100 years. Neither are native to Georgia.

In early summer 2014, the second Georgia TCA site was brought to our attention by a pest control operator in Waverly, GA (southeast Georgia; shown on Joe MacGown's distribution map of *N. fulva*). In early August 2014 we will investigate additional reports of TCA in southeast Georgia. We have suggested that pest management professionals and county extension agents along Georgia's coast, in southeast Georgia, and in the southern half of Georgia be on alert for the existence of this major nuisance ant pest.

Figure 1. The first ever discovery of the Tawny Crazy ant, *Nylanderia fulva*, in Georgia was in Southwest Georgia (Albany, GA) in August 2013 by a county extension agent. The ant was prevalent among trash piles on the property of a home for the elderly, and as of June 2014 appeared well-established.

Invasive species, including ants, can be highly disruptive to native habitats. Invasive ants are known to drive native ant species to extinction or near extinction, and can disrupt the "balance" of native ecosystems, resulting in a cascade of detrimental impacts on a system's ecology.

Excluding private marinas, there are approximately 71 commercial, oceanic ports of entry in the U.S. (Association of Port Authorities; aapa-ports.org): 11 in the Northeast (Virginia northward); 37 in the Southeast (North Carolina to the southern tip of Texas); and 23 on the west coast. In the Southeast, Texas (10 ports), Louisiana (9 ports), and Florida (8 ports) account for 27 of 37 (73%) commercial ports of entry. In 2012, the Port of Savannah (POS), GA was the fourth busiest commercial port in the U.S. (Los Angeles/Longbeach, CA #1/#2 and New York/New Jersey #3). In that year, the 1,200 acre POS processed 2,313 cargo ships carrying 1.65 million containers; daily, 8,000 transport trucks departed from and arrived at the port (Association of Port Authorities; aapa-ports.org). Currently, the POS, as well as other oceanic ports along the U.S. east coast, are in the process of deepening their waterway to accommodate so-called "supersized" cargo ships (**Figure 2**). Supersized cargo ships carry 3- to 5-times more cargo (and in some cases more) than a typical cargo ship. To accommodate such large ships the POS must be deepened, at an estimated cost of $650 million. The increase in cargo brings with it the potential for an increased occurrence in invasive species, including ants.

Figure 2. In 2012 the Port of Savannah, GA was the fourth busiest commercial port in the U.S. The port will be deepened to accommodate supersized container ships carrying 3- to 5-fold more cargo per ship than current ships.

Table 1. Exotic ant species diversity in the Southeastern U.S.

Southeastern State	Number of Exotic[1,2] Ants Species	Origin[1]
Alabama	26	Central and South America, Europe, Africa, Australia, Asia
Arkansas	9	Central and South America and Old World Tropics
Florida	65	Central and South America, Europe, Africa, Australia, Asia
Georgia	21	Central and South America, Europe, Africa, Australia, Asia
Louisiana	28	Central and South America, Europe, Africa, Australia, Asia
Mississippi	30	Central and South America, Europe, Africa, Australia, Asia
Missouri	11	Central and South America, Europe, Africa, Asia
North Carolina	13	Central and South America, Europe, Africa, Asia
South Carolina	20	Central and South America, Europe, Africa, Asia
Tennessee	8	Central and South America, Europe, Africa

[1]MacGown, J. Ants (Formicidae) of the Southeastern United States. http://mississippientomologicalmuseum.org.msstate.edu/Researchtaxapages/Formicidaehome.html#.U8O317HLLdU.
[2] *Exotic* is defined as a species that is not native; an exotic species is one that has been introduced from another geographic region to an area outside its natural range (K. Vail).

Introduced Stinging Hymenoptera –deliberate and accidental. *Aphis* to *Zeta.*

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Introduction

If we examine the introduced species of Hymenoptera into North America, we find that most cannot sting humans. They include 28 parasitoids of exotic pests, 48 species of sawflies, horntails, and gall wasps, and 21 stingless tramp ants. They are too small or not equipped to sting people. These and stinging ants will not be covered here. Most of the bees and wasps that have been introduced are solitary species that are not defensive and rarely sting people. These exotic bee and wasp species make up a small proportion of of the North American pollinator community. As an example, of the 316 bee species found in Florida, only 5 species are exotic. Some of the social exotic species do have a significant impact on people and native environments. It has been said that the western honey bee, *Apis mellifera* (Apidae), is one of the most successful invasive species in the world. It has certainly garnered a lot of press, especially the African-derived hybrids of *A. m. scutellata*. This is a summary of the known introduced species of bees and wasps that have been found in North America.

Table 1. The identified introduced bee and wasp species to North America, generally north of Mexico.

Family	Subfamily Tribe	Genus species	Common name	Original Distribution	North American Distribution
Andrenidae	Andreninae	*Andrena wilkella*	a mining bee	Europe; Likely accidental introduction	Northeastern US and Eastern Canada
Apidae	Apinae; Centrini	*Centris nitida*	a neoptropical oil collecting bee	Neotropics, very recently	Southern Florida
Apidae	Xylocopinae	*Ceratina dallatorreana*	a small carpenter bee	From Europe and the Middle East	Introduced into California
Apidae	Apinae; Euglossini	*Euglossa dilemma* formally *Euglossa viridissima*	Neotropical Green Orchid Bee	Mexico and most of Central America	First record in Southern Florida in 2003
Apidae	Apinae; Anthophorini	*Anthophora plumipes*	Hairy-Footed Flower Bee	Palaearctic	Introduced into Beltsville MD by USDA in 1980s or 1990s
Apidae	Apinae; Apini	*Apis mellifera*	Western honey bee	Europe, Africa, SW Asia	Introduced into Jamestown in 1622
Chrysididae	Chrysidinae; Chrysidini	*Chrysis angolensis*	cuckoo wasp	Palaearctic, introduced 1940s	Parasitizes *Sceliphron caementarium* nests , widespread
Chrysididae	Chrysidinae; Chrysidini	*Chrysis ignita*	cuckoo wasp	Europe, very recently	
Chrysididae	Chrysidinae; Elampini	*Pseudomalus auratus.*	cuckoo wasp	Palaearctic,	Probably introduced to the eastern U.S. before 1828
Colletidae		*Hylaeus hyalinatus*	Hyaline Masked Bee	Europe, North Africa	
Colletidae		*Hylaeus leptocephalus.*	Slender-faced Masked Bee	Palaearctic before 1912	Reported from Michigan, NY, NJ, IN, District of Columbia, Virginia, North Carolina, Georgia, Quebec and Ontario.
Colletidae		*Hylaeus punctatus.*	Punctate Masked Bee	Europe. Very recently.	North and South America

Family	Subfamily Tribe	Genus species	Common name	Original Distribution	North American Distribution
Halictidae	Halictinae; Halictini	*Halictus tectus*	sweat bee	Southern Europe to Mongolia, recently	eastern US (MD, PA, DC)
Halictidae	Halictinae; Halictini	*Lasioglossum (Leuchalictus) leucozonium*		Palaearctic	New Brunswick to North Dakota
Halictidae	Halictinae; Halictini	*Lasioglossum (Leuchalictus) zonulum*		Palaearctic	Nova Scotia to Minnesota
Megachilidae	Megachilinae; Anthidiini	*Anthidium manicatum*	European Wool Carder Bee	Europe	USA-NC to CA and north; Canada -BC, Q, ON
Megachilidae	Megachilinae; Anthidiini	*Anthidium (Proanthidium) oblongatum*	A wool carder bee	Mediterranean and into Central Asia	Established NE USA to CO and Ontario (was first found in e. PA in 1995)
Megachilidae	Megachilinae; Osmiini	*Chelostoma campanularum*	Harebell Carpenter Bee	Palaearctic	New England and adjacent Canada
Megachilidae	Megachilinae; Osmiini	*Chelostoma rapunculi*		Palaearctic	New England and adjacent Canada
Megachilidae	Megachilinae; Megachilini	*Coelioxys coturnix*	A leafcutter bee	circum Mediterranean to Southern Asia	MD and PA before 2009
Megachilidae	Lithurginae	*Lithurgus chrysurus*	Mediterranean Wood Boring Bee	circum Mediterranean and Middle East	Currently found in NJ in 1978 and PA in 2007
Megachilidae	Megachilinae; Megachilini	*Megachile* (*Eutricharaea*) *apicalis*	A leafcutter bee	Europe, Central Asia, North Africa	United States (CA, WA, OR, UT, NJ, VA) and Canada (BC, ON)
Megachilidae	Megachilinae; Megachilini	*Megachile (Eutricharaea) concinna*	Pale leafcutting bee or Elegant leaf-cutter bee	North Africa and Mediterranean Europe	West Indies, US, Mexico
Megachilidae	Megachilinae; Megachilini	*Megachile lanata*	A leafcutter bee	Ethiopian/ Oriental regions	Florida, Caribbean
Megachilidae	Megachilinae; Megachilini	*Megachile rotundata*	Alfalfa Leafcutter Bee	Eurasia	Introduced to US after 1940's Distribution now cosmopolitan

Family	Subfamily Tribe	Genus species	Common name	Original Distribution	North American Distribution
Megachilidae	Megachilinae; Megachilini	*Megachile sculpturalis*	Giant Resin Bee	East Asia	Accidentally introduced; eastern US and Canada.
Megachilidae	Megachilinae; Osmiini	*Osmia cornifrons*	"Japanese" Hornfaced Bee	East Asia	Introduced to eastern North America from Japan by USDA in 1977 to pollinate apples.
Megachilidae	Megachilinae; Osmiini	*Osmia caerulescens*	European Mason Bee	Europe, Sweden to Bulgaria	United States CA, IL, MD, ME, MN, NC, OH, PA, Canada NS, ON
Megachilidae	Megachilinae; Osmiini	*Osmia cornuta*	Red Mason Bee	Spain	Introduced into United States (UT) by USDA for Orchard Pollination
Megachilidae	Megachilinae; Osmiini	*Osmia taurus*	Asian Mason Bee	China and Japan.	Accidental introduction by USDA during introduction of *Osmia cornifrons* (hypothetical) into MD, now middle Atlantic states to FL.
Megachilidae	Megachilinae; Anthidiini	*Pseudoanthidium nanum*	False carder bee	Europe, Mid East	Very recently introduced into MD, NY (and likely NJ, PA, VA)
Crabronidae	Crabroninae; Larrini	*Larra bicolor*	Mole Cricket Hunter	South America, introduced from Bolivia	1988-89 introduced into FL as a biological control agent for exotic mole crickets.
Crabronidae	Crabroninae; Trypoxylini	*Pison koreense*		SE Asia	Accidental
Sphecidae	Sceliphrinae; Sceliphrini	*Sceliphron curvatum* or *Sceliphron deforme*	A mud dauber	Asia	Introduced into Europe,then found in Quebec in 2013 and Colorado in 2014
Vespidae	Eumeninae	*Ancistrocerus gazella*	European tube wasp or European potter wasp	Europe	Introduced into Northeastern USA and Ontario, Canada recently before 1961.

Family	**Subfamily Tribe**	**Genus species**	**Common name**	**Original Distribution**	**North American Distribution**
Vespidae	Eumeninae	*Ancistrocerus parietum*	Wall Mason Wasp	Eurasia	Introduced before 1916, current range Eastern Canada to Saskatchewan and Northeastern USA
Vespidae	Eumeninae	*Delta rendalli*	A potter wasp	From Africa,	Introduced into Jamaica, 1979, then Florida,1981
Vespidae	Polistinae	*Polistes dominula*	European Paper Wasp	Eurasia, Introduced to US in the 1978 in MA	As of 2006, known to include northeastern US, Florida, Ontario, British Columbia, Washington to California and east to Colorado. Range continues to expand.
Vespidae	Vespinae	*Vespa crabro*.	European Hornet	From Eurasia, 1800s	Eastern US and Southern Canada
Vespidae	Vespinae	*Vespula (Paravespula) germanica*	German Yellowjacket,	Europe including UK into Central Asia	USA, Canada, Chile, Tasmania, Australia, New Zealand, and Madeira Islands
Vespidae	Eumeninae	*Zeta argillaceum*.	A potter wasp	Native to the Neotropics (Mexico to Argentina)	Established in FL

Table 2. Common and scientific name, distribution in the Southeastern U.S., and region of origin of 13 exotic ant species considered pests by the pest management industry.

Common Name	Scientific Name	Southeastern States Distribution	Origin
Dark Rover Ant	*Brachymyrmex patagonicus* Mayr	AL, AR, FL, GA, LA, MO, MS, NC, SC	Argentina, Neotropics
Argentine Ant	*Linepithema humile* (Mayr)	AL, AR, FL, GA, LA, MS, NC, SC, TN	Argentina
Pharaoh Ant	*Monomorium pharaonis* (Linnaeus)	AL, AR, FL, GA, LA, MO, MS, NC, SC, TN	Africa?
Tawny Crazy Ant	*Nylanderia fulva* (Mayr)	FL, GA, LA, MS	South America
Asian Needle Ant	*Pachycondyla chinensis* Emery	AL, FL, GA, MS, NC, SC, TN	China, Japan
Black Crazy Ant	*Paratrechina longicornis* (Latreille)	AL, FL, GA, LA, MS, NC, SC, TN	Old World Tropics-Africa?
Big-Headed Ant	*Pheidole megacephala* Fabricius	FL, MO	Old World Tropic-Africa?
Red Imported Fire Ant	*Solenopsis invicta* Buren	AL, AR, FL, GA, LA, MO, MS, NC, SC, TN	Brazil
Black Imported Fire Ant	*Solenopsis richteri* Forel	AL, MS, TN	Argentina
Ghost Ant	*Tapinoma melanocephalum* (Fabricius)	FL, GA, LA, MO, MS, NC, SC	Indo-Pacific
Difficult Ant (=white-footed ant)	*Technomyrmex difficilis* Forel	FL, GA, LA, MO, NC, SC	Old World Tropics
Pavement Ant	*Tetramorium caespitum* (Linnaeus)	AL, MO, MS, NC, SC, TN	Possibly Native-Europe
Little Fire Ant	*Wasmannia auropunctata* (Roger)	FL	South America

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Submitted Papers URBAN MOSQUITO CONTROL

Welcome to Texas and Introduction to Mosquito Control in Urban Areas

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Mosquitoes are a growing urban health threat throughout the United States, so it is appropriate that an NCUE symposium be devoted to issues relating to mosquito control in urban areas. Speaking as an extension entomologist and a public health veterinarian, this reality was recently driven home to us by the 2012 epidemic of West Nile virus (WNV) in Dallas, TX. Nearly 400 cases of West Nile virus and 18 deaths were reported in Dallas County alone in 2012. A Dallas-based WNV survivor's group based in Dallas has also been instructive about the severity of the disease and its long-term impacts on human lives—something that's often missed in newspaper and TV accounts.

Mosquitoes are a significant urban insect pest that we can no longer afford to ignore. In addition to the annual occurrence of WNV, urban areas in the U.S. face a real threat of new and old diseases carried by mosquitoes. Dengue fever shows up with increasing frequency in south Texas, and health officials here and in other states are preparing for the inevitable U.S. arrival of Chikungunya virus, a mosquito-borne disease that has recently jumped from Africa to the Caribbean. And the last decade has taught us that we are not immune to natural disasters. Hurricanes, like Rita and Katrina, remind us of the fragility of our infrastructure in the face of nature, and the importance of public health programs designed to protect us from mosquito borne disease. Despite the cyclical nature of mosquito borne disease, neither the public nor the research community can afford to be complacent about the potential health impacts of mosquitoes in our urban areas.

Mosquito control is no longer solely the domain of public health agencies. The public is beginning to demand mosquito control services from the pest control industry. In a recent survey by PCT magazine, 38% of pest control companies now offer mosquito control services (n=146), although 76% of these companies say that mosquito control still accounts for 10% or less of revenue (Readex Research 2014). Despite the modest scale of commercial mosquito control services at present, 55% of those surveyed felt that the percentage of their company's pest control service devoted to mosquito control will increase in the coming year.

Community-wide and area-wide mosquito control is generally conducted by local government jurisdictions in the State of Texas. Although most jurisdictions do not engage in mosquito surveillance and control, there are fourteen local mosquito control districts in Texas. Most of these districts are funded and currently active. Additionally, some cities and counties do mosquito surveillance and control outside of the mosquito control district structure. Mosquitoes may be collected and tested in-house by these jurisdictions, or independent contractors may be used for these services. Specimens collected by jurisdictions may also be submitted to The Texas Department of State Health Services (DSHS) Arbovirus Laboratory (AL). Testing is sensitive for all potentially circulating arboviruses, including West Nile virus. The AL provides mosquito identification year-round, but performs virus isolation only from May through December. Broad-based testing relies on cell culture followed by indirect fluorescent antibody testing. Polymerase Chain Reaction-based testing is performed on a limited basis. Electron microscopy and testing by the Centers for Disease Control and Prevention are sometimes utilized.

The DSHS, Zoonosis Control Branch (ZCB) receives all data streams for arbovirus surveillance, including mosquito testing data. Reporting of mosquito data is voluntary. Local jurisdictions may report data to a dedicated email address. In addition, the ZCB has zoonosis control staff in each of eight Health Service Regions across the state to support regional stakeholders. More information on ZCB is available at www.texaszoonosis.org.

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Putting A Human Face On Vector-borne Disease

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Recent challenges brought forth in opposition to mosquito control efforts during outbreaks of mosquito-borne disease have necessitated a change in approach to public education by vector control agencies to a more personalized view. In many instances science is not winning the day, allowing emotional appeals to an increasingly suspicious public and political forces to compromise science-based control efforts.

To more effectively counteract this, constituents of the American Mosquito Control Association are bringing into play survivor stories that place mosquito-borne diseases into a more personal context, showing the very real and devastating effects these diseases have on their victims and extended families.

To this end, Central Life Sciences and Bayer CropScience have each developed videos graphically demonstrating the suffering undergone by family members of victims over and above that suffered by the victims themselves. The Central Life Sciences video is 6:27 minutes in length and concentrates on the grief of a mother having lost her 5-year old child to EEE. Two surviving victims are featured, with one being a physician. This video provides a powerful message of the true toll exacted beyond mere case numbers. This video is free as a download at the "I'm One" section of the AMCA website at www.mosquito.org

The second video, by Bayer CropScience, also focuses on three disease cases, with one being a fatal case of EEE in a teenaged daughter, bringing to light the fact that these disease attack all age groups. This video is 3:58 minutes and is available for free download at http://www.backedbybayer.com/vector-control/resource-library.

Message points for the public were also discussed, those being:

- Vector-borne disease is here to stay
- Vector-borne disease is serious
- Vector-borne disease can be prevented by personal protective measures and accepted mosquito control practices

Submitted Papers
GREEN ROOFS

Green Roofs – Introduction and Overview

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The concept of placing plant material in the infrastructure of man-made construction, known as living architecture, has captured the imagination of ecologically minded architects, builders and property owners. The term Green Roof references the concept of using the upper portion of a building as a habitat for plants (Green Roofs, 2014). All Green roofs have 4 major components – a waterproof and plant-root barrier, a drainage/storage level, a filter-fiber layer, a deposit of growing medium and a cover of vegetation.

The justification for use of this technology includes improvement in urban water quality, energy conservation, aesthetics and quality of life (Villareal et al. 2004, Castleton et al. 2010, Mentens et al. 2006, Gettler and Bradley Rowe 2006, Fuller et al. 2007, Carter and Butler 2008, Fuller and Irvine 2010, Francis and Lorimer 2011). A number of studies have surveyed the avian and plant populations associated with green roofs and found an increase in biodiversity in structures incorporating living architecture (Miller et al. 2001, Baumann 2006, Baumann and Kasten 2010, MacIvor and Lundholm 2011, Cook-Patton and Bauerle 2012, Madre et al. 2013). Surveys of arthropod communities associated with green roofs have involved a number of taxa but inevitably from an ecological perspective and nothing has been published on entomological pests associated with green roofs (Schindler et al. 2011, Braaker et al. 2014).

Recently publications have critically analyzed many of the aforementioned features of the living architecture movement and question the unmitigated benefit(s) of the green roof concept (Simmons et al 2008, Henry and Frascaria-Lascoste 2012, Mullen et al. 2013). Niche theory intuitively predicts that any human-built habitat will be occupied by some life form and from a pest management perspective that generally involves a synanthropic species whose populations could build to the point of pest status. An informal survey of three green roofs on the University of Georgia campus prior to this meeting found fire ants on each roof although none of the building residents complained of infestation. Pest populations associated with living architecture could provoke an intervention aimed at reducing the infestation that might include remodeling and/or repairing components of a green roof to application of a pesticide.

This symposium will provide information on this growing segment of the urban architecture in the United States and raise topics certain to be points of conversation with PMP's, property owners and regulatory lead agencies in the coming decade. The pest management community should be aware of the potential for pest issues associated with this burgeoning urban landscape feature including, legality of pesticide application to green roofs, tenant/landlord responsibilities, PMP responsibilities and opportunities to serve as a resource on pest issues for property owners interested in living architecture.

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Beekeeping in New York City

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Abstract

On March 16, 2010, the New York City (NYC, City) Board of Health voted unanimously to legalize beekeeping in NYC. Prior to this vote, many beehives existed in NYC illegally. To date, there are 122 registered beehive owners with 319 hives in the City. Beekeepers are required to provide the name and contact information of the beekeeper and the location of the hive(s). Beekeepers must adhere to appropriate practices, such as providing constant and adequate water to the hives, and locating the hives so that the movement of bees does not become a nuisance. Beekeepers shall be able to respond immediately to control bee swarms. Besides responding to complaints, DOHMH regularly inspects beehives, issuing violations as appropriate. The legalizing of beekeeping in NYC has been a “win-win” situation for the City beekeepers and DOHMH. A once somewhat adversarial relationship is now a partnership. Beekeepers are able to have their beehives, and to gather honey and other bee products which many sell locally, which many residents of the City enjoy. The beekeepers have responded to many situations where bee swarms were occurring. DOHMH has been able to regulate a group that already does an excellent job of self-regulating.

Introduction

Albert Einstein once stated that "If the bee disappears from the surface of the earth, man would have no more than four years to live" (Evans-Pritchard 2011). Honey bees are critical to the pollination of most flowering plants and much of the food production in the world. They are important to at least 35% of the world’s crop production (Klein et al. 2007). In the U.S., Honey bees pollinate an estimated $15 billion of crops each year (Potts *et al.* 2010). Because of its nutritional and medicinal value, honey has been collected for consumption since the Stone Age. Historical record shows that the first human constructed honey beehives (a container provided for bees to nest in) were built prior to 900 BC (vanEngelsdorpa and Meixnerb 2010). Only four of the 20,000 species of bees in the world produce honey. In the USA, the European honey bee (*Apis mellifera mellifera)* is the source of commercial honey. This species is docile and unlikely to pose a problem unless someone is in close proximity to the entrance of a hive. Bees only sting when defending the hive or their own selves. Most “bee stings” that people get are actually from wasps, which are far more aggressive and can sting repeatedly, whereas honey bees sting only once and die. Beekeeping is the most flexible and land-efficient form of urban agriculture, as beehives require very little land and can be placed almost anywhere. New York City (NYC, City) has a huge amount of bee flora; many species of the > 5.8 million trees are major honey and pollen producing plants. Just in the streets of the City, there are >135,000 maple trees, >50,000 honey locust trees, and many thousands of basswood and Russian olive trees (Peter *et al.* 2007). In addition, there are innumerable honey and pollen producing plants (such as dandelions, raspberries, clover, sumac, milk weed, purple loose strife, goldenrod, aster, bamboo, and others) in natural areas, parks and private properties. Honey bees

usually have higher survival rates and honey yields in urban areas (Berquist *et al.* 2012) and do not pose a threat to species richness in the cities (Tomassi *et al.* 2004).
On March 16, 2010, the NYC Board of Health voted unanimously to legalize beekeeping in the City. NYC Health Code Article 161 regulates beekeeping and is intended to prevent public nuisance and health risks associated with the presence of beehives. This article requires beekeepers to register with the Department of Health and Mental Hygiene (DOHMH) and to adhere to appropriate practices. Beekeepers must be able to control bee swarms and ensure that the hives do not interfere with pedestrians or neighbors. They are required to file a notice with the Department, on a form provided by the Department, containing the beekeeper's name, address, telephone, e-mail and fax numbers, emergency contact information, and location of the hive, and they must notify the Department within ten business days of any changes to such information.

Bee Nuisance Mitigation

According to NYC Health Code §161.02, conditions that can lead to bee nuisance include "aggressive or objectionable bee behavior, hive placement or bee movement that interferes with pedestrian traffic of persons residing on or adjacent to hive placements; and overcrowded, deceased or abandoned hives" (rules.cityofnewyork.us). If not properly managed, beehives can become nuisance for people and domesticated animals.
A bee swarm in a public space would cause excitement and fear. This concern emphasizes the need for appropriate regulation to ensure public safety and improve responsible practices. Swarms often occur when bee colonies are overcrowded, but they can be easily prevented by properly managing hives. For example, bees need to visit water sources, and can annoy neighbors who have swimming pools. Placing a consistent water source near the beehives would commonly resolve this problem.

General Recommendations for Beekeeping in NYC

Here is a list of some general recommendations for safer beekeeping in NYC:

- **Hive Temperament:** Beekeepers must maintain beehive(s) that contain only docile and non-aggressive/non-defensive honey bees (*Apis mellifera mellifera*).
- **Best Management Practices:** Beekeepers are encouraged to follow the "Best Management Practices for Safe Urban Beekeeping" developed by local beekeepers associations.
- Moveable-Frame Hives: Bee colonies should be maintained in moveable-frame hives. These hives facilitate inspection and manipulation of colonies [moving frames of bees or honey-filled frames from a strong colony to fortify a weaker one. They also permit efficient harvesting of honey (honeycombs in their frames can be emptied and returned to the hive, which allows increased honey production because the bees do not have to construct fresh combs)].
- Hive Density: Beehives should be in such a density that the area can support foraging bees. A three-mile radius around the beehive(s) must be assessed to insure that the adequate foraging (flowering plants and trees) is available.
- **Hive Flyway:** All colonies must be maintained at least 10 feet away from all property lines. For any colonies, less than 40 feet from property lines, the beekeeper must establish and maintain a flyway barrier at least 6 feet in height. Barriers can be screens, shrubs, walls, hedges, and/or fences, and must be of sufficient density to make bees fly above head height.

- **Provision of Water:** A clean and adequate water source must be maintained within 50 feet of colonies, or less than one-half the distance to the nearest unnatural water source.
- **General Maintenance:** Work on hives should be done as quickly and with as little of disturbance to the beehive as possible. Work should be limited to when persons are not in close proximity and the weather is favorable. In late spring and summer, work on the hive should be done in the late afternoon.
- Preventing Swarms: Beekeepers must use established swarm management practices including, but not limited to, population control, replacing queens and destroying all drone brood in colonies exhibiting defensive behavior that may be injurious to the general public or domesticated animals. The bee owners should be able to respond immediately to remediate any nuisance conditions.

Medical Aspects of Honey Bees

The sting of a honey bee can be serious and can even be lethal to some, especially those who are hypersensitive to the insect stings (up to 4% people are hypersensitive). Stinging by bees, wasps, yellow jackets and fire ants cause 40-50 deaths/year in the United State (Magill et al. 2013). People who are hypersensitive must carry medication when visiting areas with bee/wasp activity. For most individuals, the bee sting is painful but without any major incident. Swelling at the site of bee sting is a normal reaction. Lethal dose in humans from bee sting is 10 stings/pound of body weight (www.ars.usda.gov/News/docs.htm?docid=11067). Allergic reactions to bee stings may include rash/hives, stomach cramps/vomiting, dizziness/headache and swelling in the areas other than the sting site, particularly in the throat, neck, or tongue (which may cause shortness of breath or difficulty in swallowing). It is important to seek emergency medical assistance immediately if experiencing any of these symptoms.

When a bee stings, the stinging apparatus (barbed stinger with poison-sack) stays embedded in the skin of the victim and continues to inject venom. The sooner the stinger is removed the less venom will enter the wound. The stinger should be scraped out of the skin with fingernails or the edge of a plastic (credit) card. Pulling with fingers or tweezers may squeeze more venom into the wound (www.ent.uga.edu/bees/get-started/stings.html).

Beehive Registration

In NYC, there were a total of 319 beehives belonging to 122 beekeepers in 2013, and 366 hives belonging to 154 owners in 2012. The decrease was due to a loss of 45 hives to Hurricane Sandy during 2012.

Beehive Placement

Rooftops and backyards are the preferred locations for beehive placements in NYC, as shown by Figure 2. We recommend that beehives should be restricted to rooftops or rear yards, and other locations where they can be safely, easily, and regularly accessed. Beehives placed at ground level should be in a quiet area, away from pedestrian traffic, human activity and presence of animals. For rooftop placement, beehives should be able to withstand high winds and placed in an area that can support the weight of the beehive(s) and beekeeper.

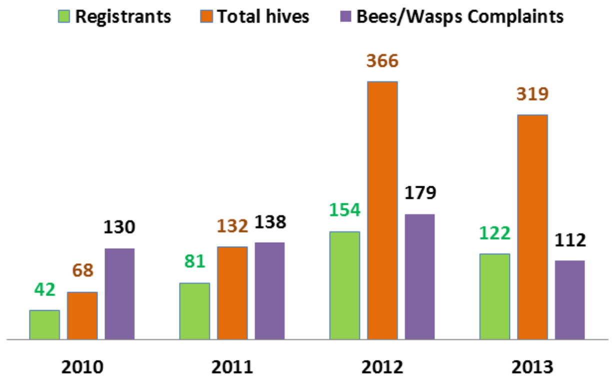

Figure 1. Beehive Registration (2010 – 2013)

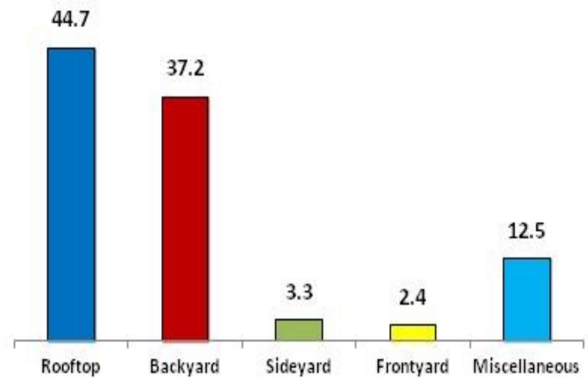

Figure 2. Beehive Placement (%) (2011-2013)

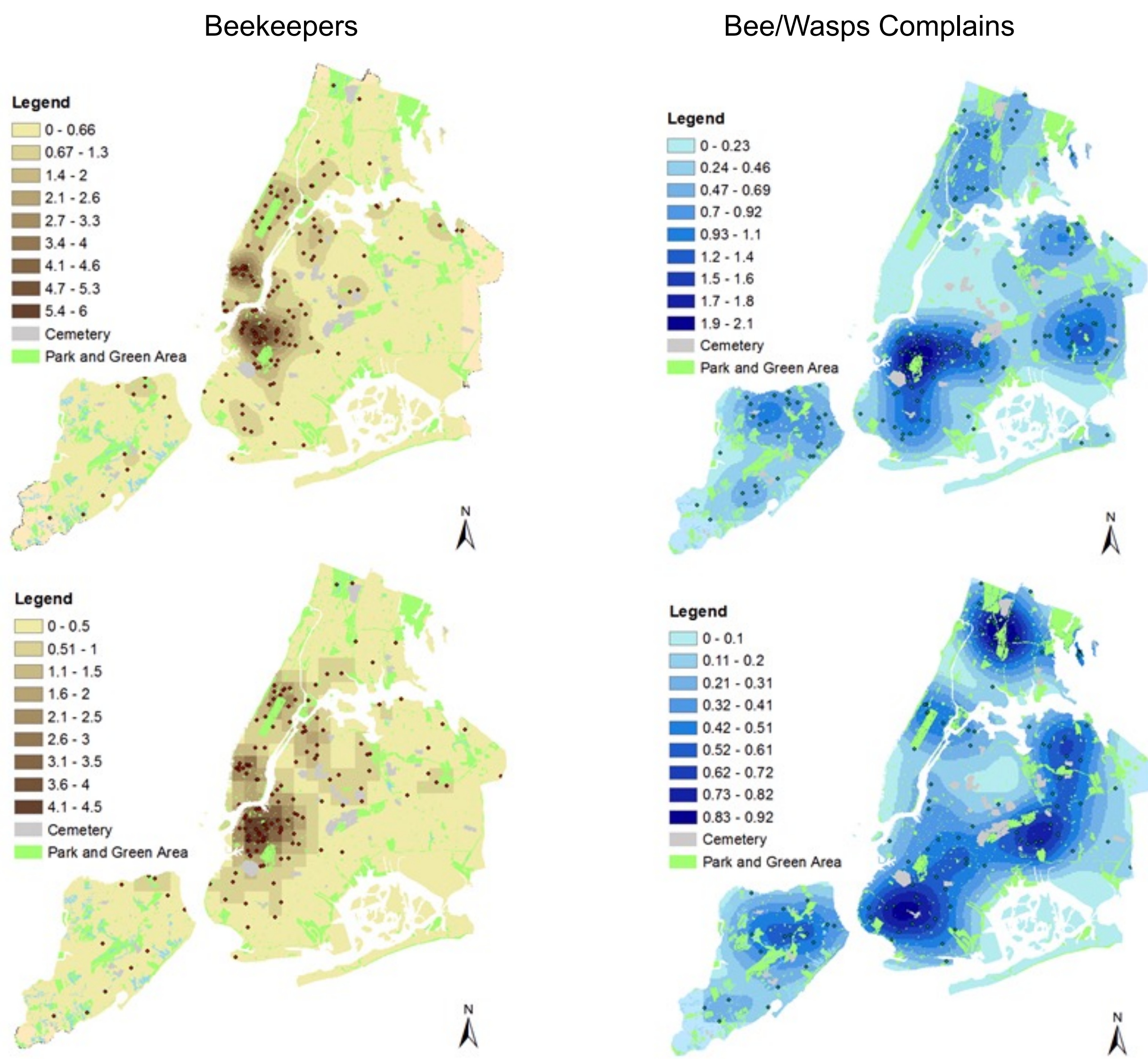

Figure 3. *Hotspot Analysis for Beehive Locations and Bee Complaints Received from the Public*

Bee Nuisance Complaints in relation to Physical Locations of Beehives

We performed a "Kernel Density Analysis" to highlight the "hotspots" that generate the most stinging insect complaints in relation to the physical locations of beehives in the City. There was no (significant) relationship between the hotspot areas for nuisance complaints and physical locations of hives in the City (Figure 3). Most complaints were made from the areas with no or few beehives. We conclude that legalizing beekeeping in NYC had no effect on bee nuisance reporting from the public.

Conclusion

Beekeeping fits perfectly in the urban agriculture. Besides honey production, it can benefit gardens and provide recreational and educational opportunities. However, urban beekeeping requires responsible management to avoid creating nuisance and/or safety problems for residents. We observed a cooperative and productive relationship between New York City beekeepers and the Health Department. As a result, beekeeping has been thriving in the City since its legalization in 2010.

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The Red Imported Fire Ant versus the Green Roof

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The use of green roof technology is gaining popularity among many real estate groups because of the marketable benefits which include energy conservation, storm water management, air pollution mitigation, scenic landscapes, wildlife habitat, and added recreational areas. In 2003 the United States Environmental Protection Agency cited reduced urban heat-island effects and lowered cooling costs as benefits for buildings utilizing this technology (USEPC 2003). Jacob White Construction Company, (2000 West Parkwood, Friendswood, TX) is a leader in the design and construction of green roofs atop of new "green" building projects in and around the Houston area.
During the early spring of 2011 active red imported fire ants, *Solenopsis invicta* Buren (Hymenoptera: Formicidae) were observed on the green roof located on the Jacob White Construction Company headquarters. This report outlines the strategy used for the management of this pest.

Materials and Methods

The green roof located atop the Jacob White Construction Headquarters was assessed 3 May 2011 and nine subsequent dates (Fig. 1) for the presence of the red imported fire ant. Foraging ant activity was checked using individual hot dog slice food lures (0.25 in thick hot dog slices, Bar-S Jumbo Franks) that were placed in a grid across the green

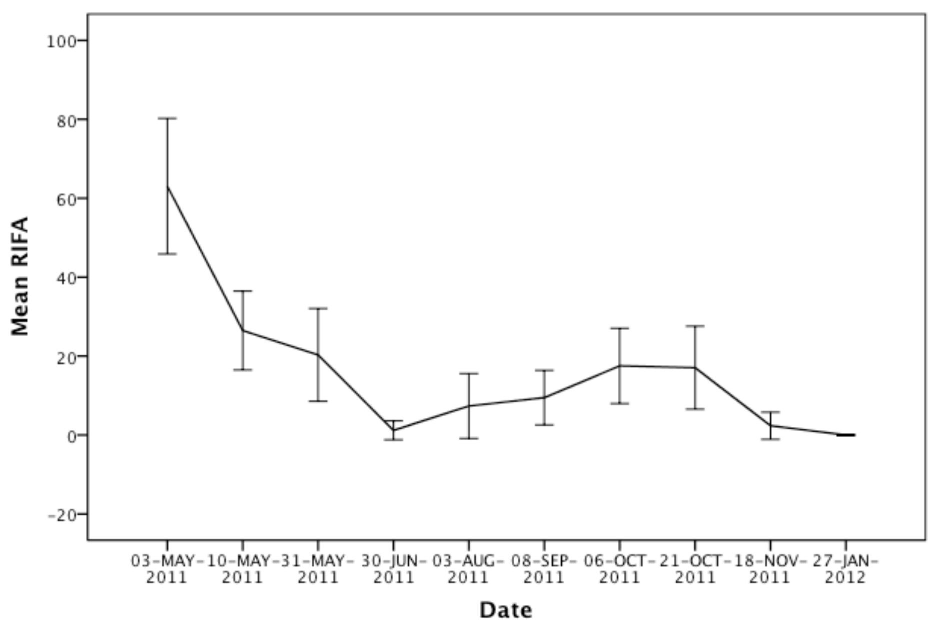


Figure 1. Mean number of red imported fire ants (RIFA) per food lure at various assessment dates atop green roof in Galveston County, 2011. No overlap among 95% CI indicates significant differences, and overlap indicates no significant differences.

Error bars: 95% CI

roof. Twenty three lures were used on 3 May 2011, while 34 lures were used on subsequent assessment dates. Food lures were checked after 60 minutes and total ants present on the lures were recorded.

DuPont™ Advion® ant bait arenas (30 arenas, 0.1% indoxacarb) were positioned in a grid pattern within the confines of the green roof. Bait stations were used so as not to directly apply a pesticide to the green roof growing media. Through a rainwater catchment system, all irrigation water applied to the roof is recycled and reapplied on site. The selection of bait arenas was to reduce the chance of pesticide movement from the target site. Additionally, irrigation water is applied several times per day as an energy saving passive cooling method. The frequent irrigation may have disrupted the integrity of an "unprotected" bait product. Since the roof was 11,000 sq. ft., the total active ingredient (0.059 g) contained within the 30 bait arena's was approximately equal to the active ingredient (0.052 g) in a 1.0 pound product per acre broadcast application of the DuPont™ Advion® fire ant bait (0.045% indoxacarb). Since assessments of fire ant activity on the green roof indicated the continued presence of a population of fire ants (Fig. 1), a fall broadcast application of the DuPont™ Advion® fire ant bait (2.0 pounds product per acre) was planned for the grounds around the Jacob White Headquarters. Total mound counts were taken on 22 September 2011 before fire ant bait applications and on 4 subsequent dates (Fig. 2). To determine if a mound was active, visible fire ant mounds were checked using the minimal disturbance method, i.e., mounds were probed with a shovel and if no fire ants appeared after 15 seconds, the mound was considered inactive. The fire ant bait product was evenly spread with Scotts® HandyGreen® II Hand-Held Spreader set on smallest opening. In addition to

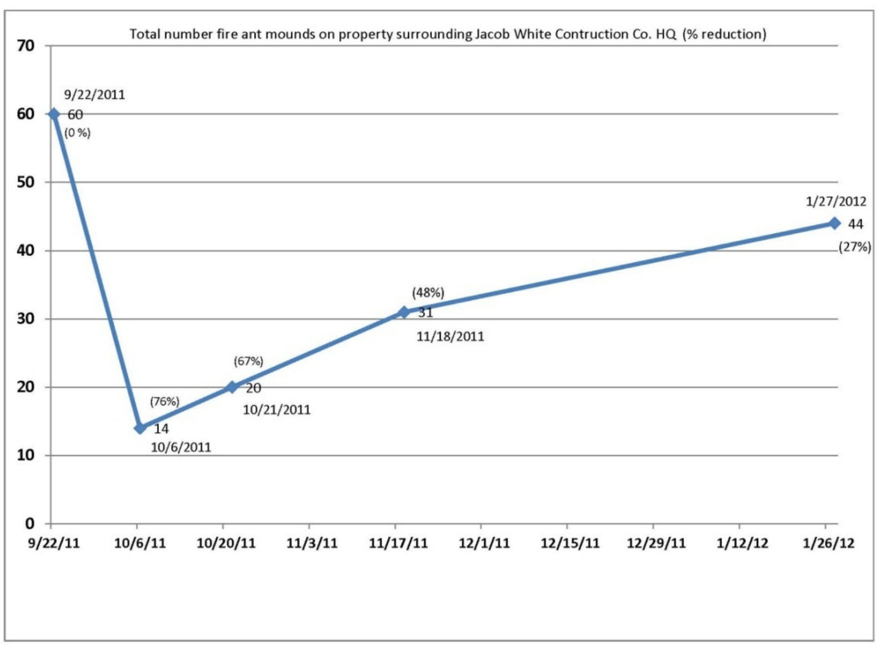


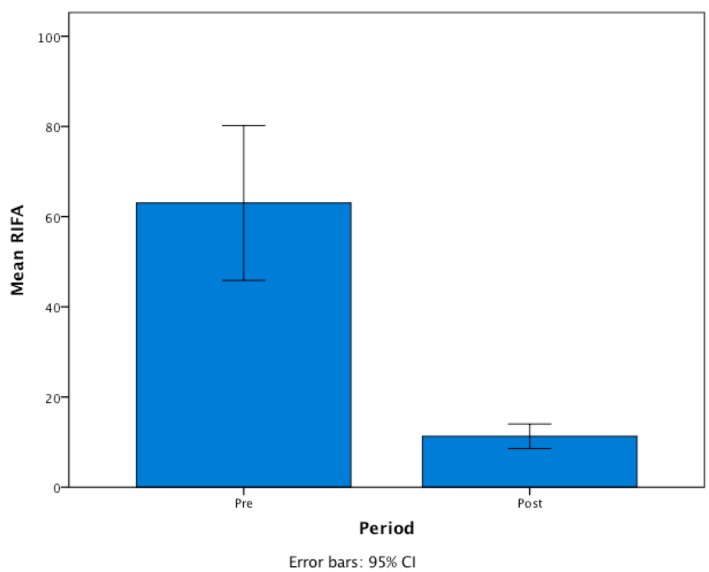
Figure 2. Total number of fire ant mounds found on grounds around Jacob White Construction Company Headquarters, before and after broadcast application of

the broadcast application on 21 October 2011, DuPont™ Advion® fire ant bait (0.5 oz/ mound) was uniformly distributed around the active mounds with active brood.

A T-test statistical analysis to compare the mean numbers of worker ants observed at lures before and after the arena bait station treatment was used. The mean and 95% Confidence Intervals (CI) for each sampling and display on a time series graph (Fig. 1) was also estimated. No overlap among 95% CI indicates significant differences, and overlap indicates no significant differences. This approach allow us to compare post-treatment dates to pre-treatment numbers which in this case are consider a Control.

Results and Discussion

The DuPont™ Advion® ant bait arenas did successfully reduce the ant population at all assessment dates (Fig. 1), based on food lures, on the green roof atop the Jacob White Construction Company Headquarters. Results of the T-test (P <0.000, df: 327, F= 26.270) indicated that the mean number of worker ants recorded on food lures over the assessment period were significantly reduced compared to the initial pre-treatment values (Fig. 3).



Group Statistics

	Period	N	Mean	Std. Deviation	Std. Error Mean
RIFA	Pre	23	63.04	39.707	8.280
	Post	306	11.30	24.245	1.386

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RIFA	Equal variances assumed	26.270	.000	9.356	327	.000	51.743	5.531	40.863	62.623
	Equal variances not assumed			6.164	23.249	.000	51.743	8.395	34.387	69.098

Figure 3. Analysis of mean number of red imported fire ants (RIFA) on food lures over nine assessment periods (10 May 2011 – 27 January 2012), Galveston County, 2011. T-test: P <0.000, df: 327, F= 26.270.

Since some fire ant foraging activity was observed during the assessment period, and active fire ant mounds were found on the grounds surrounding the Jacob White Headquarters, DuPont™ Advion® fire ant bait was broadcast to the grounds and a 76% reduction in active fire ant mounds was observed 14 days after the treatment (Fig. 2). Subsequent assessments of active fire ant mounds showed a continued increase in mound activity with no discernible reduction in activity after the additional single mound treatments with DuPont™ Advion® fire ant bait. Investigations indicated excessive irrigation occurred after initial spreading of the fire ant bait product which could account for the less than expected decrease in fire ant mound activity.

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Don't Jump: Pest Managers Think on Green Roofs

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The vertical height of a building doesn't pose much of a problem for pests. They find their way onto the roof just fine, no matter the size and height. Once there, it may be unclear who has the responsibility for managing them.

This warning comes from academic and industry experts who attended the National Conference on Urban Entomology in San Antonio, Texas in May of 2014. A session on pest management in the green roof environment was moderated by Allison Taisey, board certified entomologist and program coordinator at the Northeastern IPM Center.

A green roof, that "growing" trend in sustainable living, attracts both urban and agricultural pests. Managing them safely requires knowledge of both structural and agricultural pest management. Attendants at this session began working out some of the nuances. When faced with a green roof, a pest management professional (PMP) might find the pest problem out of the contract scope, license category, or pesticide label restrictions.

According to Wikipedia, a green roof or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems.

Experts want to know: what are the potential pests that might be new to the urban PMP? Which have potential to damage the membranes that protect the building from moisture in the soil? The starter list includes adelgids, grubs, crane flies, overwintering insects, and vegetable garden pests. These pests lengthen the list that green roof experts already know, including roof rats, mosquitoes, fire ants, termites, pigeons, and carpenter ants. Session attendees identified a need for a pest identification guide for rooftop gardens and green roofs.

For now, PMPs should contact their local cooperative extension office for identification and insights on controlling agricultural pests. Visit http://npic.orst.edu/mlr.html to find your nearest office. The Northeastern IPM Center plans to add literature on green roof pest management to its resources database when it becomes available. Experts say urban and structural PMPs will need training on identifying agricultural pests, working safely around beehives, and applying materials on a green roof.

Another concern for pest managers: A structural applicator's license may not qualify a PMP for pesticide application on a green roof. PMPs must be clear about the scope of their abilities (legally-speaking) when promising to manage pests in and around structures with green roofs. Experts suggest a turf and ornamental license may be more appropriate for this setting. In the same vein, PMPs should contact pesticide manufacturers to make sure a rooftop setting is a legal site for application. If a contract does include a green roof, PMPs must be able to access the roof for inspections—this can be difficult in the more self-sustaining extensive green roof systems.

Another topic that came to light in this session was water quality. Water runoff is a major component of green roof planning. How pesticides break down in the green roof media is an area that needs to be researched.

"Green roofs are now part of the building ecosystems that PMPs are trying to protect from pests," Taisey said. "The green roof topic is full of opportunities for industry-extension partnerships that would help people manage pests on green roofs while posing the least risk to health, property, and the environment."

Submitted Papers
CHALLENGES OF BED BUG MANAGEMENT

What Causes Bed Bug Control Failure? - The Resident Factor

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Bed bugs are one of the most difficult urban pests to manage. Due to the biology of bed bugs and the limitations of available control methods and materials, human factors play important roles in the success of bed bug management efforts. More than any other urban pest, the safe and efficient elimination of bed bug infestations requires close collaboration among residents, property management staff, and the pest control provider. In practice, there are often disputes over the causes of control failures. Lack of resident collaboration is the most commonly cited cause of failure among pest management professionals (PMPs) and property managers. Whereas, residents often argue the inferior quality of the pest control service is to blame. These different opinions have, at least in part, arisen from the lack of understanding (or mis-understanding) of bed bug behavior and the role of non-chemical bed bug control techniques in eradication of infestations. In this article, we will analyze the major types of obstacles created by residents and discuss effective methods to overcome these challenges.

Types of Obstacles from Residents

1. **Infrequent Laundering.** Studies have shown that 93-99% of the bed bugs found by visual inspection are located on furniture (Potter et al. 2006, Wang et al. 2007). Frequent laundering of the bed linens is one of the most cost effective methods to reduce/eliminate bed bugs (Naylor and Boase 2010). When the mattress and box spring are wrapped in the original plastic or are encased with vinyl zippered covers, frequent laundering of bed linens becomes especially important. Under these conditions, bed bugs tend to hide on bed linens avoiding the smooth plastic.

2. **Clutter and Housekeeping Practices.** Presence of clutter in homes hinders effective and efficient treatment. Clutter may harbor bed bugs that are difficult to find and treat. The location of clutter is often more important than the amount of clutter. Even a small amount of clutter on, under or next to a host sleeping or resting area (i.e. bed or upholstered furniture) is likely to serve as a safe haven for bed bugs and can lead to elimination failure if not addressed. In contrast, a large amount of clutter located away from the sleeping or resting areas has a much lower risk of harboring bed bugs and unless the residence is heavily infested, is less likely to hinder the

control effort even if it is not removed. Moving around infested items (such as bags, pillows, clothing, stuffed animals etc.) will disturb and spread bed bugs.

3. **Presence of Difficult-to-Treat Furniture.** Certain types of furniture are difficult to treat. Examples include wooden furniture that is in disrepair or has many cracks and crevices, overstuffed upholstered furniture, sleeper sofas and wicker furniture, all which provide numerous harborages for bed bugs and make pesticide or steam application very difficult. Other examples that pose challenges to treatment include platform beds, wood panels placed on bed to support the mattresses, and reclining chairs.

4. **Resident Behavior.** Where the resident sleeps and spends the most time during the day dictates where the bed bugs are likely to hide. Bed bugs hide close to host sleeping or resting places. For example, we found two disabled residents who spent hours of time on wheelchairs had dozens of bed bugs hiding on their wheel chairs. In another case, a handicapped resident who spent large amounts of time sitting in the bathroom. Bed bugs were found on the toilet seat and the wooden chair beside the toilet seat in this apartment. For this reason PMPs should always ask where the resident sleeps, sits and rests over the course of the day. This information can be critical in locating pockets of bed bug activity that otherwise may go undetected. Changing sleeping locations as a result of the bed bug infestation will spread bed bugs to new sleeping areas, making treatment more difficult and time consuming. It is very important that the resident should not change sleeping or resting locations during the course of treatment.

5. **Improper Preparation by Resident.** PMPs commonly ask clients to prepare for treatment without realizing that most residents do not know how to properly prepare. Residents may simply not read or not interpret the instructions correctly. Improper preparation can be counter-productive, leading to the spread of bed bugs, complicating the inspection and treatment process, and reducing the efficiency of the eradication process. We observed one resident who moved an infested suitcase along with many other items to the backyard as part of the preparation. On another occasion, we noticed a resident moved all bed lines to the corner of the bed room. After PMP's treatment, the resident placed the bed lines back on the bed without washing them. In both cases the infested items were not properly addressed and left unexposed to treatments. It would've been better had the resident not moved these items.

6. **Refused Access.** For various reasons, some residents prefer not be bothered by visitors including PMPs even it is a free service provided by the property management office. They may change their locks, not open the door, or ask PMP to come back another time. Without prompt treatment, an infestation isl likely to spread to neighboring units within the building leading to higher control costs and more difficulties in elimination. (Wang et al. 2010) reported that 101 of the 223 units in an apartment building became infested within 41 months of the first confirmed bed bug

introduction. Therefore, gaining access to all apartments is critical for success of the treatment program.

Solutions

Bed bug infestation in multi-unit dwellings is a social issue and requires the cooperation of the residents, property management and the PMP. Overcoming these obstacles starts with education. Educate residents and property management staff regarding bed bug biology, prevention and non-chemical control methods. An educated resident is more likely to identify infestations and follow PMPs' recommendation. Likewise a knowledgeable housing staff will be more effective in setting up a good bed bug management program and assist PMPs in identifying and removing the obstacles created by the residents.

In some instances residents may possess a handicap and are thus unable to fully cooperate, while others are not bothered by the bed bugs and are simply uncooperative. In such cases property management must take initiatives to help the PMP solve the problems. There are many cost-effective methods to remove the above-mentioned obstacles. These may include:

1. Encourage residents to hot launder bed linens at least once per week. For residents that are on a tighter budget it should be explained that they can still kill bed bugs by skipping the wash cycle and placing linens in the dryer on high heat. Other items such as pillows, stuffed animals and hard to wash items like comforters and afghan blankets can also be heated in a dryer.

2. Discourage residents from moving infested items to new locations and encourage them to eliminate clutter on, under and next to sleeping and resting areas. To prevent spread of bed bugs, these items should be hot laundered, placed in a sealed plastic container or discarded if no longer needed. Assist physically challenged residents in removing clutter is more cost-effective than hiring outside service providers. Enlist the help from social workers, relatives, home aids, etc. Ask them to help residents doing weekly laundering and keeping the house uncluttered and clean.

3. Resident should consider disposing of complex furniture that is heavily infested and in disrepair. Furniture that is still in good condition should only be discarded if the resident agrees with disposing of it. Wooden bed frames can be replaced with inexpensive metal frames. A metal bed frame only costs about $35 and is an affordable solution to most people or property management. It is cost effective for property management to provide metal bed frame to residents whose beds are resting on the floor compared to costs associated with overcoming the challenges associated with not having any bed frame. Mattress encasements can also be provided by property management to people who cannot afford or are unwilling to install encasements. Zippered encasements made of plastic are very affordable and effective for assisting bed bug inspection and treatment. Although they are not as comfortable and sturdy as the fabric encasements, they greatly reduce the

probability of bed bugs hiding on the mattresses and box springs (more so than the fabric encasements based on our field observations). In a low-income community, we found that among encased mattresses and box springs, 88% were in plastic encasements and 12% were in fabric encasements, demonstrating that residents are willing to install plastic encasements as a cost-effective method to control bed bug infestations.

4. Identify where the resident sleeps, sits and rests over the course of the day. These areas must be treated and inspected for activity until the infestation is eliminated. Discourage residents from changing sleeping locations to reduce the spread of bed bugs. The fewer the sleeping and resting places used by the resident, the more localized the bed bug distribution will be and the easier it will be to eliminate.

5. Stop asking residents to prepare for treatments except to provide access. Ask residents not to place items on infested furniture or take items from infested furniture to a different location unless it is properly inspected and treated. Inspections of undisturbed apartments will provide the most accurate assessment of the infestation and enable appropriate recommendations for the specific type of cooperation needed from the resident.

6. When PMPs' access of an infested unit is denied by the resident, the management office should find solutions to gain access rather than skipping the treatment.

From our field experiences, we were still able to eliminate many difficult bed bug infestations even when the above mentioned obstacles were present, but months of biweekly inspections/treatments were required to do so. In a community-wide bed bug integrated pest management demonstration study in low-income community, 95% of 66 treated infestations were eliminated over 12 months when many apartments had the above mentioned obstacles (R. Cooper, unpublished data). In that study, the housing staff took the double role of pest control technician and maintenance. He assisted residents with challenges, provided tokens for weekly laundering and followed through with each infestation until no bed bugs were detected. It took a median number of 7 biweekly visits to eliminate an infestation. These successful cases demonstrate that the lack of resident cooperation should not be used routinely as an excuse for control failure. Inaction will only worsen the bed bug problems and incur more difficulties and higher costs over time. Rather, PMPs and housing staff should take proactive roles in correcting/minimizing the obstacles and design treatment strategies based upon the characteristics of the communities. With the available tools and materials, PMPs can still deliver effective bed bug elimination in challenging situations.

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Inherent Challenges of Bed Bug Management: The Human Element Challenges for the Technician

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The Technician

There a number of methods for bed bug control, but today we will be focusing on the use of pesticides by technicians. Heat, vacuuming, fumigation, cold, laundering and a variety of other methods are in play, but to a large degree the work is being done by the service technician using commercial products.

Bed bugs remain the most difficult pest to control for a number of reasons. The products available are lackluster at best. Our best residual products in many situations require at least one and usually more follow-up treatments. For what other pest must you wait a week or weeks for pests to succumb?

In the course of pesticide application, bed bugs on items that cannot be treated must be found and dealt with. The result is a painstaking operation with no immediate indication of success.

Complex challenges

A variety of factors influence the difficulty of service work:

- Level of Infestation
- Environmental Complexity
- Rate of Immigration
- Cooperation

Level of infestation

Failure to grasp the concept of introduction vs. infestation confounds the process of elimination. How many treatments have been performed for 1 or 2 introduced bugs as if it were an established infestation? Such a treatment is a significant waste of resources.

An infestation is qualitatively a breeding population of bed bugs. Quantitatively, it may not be so simple. A series of nymphs with no adult may or may not ever produce a mature of each gender, but may be considered by some to be an infestation.

We need to be able to characterize the population, but to date we lack the knowledge. It certainly appears that bed bug behavior is affected by population size, but we don't know this for sure. Let's look at some arbitrarily chosen levels of infestation.

Introductions

No active breeding is taking place. Only one or a few individuals exist and they may not yet be in a harborage where they will be able to survive. They may never make it to such a harborage. It is extremely difficult for a technician to find these bugs, but the chances for success in elimination is quite high as these bugs may die out on their own.

Light infestations

A light infestation indicates a breeding population with only one or a few breeding adults. The bugs are limited to a single room and usually a single piece of furniture or a very few locations near the host.

They may be hard or impractical to find, but they are quite often in predictable places (beds, headboards, recliners, etc.). Occasionally, the bugs are found on a curtain or some other remote location but none are on the bed.Once found, they are not at all difficult to eliminate. Treatment requires a continued search throughout the unit for other possible bugs (introductions or infestations).

Moderate infestations

As the population grows, multiple adults, multiple generations and mixed stages can be found. Distribution is still tightly focused but bugs can be found on more than one piece of furniture and in more than one room. For control, these populations may be as easy as it gets, they are easy to find; the probability of success is still high.

Heavy infestations

Now the bugs have overflowed their original harborage and have spread around the home. Bugs found in most rooms, all beds, all couches & chairs, With all the bugs that are present, it may still be hard to see any bugs until you begin removing cushions or lifting bed clothes.

This can be difficult as every room requires a great deal of work. A vacuum cleaner to remove as many bugs as possible drastically improves the ease of doing this work and the results gained. Invariably there are live bugs found in the same harborages that were treated previously.

Exploded populations

At some point the population overflows the bounds of harborage and bugs can be found in every room and on virtually everything and wandering around any time of the day. Residents of these homes take bed bugs everywhere they go. Visitors take bed bugs every time they visit. In multi-unit dwellings, bugs may disperse to adjacent units.

If the population remains at this level and residents have regular visitors or regular destinations, the constant influx of immigrant bed bugs will eventually result in concurrent infestations. Once established, these concurrent infestations will "cross pollinate" and re-infest the homes after control measures re affected.

During bed bug control work in the previous decade, we would notice single bed bugs showing up in homes thought to have been eradicated; the bugs seemed to be most often found in the harborages of the prior infestation. At the time, it was thought that these were survivors from the original infestation. In retrospect, many of them could not have been as they were nymphs and not old enough to have been spawned by the previous population. It appears certain now that they were immigrants and, quite likely, from concurrent infestations.

Environmental complexity

This factor may be subordinate to level of infestation. The complex environment may be more hostile to the immigrant bed bug seeking to find a suitable harborage. Do bedbugs have behaviors that will guide them to bed bugs already in the room? Could two single bed bugs die of old age and loneliness on opposite sides of the same bed? Much study has yet to be done before we can know the mechanisms that allow bed bugs to acquire hosts and mates in complex environments.

Environmental complexity aids the bed bug infestation with an established harborage near a regular meal. It makes them harder for the technician to find and provides abundant harborage for successive generations as the infestation grows. It has been suggested by studies in the UK that environmental complexity supports higher populations.

Heavy and exploded populations in highly complex environments are impractical to treat manually and are far better treated using fumigation or heat. Situations involving hoarding behavior confound most control efforts and the hoarding behavior must be addressed first.

Rate of immigration

Environments where new bugs are brought in routinely pose a particularly difficult challenge to the technician. The appearance of the immigrant bed bugs confounds the ability to make judgments regarding treatment strategies and decisions for future actions. Frequently, the technician will treat all bugs as if they were survivors of the original infestation. The constant switching of products, strategies, or recommendations in attempt to end the sighting of bugs will raise frustration levels for both technician and tenant beyond the limits good behavior.

At times, the immigrant bugs are coming from an adjacent unit where the population has exploded but never been reported. This has different implications in apartments than it does in the case of condominiums, but in either case, no resolution can be had until the offending unit is discovered and treated.

Cooperation

In all cases, the control and management of bed bugs cannot be administered passively. That is to say, the tenants must cooperate to some degree or efforts will be ineffective. At the very least, tenants need to stop re-introducing bed bugs and they need to ensure that the pest management professional has access to all the places where the bugs are harboring. Most importantly, items infested with bed bugs that cannot be treated must be de-infested in some other manner such as the laundering of clothes or other personal items. To ensure this happens, a prep sheet is used to guide the tenant through the process.

Preparation requirements across the urban pest management industry are in need of review. Many are written without respect to the level of infestation and tenants with a light infestation may have an unreasonable task set before them. The requirements may be written to generally to be easily understood and subsequently performed incorrectly or ignored altogether.

Some companies have implemented a minimal preparation approach that defers tenant activities until after the initial treatment. This avoids many of the pitfalls of the overly-cautious prep sheet. It still relies on the tenant's understanding of the instructions to achieve the desired effect.

Summary

Whether it is characterizing the population, dealing with a complex environment, excessive immigration or an uncooperative tenant, the service technician doing bed bug mitigation in the field has a challenge that is complex and not well understood. What can be known for certain is that more bed bugs there are, the more difficult the job will be. As environmental complexity increases, so does the difficulty of the job. If new bed bugs are constantly being introduced, it becomes difficult or impossible to know which control strategies are working and which are not. In all cases there is no substitute for a cooperative client with clear instructions and the determination to follow them.

2014 National Conference on Urban Entomology Program

2014

National Conference on Urban Entomology

May 18–21, 2014
San Antonio, Texas

http://ncue.tamu.edu

National Conference on Urban Entomology *at a glance*

For locations, see the detailed program on the following pages.

SUNDAY, MAY 18

8:00 – 12:00	**Urban IPM Community of Practice workday**
2:30 – 5:00	Registration open, upload paper presentations
2:00 – 4:20	**SYMPOSIUM** School IPM: Moving the ball forward and keeping it sustainable
6:00 – 8:00	Welcome reception (free hors d'oeuvres)

MONDAY, MAY 19

6:30 – 7:45	Breakfast on your own — included with your room
7:00 – 5:00	Registration open, upload paper presentations
8:00 – 10:00	**PLENARY SESSION**
10:00 – 10:30	BREAK
10:30 – 11:15	**STUDENT SCHOLARSHIP AWARD PAPERS**
11:15 – 12:30	**STUDENT PAPER COMPETITION**
12:30 – 1:30	Lunch on your own
1:30 – 3:00	**STUDENT PAPER COMPETITION**
3:00 – 3:30	BREAK
3:30 – 6:00	**Concurrent sessions:**
	SYMPOSIUM Significance of science and entomology literacy in graduate student training
	SUBMITTED PAPERS Bedbugs
6:00	Dinner on your own

TUESDAY, MAY 20

6:30 – 8:00	Breakfast on your own — included with your room
7:00 – 5:00	Registration open, upload paper presentations
8:00 – 10:00	**Concurrent sessions:**
	SYMPOSIUM Insect behavioral adaptations pose new challenges in pest management efforts
	SUBMITTED PAPERS Ants
10:00 – 10:30	BREAK
10:30 – 12:30	**Concurrent sessions:**
	SUBMITTED PAPERS Flies and Cockroaches
	SYMPOSIUM IPM teams at work: Success stories from community IPM programs
12:30 – 2:00	Awards luncheon
2:00 – 3:30	**Concurrent sessions:**
	SUBMITTED PAPERS Special Interests
	SUBMITTED PAPERS Termites
3:30 – 4:00	BREAK
4:00 – 5:45	**Concurrent sessions:**
	SYMPOSIUM Trade globalization is not new — 500 years of introducing urban insect pests into North America
	SYMPOSIUM Mosquito control in urban areas
6:00 – 9:00	Dinner on your own

WEDNESDAY, MAY 21

6:30 – 8:00	Breakfast on your own — included with your room
7:00 – 10:00	Registration open, upload paper presentations
8:00 – 10:00	**Concurrent sessions:**
	SYMPOSIUM Green roofs: Where agriculture and structural pest control meet
	SYMPOSIUM The inherent challenges of bed bug management — the human element
10:00 – 10:30	Hotel checkout
10:30 – 11:30	FINAL BUSINESS MEETING
11:30 – 12:00	EXECUTIVE COMMITTEE BUSINESS MEETING

2 NCUE 2014

National Conference on Urban Entomology

SUNDAY, MAY 18

8:00 – 12:00 **Urban IPM Community of Practice workday**

2:30 – 5:00 Registration open, upload paper presentations — Registration Desk Level 2

2:00 – 4:20 TEXAS A
SYMPOSIUM

School IPM: Moving the ball forward and keeping it sustainable.
Organizer and Moderator:
Janet Hurley, Texas A&M AgLife Extension

2:00 – 2:20 Making sure your efforts aren't for naught: Tools for sustaining School IPM programs.
MARC LAME
Indiana University

2:20 – 2:40 Floating unfunded mandates: Florida's IPM in Schools program.
FAITH OI and Michael Page
University of Florida and Florida Department of Agriculture

2:40 – 3:00 IPM and pesticide safety — How Washington has linked the two together.
CARRIE FOSS
Washington State University

3:00 – 3:20 Who needs to be involved? Using interviews to improve implementation of IPM in schools.
DEBORAH YOUNG, Susan Tungate, Esther Chapman, Kristen Carman, and Ryan Davis
Colorado State University and Utah State University

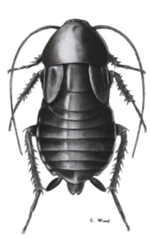
3:20 – 3:40 School IPM: Perspectives from pest management professionals.
RYAN DAVIS, Susan Tungate, and Deborah Young
Utah State University and Colorado State University

3:40 – 4:00 Implementing School IPM programs by empowering EPA stakeholders and partners: Building a smart, sensible and sustainable approach to pest management.
SHERRY GLICK and Thomas Cook
U.S. EPA Center of Expertise

4:00 – 4:20 How are states helping schools with pesticide product selection? Laws, lists, and criteria.
KACI BUHL
Oregon State University

6:00 – 8:00 WELCOME RECEPTION (free hors d'oeuvres) — MAJESTIC A BALLROOM

Oriental cockroach drawing by Dr. Gene Wood



MONDAY, MAY 19

6:30 – 7:45 Breakfast provided by hotel

7:00 – 5:00 Registration open, upload paper presentations — Registration Desk Level 2

8:00 – 11:15 MAJESTIC BALLROOM B & C
PLENARY SESSION

8:00 – 8:30 **Welcome and Orientation**
Conference Chair, President of Texas Pest Control Association, and Local Arrangements Committee

8:30 – 9:00 **Honoring Dr. Gene Wood**
PATRICIA ZUNGOLI, Clemson University

9:00 –10:00 **Distinguished Achievement Award in Urban Entomology**
The Arnold Mallis Memorial Award Lecture: Reflections on a career spanning 33 years in industry and academia.
JULES SILVERMAN, Charles G. Wright Distinguished Professor
North Carolina State University

10:00 –10:30 BREAK — Prefunction Balcony

10:30 – 11:15 MAJESTIC BALLROOM B & C
STUDENT SCHOLARSHIP AWARD PAPERS

Moderator:
Karen Vail, University of Tennessee

10:30 – 10:45 **Bachelor of Science Award**
Venom volume and aggressiveness in flooded fire ants: Coastal versus inland.
DESMARIE STEWART, Linda Hooper-Bui, and Rachel Strecker
Louisiana State University

10:45 – 11:00 **Masters of Science Award**
Molecular diagnostic technique for identification of the Formosan subterranean termite, *Coptotermes formosanus* (Isoptera: Rhinotermitidae), from other Rhinotermitidae.
MARK JANOWIECKI and Allen Szalanski
University of Arkansas

11:00 – 11:15 **Doctoral Award**
Using mark-release-recapture technique to study bed bug movement.
RICHARD COOPER, Changlu Wang, and Narinderpal Singh
Rutgers University

11:15 – 12:30 MAJESTIC BALLROOM C & B
STUDENT PAPER COMPETITION

Moderator:
Ron Harrison, Orkin Pest Management Company

11:15 – 11:25 Differential gene expression analysis in bed bug (*Cimex lectularius*) fed with 0.08% blood alcohol concentration.
RALPH NARAIN and Shripat T. Kamble
University of Nebraska-Lincoln

11:25 – 11:35 Genetic variation of the drywood termite *Incisitermes schwarzi* (Isoptera: Kalotermitidae).
MARK JANOWIECKI, Allen Szalanski, Rudolf Scheffrahn, and James Austin
University of Arkansas, University of Florida, BASF Corporation

11:35 – 11:45 The effects of temperature on the tunneling capacity of *Nylanderia fulva* (Mayr).
MICHAEL BENTLEY
University of Florida

11:45 – 11:55 A survey of the red imported fire ant, *Solenopsis invicta*, and parasitoid *Pseudacteon* spp. phorid flies (Diptera: Phoridae) in urban areas of central Texas.
JANIS REED and Roger Gold
Texas A&M University

11:55 – 12:05 Insecticide resistance in eggs and first instars of the bed bug (Hemiptera: Cimicidae).
BRITTANY DELONG and Dini Miller
Virginia Tech University

12:05 – 1:30 LUNCH on your own

1:30 – 3:10 MAJESTIC BALLROOM C & B STUDENT PAPER COMPETITION

Moderator:
Ron Harrison, Orkin Pest Management Company

1:30 – 1:40 Danger on the horizon: Neonicotinoid resistance in the bed bug.
JENNIFER GORDON, Subba Palli, Michael Potter, and Kenneth Haynes
University of Kentucky

1:40 – 1:50 Investigating the vector capacity of bed bugs: Feeding and defecation behaviors.
COURTNEY L. DARRINGTON and Susan C. Jones
The Ohio State University

1:50 – 2:00 Reduced cuticular penetration in the common bed bug (*Cimex lectularius* L.): a mechanism of insecticide resistance.
REINA KOGANEMARU, Dini Miller, Zach Adelman, Keith Ray, and Richard Helms
Virginia Tech University

2:00 – 2:10 Effects of salinity on the aggressiveness and venom production of the red imported fire ant, *Solenopsis invicta.*
MATTHEW LANDRY, Linda Hooper-Bui, and Rachel Strecker
Louisiana State University; LSU AgCenter.

2:10 – 2:20 Behavior of Asian needle ant, *Pachycondyla chinensis* (Emery) workers during nest emigration.
HAMILTON ALLEN, Patricia Zungoli, Eric Benson, and Patrick Gerard
Clemson University

2:20 – 2:30 Basic biology of an invasive ant pests: Intraspecific aggression and longevity in the dark rover ant (*Brachymyrmex patagonicus*).
JAVIER MIGUELENA and Paul Baker
University of Arizona

2:30 – 2:40 The response of the bed bug, *Cimex lectularius* L., to various application rates of diatomaceous earth in the laboratory.
MOLLY STEDFAST and Dini Miller
Virginia Tech University

3:00 – 3:30 BREAK — Prefunction Balcony

3:30 – 6:00 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2 MAJESTIC BALLROOM C SYMPOSIUM

Significance of science and entomology literacy in graduate student training.
Organizer and Moderator:
Shripat Kamble, University of Nebraska – Lincoln

3:30 – 3:45 Mentoring (mentor and mentee).
SHRIPAT KAMBLE
University of Nebraska

3:45 – 4:00 Course-work in science, entomology and other supporting sciences.
MICHAEL SCHARF
Purdue University

4:00 – 4:15 Fundamentals of planning and conducting scientific research.
COBY SCHAL
North Carolina State University

4:15 – 4:30 Ethics in scientific research.
ROGER E. GOLD
Texas A&M University

4:30 – 4:45 Student's perspectives in graduate training.
BRITTANY PETERSON
Purdue University

4:45 – 5:00 Mechanics of preparing successful refereed publications.
MICHAEL RUST
University of California, Riverside

5:00 – 5:15 Graduate student training for success in industry.
JOESPH SCHUH
BASF Corp.

5:15 – 5:30 Graduate training for success in academia (and Extension).
DINI MILLER
Virginia Tech University

5:30 – 5:45 Hiring candidates with science training for a multinational pest management company.
RONALD HARRISON
Orkin Pest Management Company

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM B
SUBMITTED PAPERS – BED BUGS

Moderator:
Robert Kopanic, S.C. Johnson & Son, Inc.

3:30 – 3:45 Dealing with bed bugs in New York City.
WAHEED BAJWA and Edgar R. Butts
New York City Department of Health and Mental Hygiene

3:45 – 4:00 Can we detect bed bugs in occupied multifamily housing units using four or fewer monitors?
KAREN VAIL and Jennifer Chandler
University of Tennessee

4:00 – 4:15 Attracting bed bugs using sugar-yeast and a bed bug lure.
NARINDERPAL SINGH, Changlu Wang, and Richard Cooper
Rutgers University

4:15 – 4:30 Bed bug IPM in high-rise apartment buildings using pyrethroid and neonicotinoid mixtures.
AMEYA GONDHALEKAR, Aaron Ashbrook, Mahmoud Nour, and Gary Bennett
Purdue University

4:30 – 4:45 An update on BASF Bed Bug Secure and an ongoing project with a large, low-income housing apartment building.
GAIL GETTY, Jason Meyers, Robert Hickman, Robert Davis, Freder Medina, Joseph Schuh, and Joey Hoke
Getty Entomological Research & Consulting; BASF Corp.; American Pest Management

6:00 DINNER on your own

TUESDAY, MAY 20

6:30 – 8:00 Breakfast provided by hotel
7:00 – 5:00 Registration open, upload paper presentations — Registration Desk Level 2
8:00 – 10:00 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2

MAJESTIC BALLROOM A
SYMPOSIUM

Insect behavioral adaptations pose new challenges in pest management efforts.
Organizers and Moderators:
Coby Schal and Jules Silverman, North Carolina State University

8:00 – 8:05 Introduction to Symposium.
COBY SCHAL
North Carolina State University

8:05 – 8:30 Glucose-aversion in cockroaches: Altered taste perception saves lives.
JULES SILVERMAN, Ayako Wada-Katsumata, Alex Ko, and Coby Schal
North Carolina State University

8:30 – 8:55 Super-size me: How odorous house ants made it big in the city.
GRZEGORZ BUCZKOWSKI
Purdue University

8:55 – 9:20 Chemicals influencing movement of bed bugs: The yin and yang of their locomotor behavior.
KENNETH HAYNES
University of Kentucky

9:20 – 10:00 Aspects of biological control in termite research.
AYA YANAGAWA and Chow-Yang Lee
Kyoto University and Universiti Sains Malaysia

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM C
SUBMITTED PAPERS – ANTS

Moderator:
Robert Kopanic, S.C. Johnson & Son, Inc.

8:00 – 8:15 Modifying perimeter sprays for ant control to reduce pesticide runoff into urban waterways.
MICHAEL RUST, Les Greenberg, and Dong-Hwan Choe
University of California Riverside

8:15 – 8:30 Comparison of two community-wide programs targeted to manage red imported fire ants, *Solenopsis invicta* (Buren).
WIZZIE BROWN
Texas A&M AgriLife Extension Service

8:30 – 8:45 Red imported fire ants and *Pseudacteon* phorid flies: Unanticipated consequences of biological control on traditional fire ant management approaches.
ROBERT PUCKETT, Janis Reed, and Roger Gold
Texas A&M University

8:45 – 9:00 Evaluation of liquid and bait insecticides against the rover ant (*Brachymyrmex patagonicus*).
Javier G. Miguelena and PAUL BAKER
University of Arizona

9:00 – 9:15 Diet preferences of *Brachymyrmex patagonicus* Mayr (Hymentoptera: Formicidae).
T. CHRIS KEEFER and Roger Gold
Texas A&M University

9:15 – 9:30 Efficacy of Alpine® WSG insecticide and Termidor® SC termiticide/insecticide treatments on tawny crazy ant infestations.
Paul Nester, Tom Rasberry, and ROBERT DAVIS
Texas A&M AgriLife Extension Service, Rasberry Pest Professionals, BASF Pest Control Solutions

9:30 – 9:45 An urban entomologist goes to the marsh and finds … naphthalene.
LINDA HOOPER-BUI, Edward Overton, Alexander Sabo, Xuan Chen, and Rachel Strecker
University of California at Riverside, Syngenta Lawn & Garden, University of California Cooperative Extension

9:45 – 10:00 Using acrobat ants to determine the effect of Macondo oil on saltmarsh terrestrial arthropod food webs.
LINDA HOOPER-BUI, Alexander Sabo, Brooke Hesson, Xuan Chen, and Rachel Strecker
Louisiana State University

10:00 – 10:30 BREAK — Prefunction Balcony

10:30 – 12:30 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2

MAJESTIC BALLROOM A
SUBMITTED PAPERS–FLIES AND COCKROACHES

Moderator:
Molly Stedfast, Virginia Tech

10:30 – 10:45 Laboratory screening and field evaluation of four commercially available scatter baits and one novel bait against *Musca domestica* and *Fannia canicularis.*
Amy Murillo, Alec Gerry, NICOLA GALLAGHER, Nyles Peterson, and Bradley Mullens
California Riverside

10:45 – 11:00 Recent findings from insecticide resistance studies in German cockroaches.
MICHAEL SCHARF and Ameya Gondhalekar
Purdue University

11:00 – 11:15 Sexual behavior of the resurgent Turkestan cockroach, *Blatta laterialis* (Dictyoptera: Blattidae).
ALVARO ROMERO and Manda Sechler
New Mexico State University

11:15 – 11:30 Laboratory efficacy studies of Tekko Pro™ for the control of *Blattella germanica* (Blattodea: Blattellidae)
WILLIAM A. DONAHUE, Bret E. Vinson, and Michael W. Donahue
Sierra Research Laboratories, Inc., Modesto, CA

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM C
SYMPOSIUM

IPM teams at work: Success stories from community IPM programs.

Organizer and Moderator:
Allie Taisey, Cornell University Northeastern IPM Center

10:30 – 10:35 Introduction to Symposium.
ALLIE TAISEY
Cornell University Northeastern IPM Center

10:35 – 10:55 Extension's role in urban agriculture: working with community gardens to reduce pest issues.
MOLLY KECK
Texas A&M Agrilife Extension Service

10:55 – 11:15 A+ Schools — getting everyone involved in the IPM program.
JANET HURLEY
Texas A&M AgriLife Extension Service

11:15 – 11:35 IPM Coordinators in Affordable Housing.
NANCY CRIDER
Cornell University Northeastern IPM Center

11:35 – 11:55 Reducing asthma triggers in public housing.
SHERANI PATTERSON
Nemours Health and Prevention Services

11:55 – 12:30 Panel discussion: What strategies work best for establishing and maintaining diverse partnerships?
ALL SPEAKERS

12:30 – 1:30 AWARDS LUNCHEON — Majestic Ballroom A & B — including:

Student Paper Competition Awards
RON HARRISON
Orkin Pest Management Company

Student Scholarship Awards
KAREN VAIL
University of Tennessee

Entomological Society of America BCE and ACE Programs
CHRIS STELZIG
Entomological Society of America

2:00 – 3:00 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2

MAJESTIC BALLROOM A
SUBMITTED PAPERS – SPECIAL INTERESTS

Moderator:
Brittany Delong, Virginia Tech University

2:00 – 2:15 Effectiveness of driveway buffer zones for limiting the runoff of bifenthrin and fipronil.
LES GREENBERG, Michael Rust, and Dong-Hwan Choe
University of California, Riverside

2:15 – 2:30 Deposition of fluoride on inert surfaces during fumigation with sulfuryl fluoride.
BARBARA NEAD-NYLANDER and Ellen Thoms
Dow Agrosciences

2:30 – 2:45 UGA homeowner insect and weed diagnostics lab: A 5-year summary for urban spiders with an emphasis on *Loxosceles rufescens* (DuFour).
LISA AMES
University of Georgia

2:45 – 3:00 Efficacy of mosquito adulticiding in reducing incidence of West Nile virus in New York City.
WAHEED BAJWA and Edgar Butts
New York City Department of Health and Mental Hygiene

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM C
SUBMITTED PAPERS – TERMITES

Moderator:
Robert Kopanic, S.C. Johnson & Son, Inc.

2:00 – 2:15 Slow termiticides: A faster way to affect termites.
Bennett Jordan, ROBERTO PEREIRA, and Philip Koehler
National Pest Management Association; University of Florida; University of Florida

2:15 – 2:30 Development of baiting as a method to control subterranean termites.
Michelle Smith and NEIL SPOMER
Dow AgroSciences

2:30 – 2:45 Ecological niche separation between the Formosan and Asian subterranean termites in Taiwan.
HOU-FENG LI
National Chung Hsing University, Taiwan

2:45 – 3:00 Overview of studies conducted in the development of Recruit® HD.
JOE DEMARK, Joe Eger, Mike Tolley, Ronda Hamm, Neil Spomer, Eva Chin-Heady, Michelle Smith, Mike Lees, Ellen Thoms, Barb Nead-Nylander, and Paige Oliver
Dow AgroSciences

3:00 – 3:15 Genetic diversity of Caribbean *Heterotermes* (Isoptera: Rhinotermitidae) revealed by phylogenetic analyses of mitochondrial and nuclear genetic markers.
TYLER EATON, Susan Jones, and Tracie Jenkins
The Ohio State University; University of Georgia

3:15 – 3:30 Termiticide application efficiencies gained with Termidor® HE (High Efficiency) termiticide.
ROBERT HICKMAN, Robert Davis, Kyle Jordan, Freder Medina, Jason Meyers, Thomas Nishimura, and Joseph F. Schuh
BASF Corporation

3:30 – 4:00 BREAK — Prefunction Balcony

4:00 – 5:45 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2

MAJESTIC BALLROOM A SYMPOSIUM

Trade globalization is not new — 500 years of introducing urban insect pests into North America.
Organizers and Moderators:
Ellen Thoms, Dow AgroSciences
Dan Suiter, University of Georgia

4:00 – 4:15 Anthropogenic transport of pestiferous termites.
RUDOLF SCHEFFRAHN
University of Florida

4:15 – 4:30 The legacy of trade globalization from the perspective of urban insect pests — "I've always wanted to have a neighbor just like you."
ELLEN THOMS
Dow AgroSciences

4:30 – 4:45 Introduced wood-boring beetles are not boring.
THOMAS ATKINSON
University of Texas

4:45 – 5:00 Introduced cockroaches in North America, the closer you look the more you see!
ART APPEL
Auburn University

5:00 – 5:15 Unwelcomed house guests — Introduced Heteroptera as urban pests in North America.
JOE EGER
Dow AgroSciences

5:15 – 5:30 Good invaders come in small packages — Introduced ants of the Southeast United States.
DAN SUITER
University of Georgia

5:30 – 5:45 Introduced stinging Hymenoptera — Deliberate and accidental from Aphis to Zeta.
BILL KERN
University of Florida

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM C SYMPOSIUM

Mosquito control in urban areas.
Organizer and Moderator:
Mike Merchant, Texas A&M AgriLife Extension

4:00 – 4:15 Welcome to Texas/Texas Department of State Health Services.
MIKE MERCHANT and Tom Sidwa
Texas A&M AgriLife Extension; Texas Department of State Health Services

4:15 – 4:30 Lessons learned from the 2012 Dallas West Nile virus epidemic.
WENDY CHUNG
Dallas County Health and Human Services

4:30 – 4:45 Mosquito distribution and abundance in urban environments.
GABE HAMER
Texas A&M University

4:45 – 5:00 Effectiveness of PMP-applied insecticides in home landscapes.
GRAYSON BROWN
University of Kentucky

5:00 – 5:15 Mosquito control opportunities for the pest control industry.
MIKE SWAN
EnTex Pest Solutions, Dallas, TX

5:15 – 5:30 Putting a human face on West Nile Virus.
JOE CONLON
American Mosquito Control Association

6:00 Dinner on your own

WEDNESDAY, MAY 21

7:00 – 8:00 Breakfast provided by hotel

7:00 – 10:00 Registration open, upload paper presentations — Registration Desk Level 2

8:00 – 10:00 Concurrent Sessions begin

CONCURRENT SESSIONS 1 of 2

MAJESTIC BALLROOM A SYMPOSIUM

Green roofs: Where agriculture and structural pest control meet.
Organizer and Moderator:
Allie Taisey, Cornell University, Northeastern IPM Center

8:00 – 8:20 Introduction and Overview.
BRIAN FORSCHLER
University of Georgia

8:20 – 8:40 Beekeeping in New York City.
WAHEED BAJWA
NYC Department of Health & Mental Hygiene Office of Vector Surveillance and Control

8:40 – 9:00 Fire ant management on a green roof.
PAUL NESTER
Texas A&M AgriLife Extension

9:00 – 9:30 Don't jump: Considerations in regard to rooftop gardens and the structural pest manager.
GIL BLOOM
Standard Pest Management

9:30 – 10:00 Panel discussion: What do urban entomologists need to know?
ALLIE TAISEY, Jim Fredericks, and Presenters
Cornell University Northeastern IPM Center; National Pest Management Association

CONCURRENT SESSIONS 2 of 2

MAJESTIC BALLROOM C SYMPOSIUM

Inherent challenges of bed bug management — the human element.

Organizers and Moderators:
Dini Miller, Virginia Tech University
Changlu Wang, Rutgers University

8:00 – 8:20 What causes bed bug control failure — the resident factor?
CHANGLU WANG, Narinderpal Singh, and Richard Cooper
Rutgers University

8:20 – 8:40 Challenges of bed bug infestations in Ohio residential settings.
SUSAN JONES
The Ohio State University

8:40 – 9:00 Affordable bed bug control: From heat treatments to volatile pesticides and traps.
ROBERTO PEREIRA, Philip Koehler, and Ben Hottel
University of Florida

9:00 – 9:20 Challenges for the technician.
MARK SHEPERDIGIAN
Rose Pest Solutions

9:20 – 9:40 Let's beat the bug campaign.
STEPHEN KELLS
University of Minnesota

9:40 – 10:00 How do you lose a million dollars?: When amateurs write pest control contracts.
DINI MILLER
Virginia Tech University

10:00 – 10:30 Hotel checkout

MAJESTIC BALLROOM A

10:30 – 11:30 **Final business meeting**

11:30 – 12:00 **Executive committee business meeting**

Special thanks to Jane Medley,
UF/IFAS Entomology and Nematology Department,
for graphic design and layout.

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 W. Bennett
2000	Michael K. Rust
2004	Roger E. Gold
2006	Coby Schal
2008	Nan-Yao Su
2010	Don Reierson
2012	Shripat Kamble

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 National Conference on Urban Entomology Planning Committee

Conference co-chair: FAITH OI, University of Florida
Conference co-chair: GRZEGORZ BUCZKOWSKI, Purdue University

Program co-chair: ROBERT KOPANIC, S.C. Johnson & Son, Inc.
Program co-chair: DINI MILLER, Virginia Tech University

Awards chair: KAREN VAIL, University of Tennessee

Treasurer: ROGER GOLD, Texas A&M University
Roger Gold's assistant: LAURA NELSON, Texas A&M University

Local arrangements co-chair: ROGER GOLD, Texas A&M University
Local arrangements co-chair: LAURA NELSON, Texas A&M University

Sponsorship chair: DANIEL R. SUITER, University of Georgia
Sponsorship member: SHRIPAT KAMBLE, University of Nebraska
Sponsorship member: GARY BENNETT, Purdue University

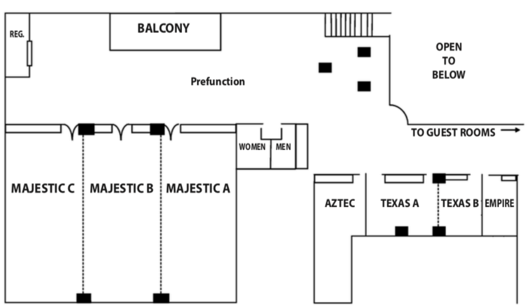
Secretary: KYLE JORDAN, BASF

Proceedings co-chair: KYLE JORDAN, BASF
Proceedings co-chair: JASON MYERS, BASF

NOTES

San Antonio Riverwalk – Downtown

LAYOUT



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2014 National Conference on Urban Entomology

To be a **Corporate Sponsor of the National Conference on Urban Entomology** is to be a supporter of current activities in the area of urban entomology and a partner in promoting a better understanding of the science of urban entomology. The following are the National Conference on Urban Entomology Corporate Sponsors for 2014.

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2014 NATIONAL CONFERENCE ON URBAN ENTOMOLOGY PLANNING COMMITTEE

Conference Co-Chair: Faith Oi (University of Florida)
Conference Co-Chair: Grzegorz Buczkowski (Purdue University)

Program Co-Chair: Robert Kopanic (S.C. Johnson & Son, Inc.)
Program Co-Chair: Dini Miller (Virginia Tech University)

Awards Chair: Karen Vail (University of Tennessee)

Treasurer: Roger Gold (Texas A&M University)
Assistant to Dr. Gold: Laura Nelson (Texas A&M University)

Local Arrangements Co-Chair: Roger Gold (Texas A&M University)
Local Arrangements Co-Chair: Laura Nelson (Texas A&M University)

Sponsorship Chair: Daniel Suiter (University of Georgia)
Sponsorship Member: Shripat Kamble (University of Nebraska)
Sponsorship Member: Gary Bennett (Purdue University)

Secretary: Kyle Jordan (BASF)

Proceedings Co-Chair: Kyle Jordan (BASF)
Proceedings Co-Chair: Jason Meyers (BASF)

2016 National Conference on Urban Entomology Planning Committee

Conference & Program Chair: Kyle Jordan (BASF)

Awards Co-Chair: Faith Oi (University of Florida)
Awards Co-Chair: Grzegorz Buczkowski (Purdue University)

Treasurer: Ed Vargo/Laura Nelson (Texas A&M University)

Local Arrangements Co-Chair: Bob Davis (BASF)
Local Arrangements Co-Chair: Alvaro Romero (NM State)

Sponsorship Chair: Dan Suiter (University of Georgia)

Secretary: Allie Taisey (NPMA)

NATIONAL CONFERENCE ON URBAN ENTOMOLOGY 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

2014 NCUE Closing Meeting Minutes

Meeting Summary
222 attendees
$32,250 from sponsors (best year since 1986)
Proceedings deadline - July 1
2016 NCUE
Embassy Suites Old Town in Albuquerque, May 22-25, 2016
Free parking, close to airport
Old town, baseball, zoo, natural history museum, pueblo museum
Pre-arranged shuttle service from hotel
Rates extended for a few days either way
Breakfast & manager reception/happy hour

- Conference Chair: Bob Kopanic
- Program: Kyle Jordan
- Secretary: Allie Taisey
- Treasurer: Ed Vargo & Laura Nelson
- Awards: Faith Oi & Grzesiek Buczkowski
- Sponsorship: Dan Suiter
- Local Arrangements: Bob Davis & Alvaro Romero

Symposia suggestions

- Bed bug something-current - Dini Miller
- RIFA - Paul Nester
- Invasive species - Bob Davis
- Molecular biology & urban entomology - Mike Merchant
- Molecular Techniques - Ed Vargo
- Nuisance flies - Grzesiek Buczkowski
- Behavior (cross-category) - Bob Kopanic
- Botanical Insecticides - Alvaro Romero
- Social interaction (non-entomologist) - Allie Taisey

Future Management Discussion
Add another day for Fire Ant Group, which merges with NCUE in 2016
Evening sessions (would have to be a symposium)
Poster sessions - adds a lot of extra cost (UNM may be able to assist) ...

- Fire Ant Group does posters
- Electronic poster session

Date neglects schools on quarters ... move to June?
ESA uses a meeting manager that is paid from the hotel once they organize
2018 Meeting
Raleigh, Denver, Atlanta, Miami, Reno, San Diego, Portland, Ft Lauderdale, Tampa, Jacksonville
NC suggestions from Kyle/Coby, FL suggestions from Bill, NE suggestions from Allie/Robert to Laura ASAP.
Other Recommendations/Topics
Program designer (Jane @ UF) retiring before 2016 ... need a graphic artist
Recommend utilizing social media to grow numbers in future
Increase registration by $25 to cover cost (Travel costs for non-entomologists & student discount need to be accounted for)
No photographs during presentations
Font size relative to room
Speakers kept on time, especially with three concurrent sessions
Template for presenters

Add Carrie Cottone & Chad Gore to volunteer list

LETTER CERTIFYING COMPLIANCE WITH IRS FILING REQUIREMENTS

Thompson, Derrig & Craig, P.C.

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Dillard Leverkuhn, CPA

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Mary Joy Venuti, CPA

May 2, 2014

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 2011, 2012, and 2013 are $21,716. Therefore a Form 990 is not required. A Form 990-N (the e-Postcard) has been electronically filed with the IRS for the 2013 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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