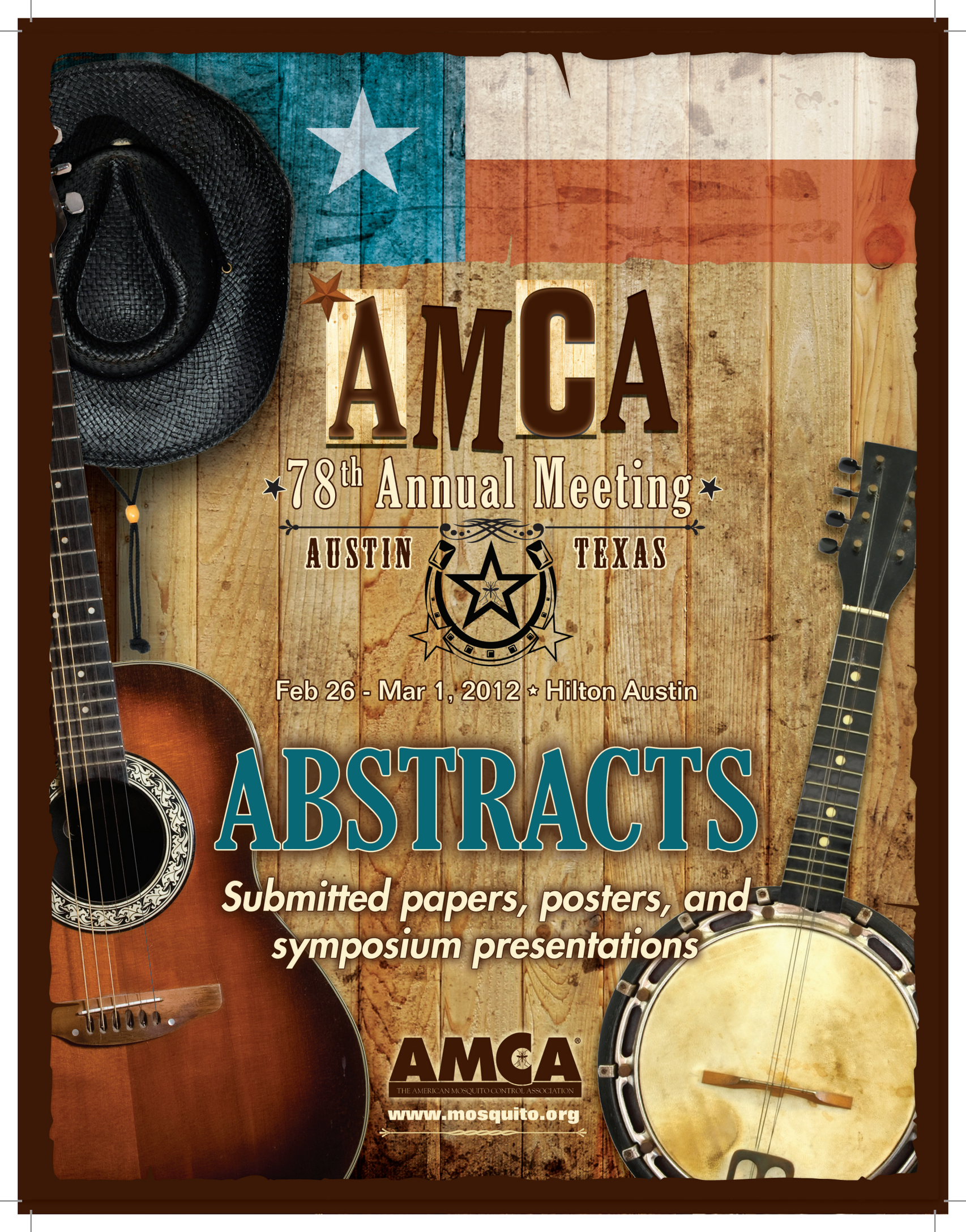
AMCA
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ABSTRACTS
Submitted papers, posters, and symposium presentations
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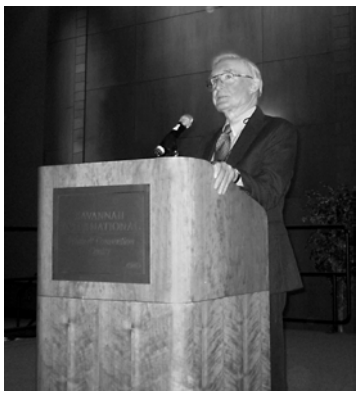
The 2012 AMCA Memorial Lecture Honoree: James Duncan Long, 1925 - 2009



Dr. James D. Long had a lifelong affiliation with the Biology Department at Sam Houston State University, and he is largely responsible for the development of the department into its current form. As Director of the Department of Biology during a period of rapid university enrollment growth, Dr. Long helped establish professional faculty hiring practices, modern curricula, faculty workloads, and class scheduling strategies; practices that remain in effect in the department today.

James D. Long was born and raised on the family farm near the east Texas town of Rusk, where he graduated from high school at the age of 16. He then attended Lon Morris Junior College in the nearby town of Jacksonville from 1942 to 1944, after which, at age 18, he was drafted into the US Navy. He was trained in malariaology at the National Naval Medical Center in Bethesda, MD, and spent one year in mosquito control on New Caldonia in the South Pacific. These experiences led him to a lifelong professional interest in mosquito biology and mosquito control. After returning from service, he attended Sam Houston State Teachers College from 1946 to 1948, earning a Bachelor of Science degree in Biology. Following 1½ years as a biology teacher in Groveton, Texas, Long returned to SHSTC where he earned an MA degree in Biology in 1951, working under Mr. Frank A. Cowan. Following one year as a high school biology teacher in Houston and one year on the faculty of biology at Lamar Institute of Technology (now Lamar University) in Beaumont, Long entered the doctorate program (1953-1957) at the University of Texas in Austin, majoring in zoology with a minor in botany. He studied mosquito biology under Professor Osmond P. Breland, who, incidentally, was a student of Alfred Kinsey, the expert in human sexuality at Indiana University.

Dr. Long's first faculty assignment was as associate Professor of Biology and Department Director at Illinois College in Jacksonville, Illinois, where he remained for three years. Interested in coming back to East Texas, Dr. Long was hired in 1959 as Associate Professor of Biology at Sam Houston State Teachers College, and was appointed Department Director and full professor in 1961. He remained as Department Director until 1972 when he returned to the regular faculty.

During Dr. Long's tenure as Department Director, he increased the number of PhD-level faculty positions from four to 16, replacing three MA faculty PhD-trained faculty. These new faculty had a lasting impact on the programs in the Biology Department. Among the 17 PhD-level faculty hired by Dr. Long, 12 served 25 years or more, with Dr Harold Foerster serving 42 years. Among this group of 12, the median tenure was 32 years of service on the faculty. This growth in the Biology Department paralleled the growth of SHSTC, which became Sam Houston State College in 1965 and then Sam Houston State University in 1969. From 1961 through 1972, fall enrollment increased from 5,044 to 10,438. During this period, university enrollments were increasing significantly throughout the US as the baby boomers began attending college. However, university enrollment leveled off in the 1970s, and the enrollment at SHSU was only at 10,685 in the fall of 1987. Following rapid growth during the past five years, the fall 2006 enrollment at SHSU was 15,935.

Dr. Long helped establish faculty hiring practices that were soon incorporated by other programs across the university. Unlike his predecessors, he set up faculty committees to advertise, screen and interview job applicants from across the country. These hiring procedures moved the department and the university from a highly inbred status, where it was common to hire back their own, to a diverse faculty trained in institutions across the nation. He further strengthened the quality of the teaching program by assigning only faculty to teach introductory biology courses, assigning graduate students to laboratory teaching only. The graduate program expanded to the point where 20 graduate teaching fellowships were awarded each semester in the early 1970s. To help manage the expanding introductory laboratory teaching program, Dr. Long established the position of Laboratory Coordinator in 1968 with the hiring of a fulltime staff person. The following individuals served as Laboratory Coordinators, and all played significant roles in the biology program: 1968-74 Wayne Prince, 1974-79 Robert Phelps, 1979-81 Jerry Rutledge, 1981-90 Leanna Smith, and 1990-present Lori Henderson Rose.

Following his return to regular faculty status, Dr. Long made significant contributions to departmental curriculum development, such as assisting in the acquisition of the old Huntsville State Fish Hatchery for use as the SHSU Center for Biological Field Studies. He also played an important role in the planning of new departmental facilities in the Lee Drain Building, constructed in 1984. In addition, Dr. Long served for 20 years as editor of the Department's annual alumni newsletter, which has helped maintain strong ties with Departmental alumni. He also served for 36 years on the university alumni committee, and was chairman of this group for 15 years.

Dr. Long was a dedicated teacher of biology and introduced this subject to several thousand students during his tenure with the Department. Many former students still comment on the instruction that they received in his introductory biology and entomology classes. He was thoughtful in the selection and preparation of class topics, and was particularly effective in the laboratory. Dr. Long served as an effective mentor to many undergraduate and graduate students, serving as thesis advisor to15 Masters Degree students. Many of these students obtained additional advanced degrees and have made significant contributions as professional biologists in teaching and research. In recognition of his many accomplishments in education, Dr. Long was awarded Professor Emeritus status by Sam Houston State University upon his retirement in 1999.

As a practicing scientist and science educator, Dr. Long made significant contributions to these professions and to several professional organizations. In 1966, he was a founding father of TUEBS (Texas Undergraduate Education in the Biological Sciences), an organization that, until recently, met yearly to consider curriculum matters of common interest to area junior and senior colleges. Throughout his career, Dr. Long played a key role in the activities of the Texas Academy of Science. While serving as President of this organization, he was responsible for revising the TAS constitution and placing the academy on a sound financial footing.

As a mosquito biologist, Dr. Long was a long-time participant and leader in the activities of the American Mosquito Control Association. In 1998 he received the distinguished service award from this organization for 13 years of service as editor of their national newsletter. Dr. Long also provided significant, long-term service to the Texas Mosquito Control Association. For 25 years he organized and coordinated their annual Spring workshops and served as treasurer of the organization from1987 to 2001.

As a researcher in the biological sciences, Dr. Long is nationally recognized for his work with Texas mosquitoes. He was one of the few scientists in the state knowledgeable about species of mosquitoes native to Texas. He and his students published numerous articles on the ecology and distribution of important Texas mosquito species. On a yearly basis, Dr Long, accompanied by other Texas entomologists, visited different regions of Texas to monitor local mosquito populations. This information has proven useful in the control of mosquito species that transmit human disease.

In summary, Dr. James D. Long has made lasting and significant contributions to teaching in the biological sciences, to research in mosquito biology, and to service both within the university, across the state and at the national level.

By Dr. Andrew A. Dewees, February, 2007

The 2012 AMCA Memorial Lecturer: John B. Welch

John B. Welch was born on 27 December 1952 at Chanute Air Force Base in Rantoul, Illinois to John O. and Irene G. Welch (nee Bertram). His father was in the United States Air Force; thus, the family moved quite a bit, living in Denver, San Antonio, Austin, Biloxi, Pasadena, Charleston, Dover, Yorktown, and Chateauroux, France. John attended 13 different schools during grades 1-12. When his father retired from the USAF, the family moved back to Texas where John graduated from high school in La Porte, Texas in 1971.

After high school, John graduated from San Jacinto College in Pasadena, Texas, later transferring to Texas A&M University in College Station, Texas. He initially majored in marine fisheries, but after taking an introductory entomology course taught by Joseph C. Schaffner, he changed his major to entomology. Soon, he learned about medical/veterinary entomology from Jimmy K. Olson in the Department of Entomology, and about insect ecology from Merrill H. Sweet in the Department of Biology. After receiving his Bachelor of Science in entomology in 1975, he planned to pursue his Master's degree in life science at Sam Houston State University (just 50 miles down the road in Huntsville) before returning to Texas A&M to work on his PhD under Sweet, studying the ecology of the "Bug Pond" on the grounds of Texas A&M.

John visited the university in Huntsville to inquire about the possibility of studies and funding, and on his first day, met a gentleman with a warm smile, rosy cheeks, and a twinkle in his eye wearing a beige cloth raincoat and a beige tweed Fedora, walking down the hall of the Biology building. John said good afternoon to the gentleman and asked him how he was doing. The gentleman responded in a very nice voice, "Fine, mighty fine thank you, and you?" John responded in the affirmative and they went their separate ways.

John received a teaching fellowship in the Department of Life Science and started classes in the fall of 1976. After a short time, John began researching the various programs of the faculty and discovered that one professor was an entomologist who studied the biology and ecology of culicids. John made an appointment with the professor and was very happy to find that it was the same gentleman with the warm smile and the twinkle in his eyes, Jimmie D. Long, a man who would have a major influence in and on his life.

After conversations with Long, John selected an ecological/biogeographical problem involving the distribution of three tree hole breeding mosquitoes in an area where their ranges overlap in Southeast Texas. Tree holes and 76 artificial oviposition traps along an approximately 200-mile circuit were sampled on a weekly basis for one year. During his time with Long, John joined both the American Mosquito Control Association and Texas Mosquito Control Association and attended meetings with Long. John presented his first papers at the meeting of the Texas Mosquito Control Association in Galveston and at the American Mosquito Control Association in Chicago. John received his Master of Science in biology in December of 1979. He and Long coauthored John's first, first-author publication, in *Mosquito News*, reporting the collection of *Aedes aegypti* from tree holes in rural Southeast Texas, which was observed during John's thesis research.

Long's tutelage, friendship and support influenced John to redirect his PhD research from "Bug Pond" to culicids. Having previously had Olson's medical/veterinary course as an undergraduate at Texas A&M, and seeing the research that he and his students presented at the Texas Mosquito Control Association and American Mosquito Control Association meetings, John knew he wanted to work with Olson. Olson agreed to take him on as a student. However, due to the timing, no funds were initially available to support John and he had to look for a source of income while he began his studies at Texas A&M University. John's search for an alternate source of income resulted in John's being sent to prison in Huntsville, TX for approximately two years.

John taught freshman zoology and botany for Lee College to inmates of the Walls and Wynne Units of the Texas Department of Corrections in Huntsville, Texas. Class lectures were Friday evenings and labs were on Saturday mornings, after which time John would drive south approximately 100 miles to Chambers County, near Anahuac, to collect soil samples (to examine for mosquito eggs) and then return to College Station, about 150 miles away. John's graduate coursework, research, and teaching preparation occupied the remainder of his time during the week. This schedule continued for two fall and spring semesters until funding was available. While conducting research in Chambers County, Texas, John was also fortunate to be able to learn about mosquitoes and their control from Matthew W. Yates, Director of the Chambers County Mosquito Control District.

John received a research assistantship at Olson's mosquito research lab and was supported through the completion of his doctoral program in December of 1983. Four publications in the *Journal of the American Mosquito Control Association* resulted from his research. While a graduate student at Texas A&M University in 1981, John was the first recipient of the Gus Foyle Memorial Scholarship from the Texas Mosquito Control Association.

After completing his PhD, John wanted to work with culicids and went as far as writing to the Department of Health of the State of Alaska for possibilities, but to no avail, as the job market at that time was extremely limited. However, O. Hugh Graham, Research Leader of the Screwworm Research Unit, of the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), stopped by Olson's laboratory around the middle of December to see if he might know of a scientist interested in a post-doctoral position in Tuxtla Gutierrez, Chiapas, Mexico.

On February 2, 1984, John began his post-doc and his studies with the primary screwworm, *Cochliomyia hominivorax* (Coquerel) which has continued through to this day. After approximately eight months, he applied for a vacant Category I Research Scientist position and became a permanent member

of the research team and further pursued his studies of the ecology and dispersal of sterile screwworm flies in Chiapas. John continued research in Chiapas until May 1985 when he was transferred to San Jose, Costa Rica, where he helped established the USDA-ARS Screwworm Research satellite laboratory and served as the Location Leader until 1991. That year, John was sent on a two-year special assignment to the Center for Space Research, at the University of Texas at Austin, to determine if advances in remote sensing technology would allow for the use of satellite imagery to characterize favorable screwworm habitat. As a result of his work and recommendations, the Screwworm Research Unit invested in state-of-the-art computer technology and hired a remote sensing scientist who continued the research and development of the technology so that the use of satellite imagery has become an integral tool of the bi-national United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS) Screwworm Eradication Programs.

John returned to Costa Rica in 1993 and served as the Research Leader of the unit until 2001. During that time he led the relocation of the screwworm research program from Costa Rica to facilities of the Smithsonian Tropical Research Institute in Balboa, Republic of Panama in 1995, opened an additional field laboratory in Gamboa, Panama, and conducted field studies of screwworm in the area of the Panama Canal and on Barro Colorado Island. In June of 1999, he was transferred to the Veterinary Toxicology and Entomology Research Laboratory in College Station, Texas, where he continued with USDA-ARS until May of 2001 when John applied for a position with the USDA-APHIS Screwworm Eradication Program in Tuxtla Gutierrez, Chiapas, Mexico.

John served as the US Technical Sub-Director of the Mexican-American Commission for the Eradication of Screwworm (COMEXA) until 2002. In that position, he worked closely with his Mexican Federal Technical Sub-Director to oversee the production of sterile screwworm flies at the mass rearing facility. In 2002, John returned to employment by the USDA-ARS and was put on special assignment as the US Director of COMEXA. He served in this position until the termination of a Memorandum of Understanding between USDA-APHIS and USDA-ARS in September of 2005, at which time he returned to the position of Program Entomologist with the Screwworm Research Unit.

John was transferred to the Knipling-Bushland US Livestock Insects Research Laboratory in April 2006 and worked on both Cattle Fever Ticks and Screwworm until November 2009. John returned to the USDA-APHIS Screwworm Eradication Program and moved back to Panama in January 2010. To date, John has served as the Technical Director for the USDA-APHIS Screwworm Eradication Program and the US Technical Director for the Panama-United States Commission for the Eradication and Prevention of Screwworm (COPEG), located in Pacora, Republic of Panama. Additionally, John has responsibility for the technical success for the US with the Mexican-American Commission for the Eradication of Screwworm.

In addition to living and working on screwworm for almost 25 years in the countries of Mexico, Costa Rica, and Panama, John has studied and/or worked to eradicate screwworm in several other countries, including: Guatemala, Belize, Honduras, Nicaragua, Colombia, Cuba, Dominican Republic, Jamaica, and Aruba.

John is internationally recognized as an authority on screwworm ecology and eradication, and has recently been designated by COPEG to serve as the Reference Expert for screwworm for the World Organization for Animal Health. He has presented papers in Spanish at the invitation of the Food and Agricultural Organization of the United Nations in Mexico, Panama, and Peru. He has trained scientists from the United States of America, Mexico, Sweden, Jordan, Australia, Iraq, Nicaragua, Costa Rica, Panama and Jamaica in identification of screwworm flies and in field collecting techniques. John trained the primary screwworm identifiers for Nicaragua, Costa Rica, Panama, and Jamaica. He was also asked by the Government of Costa Rica to lead a team to determine the presence or absence of screwworm on the Isla de Coco, approximately 300 miles off the Pacific Coast. Last month at the request of the State of Florida, he served as the USDA-APHIS expert on screwworm for their Screwworm Outbreak Eradication Simulation.

In addition to facilitating the incorporation of remote sensing for use in screwworm research and eradication, John has demonstrated his ingenuity in several other areas. These include: the training and use of a dog to detect screwworm infested animals and pupae, the use of ground release chambers at specific sites in the field to disperse sterile flies under unique conditions, the use of ground release chambers to eradicate screwworm from Aruba in 2004 and 2011, trapping of screwworm flies up to 34 m in forest canopies in the tropics, and the design of a large-scale field test to determine the efficacy of a new transgenic male-only strain of screwworm. His novel ideas have led to areas of new research and eradication tools and procedures which have saved the program millions of dollars. He is the author/coauthor of 28 peer-reviewed publications.

John has consistently received performance appraisals of “superior” and “outstanding” and has been the recipient of several awards for both his research and eradication efforts. Most recently he was recognized by the Minister of the Department of Health for the country of Aruba for leading efforts to eradicate screwworms and helping to establish a new protocol which will significantly reduce the risk of reintroduction.

John married Nancy L. Welch (nee Crist) in 1975, who is a psychologist. They have two children, Ian and Audrey. Ian was born in Bryan, Texas and served three tours in Iraq as a rifleman in the United States Marine Corps. He was medically retired with the rank of Sergeant in 2009. Audrey was born in San Jose, Costa Rica and is an artist and now married to Glen Tate, a musician.

Oral Presentation Abstracts

Student Competition I

1 Development of a novel insecticide bioassay system based on carbohydrate feeding by adult mosquitoes
Fred Stell, fmstell@ncsu.edu

Current contact-based insecticide susceptibility bioassays for resistance monitoring are logistically challenged. Our novel feeding-based bioassay assessed insecticide susceptibility in mosquitoes through exposure to insecticides in sugar solution containing Trypan blue dye. Blue fecal spot production and mortality endpoints indicated ingestion of solution. Female *Aedes aegypti* exhibited dose response mortality to sugar solutions containing permethrin, which demonstrated proof of concept.

2 Assessing larval mosquito resource competition using native and invasive mosquito species
Kristin E. Sloyer, kesloyer@gmail.com

This study investigates the idea that urban environment characteristics facilitate the introduction of invasive mosquito species. *Oc. japonicus* or *Oc. triseriatus* were reared under two temperature regimes with native or invasive detritus as a primary nutrient source. *Oc. japonicus* had higher survivorship under low food concentrations regardless of temperature. Replacement of native with invasive detritus as primary food source sped up emergence rates and increased larval mortality.

3 Model development for predicting environmental concentrations after applications of ultra-low-volume insecticides for adult mosquito management
Jerome J. Schleier, jerome.schleier@msu.montana.edu

Little is known about the fate of insecticides applied by ultra-low-volume (ULV) techniques, and no model currently exists that can accurately estimate environmental concentrations. Therefore, I developed a statistical model based on field experiments measuring environmental and physiochemical factors. Results indicate that temperature, wind speed, distance from the spray source, and density of the formulation had the largest impact on the deposition of ULV insecticides.

4 Altered complete protection times of Sindbis virus-infected mosquitoes after exposure to repellents
Whitney A. Qualls, quallsamcd@bellsouth.net

We exposed Sindbis-fed and mock-fed *Aedes aegypti* to four test repellents to determine if SINV dissemination influenced complete protection time. Dissemination of SINV significantly decreased the CPT of DEET and picaridin by 46 % and 37%, respectively. These results indicate SINV-disseminated mosquitoes respond to repellents much sooner resulting in a decreased CPT compared to their uninfected cohorts.

5 Characterization of a Controlled Release Formulation of Novaluron
Paddy McManus, pmcmanus@uoguelph.ca

Mosquitoes pose a risk to health as pathogen vectors. A number of pesticides including novaluron, a benzoylphenyl urea, are effective at controlling mosquitoes. A new slow-release, wax-based formulation containing novaluron has been developed by Pestalto Inc to regulate the release of the active ingredient in standing water. The concentration of novaluron released from the formulation was measured by HPLC in water sampled from a set of 12000-L mesocosms and compared with *Aedes aegypti* bioassays.

6 *Anopheles quadrimaculatus* in the Lower Rio Grande Valley, South Texas
Norma H. Martinez, normahmtz@aol.com

South Texas may be at risk of malaria importation due to its proximity to Mexico. We examined the distribution of the malaria vector, *Anopheles quadrimaculatus*, in the Lower Rio Grande Valley to determine the potential for malaria transmission. We conducted a three-month survey along the border between Mexico and the United States of America. Blood-fed specimens were analyzed using RT-PCR to identify blood meal source. A GIS model was developed to examine mosquito distribution.

Legislative and Regulatory Symposium I

7 Complying with the EPA PGP
Jason Kinley, director@gcmad.org

This presentation will discuss the new requirements imposed by US EPA on states that must adhere and follow the EPA Pesticide General Permit ("PGP) for applications to or over Waters of the US.

8 California NPDES permit
Gary Goodman, gwgoodman@fightthebite.net

California has been identified as having the most onerous conditions related to a NPDES permit. This presentation will discuss what California agencies are doing to comply with a permit, and how this permit may affect how other agencies must comply as well.

9 ESA updates affecting mosquito control
Angela Beehler, angela@mosquitocontrol.org

Endangered Species Act regulations are increasingly creating conditions which result in mosquito control efforts being restricted or eliminated. This presentation will discuss recent court rulings and the status of ESA restrictions on mosquito control for certain species of concern.

10 Status of the public health pesticide toolbox: Existing and potential products
Karl Malamud-Roam, kmr@aesop.rutgers.edu

Dr. Malamud-Roam will discuss efforts through the IR-4 program to retain existing public health pesticide uses and investigate opportunities for new compounds for use in public health programs.

Global Dengue Symposium I

11 Overview of current situation of dengue and dengue vector control
Gary G. Clark, gary.clark@ars.usda.gov

Dengue is the most important arbovirus of humans in the world. It is caused by one of four closely related virus serotypes whose primary vector is *Aedes aegypti* and secondarily by *Ae. albopictus*. A global dengue pandemic began in Southeast Asia after World War II and has intensified during the last 30 years. This presentation reviews the basic dengue virus transmission cycle in humans and focuses on the geographic spread of dengue and the increase of severe dengue (dengue hemorrhagic fever) internationally. It also reviews the expanding dengue problem in the Americas and reviews the major factors that have caused it to be recognized as a significant public health problem in the hemisphere. The response of international public health agencies to this situation will be presented including an effort to promote hemispheric eradication of *Ae. aegypti*. Current strategies for controlling dengue vectors will be discussed and will include traditional insecticide-based control methods as well as novel approaches that are emerging around the globe. The status of dengue vaccine development will also be reviewed.

12 Advances in entomological surveillance and control of container-inhabiting mosquitoes
Roberto Barrera, rbarrera@cdc.gov

Lack of adequate vector surveillance tools limits appropriate evaluations of the effectiveness of conventional or novel vector control measures and understanding the ecology of disease transmission. There are recent advances on methodological approaches and trap devices for estimating the size of container-mosquito populations. Sampling the pupal population provides estimates of the absolute population density (e.g., pupae/ha). Pupal surveys have been successfully used for targeting and controlling the most productive containers. Sampling approaches have been recently developed to reduce the sample size required for reliable estimations. Another important development is the BG-Sentinel trap that attracts and captures host-seeking females and in some cases males of container mosquitoes, though trap effectiveness seems to vary with species. BG traps can provide reliable estimations of relative population density and a better understanding of spatial and temporal patterns of mosquito dynamics. Several new traps have been developed for capturing gravid females. Preliminary results indicate that some gravid traps are more sensitive than enhanced ovitraps. Gravid traps can be used to monitor the relative density of ovipositing mosquitoes that are the ones with the greatest potential to transmit arboviruses. These advances significantly improve mosquito surveillance and control as well as our understanding of container-mosquito ecology.

13 Dengue control in Trinidad: A review of three major outbreaks from 1997 to 2010
Dave D. Chadee, Chadee@tstt.net.tt

A review of the dengue situation in Trinidad and Tobago from 1997 to 2010 revealed 3 major epidemics. This study examines the patterns of disease transmission and describes the vector control methods employed during these outbreaks. Based on the evidence provided, vector control strategies can be improved to exert a significant impact on the vector population thereby reducing morbidity and mortality rates and reducing the impact of future outbreaks of dengue in Trinidad and Tobago.

14 Dengue control in Mexico
Juan I. Arredondo, jiarre1@gmail.com

It has been known for long that conventional dengue risk assessment and control is ineffective to prevent/control transmission, unless intensive actions are undertaken. In past years, dengue control in México has been achieved through reactive measures carried out to interrupt outbreaks, but preventive measures have been ineffective. Main reasons for control failures were the lack of early warning systems and that dengue control measures were seldom integrated. To overcome these difficulties, early warning systems for probable transmission and entomological risk assessment, both with geographic sense, were developed in Mexico. With such information, weekly stratification to prioritize interventions was undertaken: stratum 1: street blocks with probable cases near high entomological risk; stratum 2: street blocks with probable cases but moderated to low entomological risk; stratum 3: street blocks with no transmission but high entomological risk; and stratum 4: street blocks with no transmission and moderated to low entomological risk. Corresponding focalized integrated and multidisciplinary control strategy was instrumented. Multidisciplinary teams are groups of technicians carrying out health promotion, larviciding, certification of mosquito-free non-residential spaces, indoor residual and space insecticide treatments. All measures applied in foci where measures were needed. These changes have resulted in a sharp ca. 90% reduction in transmission from 2009 to 2011.

15 Behavioral response of Sindbis virus-infected *Aedes aegypti* to repellents
Whitney A. Qualls, quallsamcd@bellsouth.net

Changes in the blood feeding behavior of *Aedes aegypti*(L.) following dissemination of Sindbis virus (SINV) were observed after exposure to repellents with the active ingredients DEET, picaridin, 2-undeconane (2-U), and lemon eucalyptus. *Aedes aegypti* with a disseminated SINV infection activated at least 2 hr sooner when compared to their uninfected counterparts after exposure to DEET and picaridin repellents. Activation times of mosquitoes with a SINV dissemination exposed to

lemon eucalyptus and 2-U were not significantly different compared to their uninfected counterparts. Mosquitoes with a disseminated SINV infection exposed to DEET and picaridin had a longer probing time than uninfected mosquitoes. However, SINV disseminated mosquitoes exposed to 2-U had a much shorter probing time compared to their uninfected cohorts. Overall, dissemination of SINV in *Ae. aegypti* exposed to DEET and picaridin resulted in significantly longer engorgement times. There was a decrease observed in blood feeding duration of mosquitoes with a positive SINV dissemination after exposure to DEET and picaridin but no differences observed after exposure to 2-U and lemon eucalyptus compared to their uninfected cohorts. Taken together, these results indicate that the presence of a repellent and SINV dissemination influences the total length of time it takes *Ae. aegypti* to successfully blood-feed.

Student Competition II

16 Identification of biologically active volatile cues from preferred and non-preferred hosts of the malaria mosquito, *Anopheles arabiensis*
Kassahun T. Jaleta, kassahun.t78@gmail.com

The malaria vector capacity of *Anopheles arabiensis* depends on its anthropophily, though it displays opportunistic feeding, making non-human hosts dead end hosts, for the *Plasmodium* parasite. Odor extracts from their preferred and non-preferred hosts, and analysis by GC-EAD and GC-MS identified antennal active compounds (alcohols, aldehydes, and phenols) both preferred and non-preferred host specific. These compounds might enable identification of attractants and repellents to control mosquito.

17 Characterization of temephos resistance in *Aedes aegypti* from San Jose de Cucuta, Colombia
Nelson Grisales, keleret@gmail.com

The dengue vector *Aedes aegypti* has developed resistance to the organophosphate larvicide temephos in Cucuta, Colombia. Bioassays, biochemical assays and microarrays were performed to characterize the resistance which was 15x that of a susceptible reference strain. Insensitive acetylcholinesterase was not detected, but microarray results showed the overexpression of other detoxification genes, including 7 CYP450s and 5 GSTs, which may be novel candidates for future temephos resistance studies.

18 Association of Esterases in Resistance to Adulticides in Field-Collections of the Southern House Mosquito
Jennifer R. Gordon, jgord13@gmail.com

Biochemical and biological assays were used to characterize insecticide resistance to naled and resmethrin in populations of *Culex quinquefasciatus* (Say). Based on bioassays, frequencies of resistance varied from 4-100% for resmethrin and 88-100% for naled. In addition, elevated esterase activities were associated with resistance in some populations. Finally, naled synergized the toxicity of resmethrin up to 2.6-fold in populations with increased esterase activity.

19 Dose-response relationships of mosquito repellents tested *in vivo* and *in vitro* using a module system
Natasha M. Elejalde, nme@ufl.edu

Repellent assays should reliably evaluate the efficacy of compounds that deter mosquito feeding. Humans are often used for screening to provide the most accurate data. However, this exposes volunteers to chemicals and mosquito bites. We explored a module-based screening method to develop a standardized protocol for measuring repellent efficacy. Using the module, the dose-response curves of four commercial repellents tested *in vivo* and *in vitro* were compared to establish a predicable correlation.

20 Filarial nematode susceptibility in *Aedes polynesiensis* is affected by *Wolbachia* infection type
Elizabeth S. Andrews, elizabeth.andrews@uky.edu

This study investigated interactions between *Aedes polynesiensis*, *Wolbachia* infection type and filarial nematodes by challenging adult females with *Brugia pahangi* infected bloodmeals. The presence of a heterologous *Wolbachia* infection inhibited numbers of infective stage nematodes within the mosquito. Altering the *Wolbachia* infection type within the vector may change parasite transmission dynamics and could be utilized as a novel control method for lymphatic filariasis.

21 Combined effects of food, water depth, and temperature on time to and size at emergence of *Anopheles gambiae sensu stricto*
Conan Phelan, conanphelan@gmail.com

We conducted a larval rearing experiment to test whether multiple environmental factors interact to influence age and size at emergence of an African malaria vector. All three factors contributed to interaction effects. These effects were understandable in the context of a familiar L-shaped relationship between age and size across different resource levels. This life history pattern provides insights into how mosquitoes respond to differences among larval environments.

22 The effect of seston on the susceptibility of black fly larvae to *Bti*
Joseph Iburg, jpiburg@gmail.com

Seston from sites exhibiting less than optimal larval mortality following *Bti* application was collected and analyzed. Individual components of the seston were exposed to black fly larvae prior to *Bti* exposure. Clay minerals had no effect on larval mortality. Exposure of larvae to viable diatom cells prior to *Bti* resulted in a significant decrease in mortality. Exposure to purified diatom frustules resulted in the most severe impairment of mortality following *Bti* exposure.

Legislative and Regulatory Symposium II

23 Development of USFWS National Mosquito Management Policy for federal refuges
William Meredith

This presentation will discuss the continued efforts of AMCA and the USFWS to work together on a National Mosquito Management Policy for National Wildlife Refuges. Focus will be on the Service's somewhat revised plans and intentions for producing a second draft of their proposed National Policy for further public review and comment, including how the AMCA might further be involved in constructively helping the Service develop their final policy. The USFWS is now also trying to complete refuge-specific comprehensive conservation plans (CCPs) containing mosquito control chapters for those NWRs where mosquito control is practiced or has been contemplated. The Service is now attempting to craft these CCPs without yet having any final National Mosquito Management Policy for NWRs in place, with the latter hopefully someday having contents for which the AMCA concurs, is creating some problems for several MCDs/MADs.

24 Providing an AMCA perspective to regulatory actions: The commenting process
Joseph Conlon

The public commenting process regarding federal agency actions allows stakeholders the opportunity to provide input to various government actions that could potentially affect their interests. The AMCA continually reviews pertinent actions listed in the federal register and drafts comments to be provided the agency via the federal rules portal. These actions could involve anything from pesticide registration documents to endangered species issues. In this way, our support or objections to the action are reviewed and recorded by the federal government. This presentation will discuss the commenting process in terms of its vital importance to the AMCA membership in addition to providing tips on how to effectively get your voice heard at federal agencies through this venue.

25 Status of EPA Pesticide Environmental Stewardship Program and new reporting requirements
Gabrielle Sakolsky-Hoopes

This presentation will discuss the AMCA's participation in the US EPA PESP program and strategic goals and objectives AMCA members can implement to protect human health and the environment.

26 AMCA Washington Conference 2012
Janet McAllister

An update of potential topics during the two-day program at a Washington, D.C. location to accomplish a number of goals. The first day provides an overview for AMCA members on the importance of legislative and regulatory issues. Secondly, AMCA broadens our political base by meeting with key Capitol Hill staffers and regulatory decision-makers resulting in our enhanced visibility to our respective congressional delegations and USEPA, National Marine Fisheries, USDA, CDC, NIH, US Fish & Wildlife Service and others.

Global Dengue Symposium II

27 Unique challenges to dengue vector control using spatial repellents
Nicole L. Achee, nachee@usuhs.mil

Although spatial repellents (deterrents) have been shown to be effective in preventing man-vector contact, there is a growing discussion about diverting host-seeking mosquitoes from treated to untreated locations during implementation. Quantifying such movement is vital in optimizing control strategies focused on vector behavior modification and modeling disease impact. Considering that dengue is primarily an urban disease in areas where houses are either adjoined or closely spaced, the role of spatial repellents for reducing virus transmission has yet to be described in these complex environments. Through mark-release-recapture studies our team has been able to monitor mosquito movement amongst experimental huts following exposure to spatial repellents under field conditions. The uniqueness of our approach is that the huts share adjoining walls and have open eave gaps thereby creating a continuum of indoor space. Such a "rowhouse" configuration is typical of many urban environments where dengue is endemic. This arrangement allows us to measure intensity of distance effects of a spatial repellent tool and potential negative impact on human hosts when varied numbers of huts are treated with the intervention. Outcomes from these studies will be presented.

28 Broad-scale aerial application of VectoBac® WDG for control of *Aedes aegypti* larval populations in Key West, Florida
Andrea Leal, aleal@keysmosquito.org

Due to the recurrence of dengue fever in Key West, FL in 2009 and 2010, the Florida Keys Mosquito Control District began trials of wide-spread application of larvicide via helicopter over residential areas of concern. Applications of VectoBac® WDG were conducted throughout 2011 in the hopes of controlling *Aedes aegypti* larvae in Key West. Because of personnel limitations as well as difficulty accessing every residence, this technique allows the District to cover a much larger area in a short amount of time. In addition to this, there are a number of cryptic breeding sites that contribute to the *Ae. aegypti* population which could potentially be controlled with these applications. During the initial phase of the applications, cups were placed throughout the treatment area to determine mortality in different locations. Throughout 2011, larval surveillance was conducted to assess the impacts of these treatments on larval populations.

29 Control of dengue vectors in Malaysia
AbuHassan B. Ahmad, aahassan@usm.my and Hamady Dieng

Dengue (DF) and dengue haemorrhagic fever (DHF) have become a public health threat in urban and rural areas in Malaysia. In 2010, there were about 41,000 cases of dengue with 120 deaths. Four serotypes (DEN1, DEN2, DEN3 and DEN4) are

circulating and being transmitted by *Aedes aegypti* and *Ae. albopictus*. The ministry of health, local, and city councils have budgets to control dengue vectors, which include source reduction and environmental management. Equally important are prompt vector control response, health education and community engagement. Law enforcement is also a component of the dengue control program; the Destruction of Disease Bearing Insect Act (DBBIA) of 1975 allows for fining homeowners if a house/premise is found with *Aedes* larvae. During outbreaks, space spraying (thermal fogging and ULV spray) for adults and larviciding are carried out. Larval *Aedes* surveillance occurs in dengue hotspots, and temephos granules are used to control them. Despite these interventions, we still face challenges in controlling these mosquitoes. The vectors have changed their habits; for example, *Ae. albopictus* is now found to feed indoors, which has great implication for dengue transmission. New approaches are being developed in controlling the vectors such as an early warning system using GIS and releasing GMO mosquitoes in small areas. Additionally, the plan is to lower dengue incidence by reducing vector production via education programs, encouraging more awareness among the community, and improving surveillance.

29a Surveillance and control of dengue vectors in Brazil

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Dengue is presently one of the most important emerging diseases in the world. In Brazil, since the 1980's, there has been intense virus circulation with epidemic bursts affecting all regions of the country. Currently, about 70% of Brazil's municipalities are infested with the dengue vector, *Aedes aegypti*, and all four dengue serotypes are circulating in the country. In Brazil, prevention and control of transmissible diseases are financed by the Federal Government through the National Health Fund and executed by the municipalities. Annually, about 600 million reais (Brazilian money) are provided for dengue prevention and control activities. The National Dengue Control Program is coordinated by the National Health Surveillance Secretariat who establishes guidelines that standardize the activities executed by municipal health programs including dengue vector control. Currently, about 60,000 vector control agents are working in the municipal dengue control programs throughout the country. Some initiatives such as the LIRAa, a rapid sampling methodology of the vector, are used to direct control efforts. Disposal of discarded tires with the support of Tire Manufacturers Association (ANIP) has also contributed to improved vector control actions. Despite the great effort supporting vector control actions, there are several challenges to the implementation of these control activities in large and medium-sized cities where the complexity of contemporary urban life generates factors that facilitate proliferation of *Ae. aegypti* and prevent the reduction of its infestation rates.

30 Integrating a self delivering microbial biopesticide with conventional pesticides for the control of dengue vectors

Stephen L. Dobson, sdobson@email.uky.edu

Conventional, chemical larvicides and adulticides are proven, cost-effective tools for the control of dengue vectors. However, their use can be complicated when the targeted mosquitoes and oviposition sites are cryptic or difficult to access. Furthermore, the ability to reduce the frequency of their application can save costs and has the potential to postpone the development of resistance. Here, the results of recent trials with a new microbial biopesticide will be presented and discussed in context with a planned, integrated management approach. Repeated, inundative releases of males infected with obligate, intracellular *Wolbachia* bacteria serve to effectively sterilize rare females that have survived chemical applications. The additional suppression that results can slow the recovery of the targeted population and reduce the frequency of subsequent applications.

31 Cemetery flower vase management for control of container-inhabiting mosquitoes

Rui-De Xue, xueamcd@yahoo.com

Mosquito breeding situation in cemetery flower vases and vase management for control of mosquito breeding have been investigated from Evergreen Cemeteries, Gainesville and St. Augustine, FL. *Aedes albopictus* (>90%) and *Ae. triseriatus* were collected from stone vases. The draining holes on vase bottom sides did not affect the percentage of mosquito larval presences in the vases due to hole-block. Repellent DEET (1%) as oviposition repellent was applied to the vases with mosquito larvae. The treatment killed mosquito larvae and prevented gravid female mosquitoes from laying their eggs for 4-5 wk. Also, the treatment by insecticide-fipronil at very low application rate could prevent mosquitoes from breeding for 5-6 wk. Mosquito control in cemetery stone flower vases by regular schedule of vase clean and treatment has been discussed and proposed.

Latin American Symposium I

32 Monitoring and reporting on dengue surveillance and control operations in Costa Rica using the VecTrack™ system

Christian Back, christian.back@gdg.ca

Monitoring and reporting field operations in a simple and easy way have always been a challenge. GDG Environment has developed a GPS data logger, the VecTrack™, which allows quick and accurate recording of all field operations. The data are automatically uploaded and integrated in a web-based portal that provides customizable reports and maps, as well as drill-down, filtering and export tools. In the fall of 2011, the Ministry of Health of Costa Rica launched a pilot project to evaluate the VecTrack™ system in the context of its dengue surveillance and control program. The presentation will focus on surveillance and control results, on the deployment of the system, and on the training of operators and their acceptance of the system.

33 Design of a microarray capable to identify DENV genotypes

Uriel López-Sánchez, uriquimic@hotmail.com**,** Alfonso Méndez-Tenorio and María de L. Muñoz

Dengue virus (DENV) is among the least neurovirulent flaviviruses. The known hosts for DENV are the mosquito vector (*Aedes aegypti*), humans, and nonhuman primates. According to the World Health Organization, there are more than 50

million dengue infections worldwide every year and about 2.5 billion people are in risk to be infected. Infection by the 4 serotypes of DENV (DENV-1, DENV-2, DENV-3, and DENV-4) is prevalent in tropical and subtropical regions around the world. These viruses can cause a spectrum of clinical manifestations like fever, rash, myalgia, arthralgias, bruising, severe bleeding, thrombocytopenia, and shock. A major effort has been devoted to relate intrinsic virulence of DENV to genotypes by accumulating sequence data from strains isolated from humans with dengue fever (DF) or dengue hemorrhagic fever/shock syndrome (DHF/DSS). Differences among DENV genotypes are limited, in part because the isolates need to be obtained during a well-characterized period of the illness, when viremia levels are high enough to permit virus isolation, genome amplification, sequence, and data analysis directly from serum samples. For this reason, this research was initiated to develop a microarray to efficiently identify DENV serotype and genotype. We analyzed all whole genomes of DENV in order to identify genotypes of each serotype and developed software to select probes for all genotypes. Furthermore, we tested the microarray with different DENV from serum samples and isolates. This microarray will provide us with information to understand the distribution of DENV serotypes and genotypes around the world and their association with DF and DHF/DSS.

34 Insecticide resistance mechanisms in *Aedes aegypti* (L) from Merida Yucatan, Mexico related with two dengue transmission seasons

Gabriela Gonzalez, gabygonzalezolvera@hotmail.com **,** Gustavo Ponce, Humberto Quiroz-Martinez, Julian E. Garcia and Adriana E. Flores

The city of Merida, Yucatan, in southern Mexico has the appropriate climate conditions for the development of *Aedes aegypti*. Seasonality exerts a direct influence on population abundance representing a potential risk for dengue outbreaks and increasing chemical control efforts for larvae and adults. Temephos as a larvicide and permethrin for adult control are commonly used in Mexico, with d-phenothrin being used during outbreaks. The goal of this study was to determine resistance levels for permethrin, deltamethrin, and d-phenothrin in adults and temephos in larvae. The samples were collected in both rainy and dry seasons in Merida from 2007 through 2010. Bottle bioassays were used to determine the resistance ratio, as well as, detoxifying enzymes, and frequency of kdr mutation Ile1,016. Results showed high resistance levels to permethrin (25.5X in rainy season of 2009), deltamethrin (30.8X in dry season of 2007), d-phenothrin (258X in dry season of 2010) and temephos (76X in rainy season of 2007). We did not find elevated enzymes levels in comparison with the susceptible New Orleans strain in any of the populations examined. High frequencies of the kdr Ile1,016 mutation were found in all pyrethroid resistant populations.

35 Genetic characterization of *Aedes aegypti* natural populations and its relation to the use of insecticides in Colombia

Idalyd Fonseca-Gonzalez, idalyd.fonseca@siu.udea.edu.co**,** Libertad Ochoa G., Dahyana Bolaños B. and Nicolás Jaramillo-O

Quibdo exhibits eco-epidemiological and social features that promote the development of high densities of *Aedes aegypti*, the dengue vector mosquito, which are controlled by the use of insecticides. Chemical vector control can generate insecticide resistance and could change the genetic conformation of mosquito populations. Our study evaluated the genetic differentiation of natural *Ae. aegypti* populations from neighborhoods with high rates of infestation, frequent use of insecticides and low susceptibility to insecticides, and the highest number of dengue fever cases annually in the Choco region, by genotyping 4 STRs (Short Tandem Repeats= microsatellites) markers (C2A8, AED19, GA and 38/38) specific for *Ae. aegypti*. Data were analyzed with Arlequín (3.01) and PopGene (3.2) statistical software. We found new alleles for the mosquito populations evaluated: 3 alleles for C2A8, 2 for AED19 and 1 for GA and 38/38. We also found levels of gene flow and low polymorphism, both possibly associated with selection events that increase the homozygous alleles between populations, particularly where the insecticides are constantly used. Although there is no population structure and isolation by distance, the information derived from this survey provides a better understanding of population structure and gene flow patterns of *Ae. aegypti* in order to design more efficient control strategies.

36 *Ile*1,016 mutation frequency in populations of *Aedes aegypti* from western Venezuela

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Frequency of the Ile1,016 associated with knockdown (KD) resistance was determined in 3 populations of *Aedes aegypti* from Venezuela. F2 females from Tres Esquinas, Pampanito and Lara were exposed with the corresponding deltamethrin KD_{50} using bottle bioassay. After 1, 4 and 24 h, mosquitoes were recorded and separated into alive, recovered, survivors and dead groups. Genomic DNA was isolated from the abdomen of each mosquito. Genotypes at the Ile1,016 locus were determined in a single-tube polymerase chain reaction (PCR) using the 2 different “allele-specific” primers and the reverse primer. In Tres Esquinas, population frequency values of Ile1,016 were 0.20 in mosquitoes alive after 1 h, 0.18 at 4 h and 0.00 in survivors at 24 h. In Pampanito, frequencies of 0.17, 0.13 and 0.05 where found at 1, 4 and 24 h, respectively, and 0.37 in Lara collection at 1h and 0.27 at 4 and 24 h. Ile1,016 frequencies in this study were consistent to deltamethrin susceptibility with KD50 RR values (<10). With these results, we recommend inclusion of this tool for the early detection of insecticide resistance in *Ae. aegypti* from Venezuela.

37 Oviposition response of *Aedes aegypti* to ovitraps with two larvicides

Humberto Quiroz-Martinez, hqm_uanl@yahoo.com**,** Violeta A. Rodriguez-Castro and Juan F. Martinez-Perales

Oviposition response of *Aedes aegypti* to the presence of spinosad and temephos was evaluated in an urban area. The water was treated with both larvicides in black, plastic containers and Pellon® paper 40 was used as oviposition substrate. Oviposition substrates were removed every week and the number of eggs present per week was recorded. Data was analyzed using the oviposition activity index (OAI). The formula for the OAI is Nt - Nc divided by Nt + Nc where Nt = the number of

eggs in the treatment and Nc = the number of eggs in the control. The resulting indices are interpreted with a correlation ranging from -1 to +1, indicating that the positive value obtained represents an attraction and the negative is repellent or deterrent. The results showed an *Ae. aegypti* preference to spinosad in ovitraps (OAI = 0.49) and repellence to ovitraps with temephos (OAI = - 0.32).

38 Indoor-outdoor eggs incidence of *Aedes aegypti* in Escobedo and San Nicolas de los Garza, Nuevo León, Mexico

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This study was carried out r to compare the indoor-outdoor incidence of *Aedes aegypti* eggs in Escobedo and San Nicolas de los Garza, Nuevo León. Ovitraps were placed indoors and outdoors of several houses during the summer season. Number of eggs per trap was recorded. The analysis was performed using the Student's t test. The statistical analysis found no difference in the incidence of eggs indoors and outdoors in Escobedo but a difference was found in San Nicolas de los Garza.

39 Experience in implementation of vector control tropical diseases with *Bti*-coconut-based community intervention: Transfer from Peru to Guyana

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Bacillus thuringiensis var. *israelensis* H-14 (*Bti*) is one of the most successful bacterial entomopathogens for controlling vector-borne diseases. The principal objective of this project was to develop, test and promote a set of techniques for larval vector control using *Bti* produced in whole coconuts, which can be delivered in a self-sustained fashion through direct community participation in Salitral-Piura, and the control community was Querecotillo-Piura. These communities were followed for 18 yr, and Salitral was given feedback every 3 yr. In the period 2008-2010, we applied knowledge transfer strategy to develop self-sustaining small-business on Salitral and Padre-Cocha Iquitos-Loreto. This strategy has included training in the manufacture of bed-nets and application of *Bti*. The participants sold bed-nets and *Bti*, which allowed them to earn money and spread the knowledge gained. In 2009, we transferred the technology to produce and apply *Bti*-coconut at Guyana. The indicators are: Salitral has had no dengue cases from 2001-2006, and has had less malaria the last years, while Querecotillo has had dengue and malaria every year. There are 2 Salitral NGOs oriented towards a healthy community, and there is 1 formal small enterprise. In Padre-Cocha there are 5 small informal enterprises. In Guyana, 66.67% of the students increased their knowledge about dengue, malaria, and filariasis. We found that after 2 wk of intervention, 83.34 % of the houses had containers with no mosquito larvae. In conclusion, the project increased knowledge, attitudes, and practices favorable to health in target communities. The projects were supported by: IDRC, Canada Embassy, Concytec, PAHO, Government of Canada, FINCYT/BID.

40 DNA barcoding reveals both known and novel taxa in the Albitarsis Group (*Anopheles*: *Nyssorhynchus*) of Neotropical malaria vectors

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DNA barcoding has been proposed as a highly useful tool for species recognition, even among closely related taxa. We tested the utility of barcoding method (NJ-K2P), and Bayesian phylogenetic analysis, for species recognition within the Albitarsis Group of *Anopheles* subgenus *Nyssorhynchus*. This work reports DNA barcodes (658 bp, COI gene) of *An. albitarsis* s.l. from Argentina, Brazil, Colombia, Paraguay, Trinidad and Tobago, and Venezuela, including specimens from type series and type localities. The analyses of 568 sequences resolved 9 NJ tree clusters, with less than 2% intra-node variation. Mean intra-specific variation (K2P) was 0.009 (range 0.002 - 0.014). Mean inter-specific distances were several-fold higher at 0.041 (0.021 - 0.056), supporting the reported "barcoding gap" for species delimitation. These results show full support for separate species status of the 5 formally described taxa in the Albitarsis Group (*An. albitarsis, An. deaneorum, An. janconnae, An. marajoara,* and *An. oryzalimnetes*) and also support species-level status for 3 informally designated lineages (*An. albitarsis* F, *An. albitarsis* G, *An. albitarsis* I) and, suggest the presence of an additional cryptic mitochondrial lineage from Rondônia and Mato Grosso, Brazil (*An. albitarsis* H).

41 *Anopheles* (*Kerteszia*) *lepidotus* (Diptera: Culicidae), not the vector we thought it was: Revised male and female morphology; larva, pupa, and male genitalia characters; molecular verification

Bruce Harrison, skeeterdoc@gmail.com**,** Freddy Ruiz-Lopez, Guillermo Calderon Falero, Harry M. Savage and Richard C. Wilkerson

The name *Anopheles* (*Kerteszia*) *lepidotus*, commonly used for an important malaria vector in the eastern cordillera of the Andes, is here corrected to *An. pholidotus*. We discovered that *An.* (*Ker.*) specimens from Peru, and reared-associated specimens from Ecuador, had unambiguous habitus characters that matched those on the male holotype of *An. lepidotus.* However, the specimens do not exhibit characters of the female allotype and female paratypes of *An. lepidotus*, which are actually *An. pholidotus*. Our specimens are the first correctly associated females of *An. lepidotus*, which allow us to provide a new morphological interpretation for the adult habitus of this species. This finding is also corroborated by highly supported molecular data from a portion of the COI gene and rDNA ITS2. The pupal stage of *An. lepidotus* is described for the first time, and additional larval characters are also noted. Diagnostic morphological characters for adult, pupal and the larval stages of *An. pholidotus* are provided to separate the two species. All stages of *An. lepidotus* are easily separated from other currently known species in subgenus *Kerteszia* and a new key to the females of *An. (Kerteszia)* is given. Previously published distribution, bionomics, and medical significance data are corrected and enhanced.

42 Morphometric studies I: Is *Psorophora pruinosa* Martini a valid species?

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In 1935, E. Martini published "The Mosquitoes of Mexico" which is a classic, useful and necessary literary source for any study of mosquito distribution in Mexico. *Psorophora* (*Grabhamia*) *pruinosa* is described by the author, and his book provides some distinctive characters to distinguish it from a very similar species: *Ps. (Gra.) signipennis* (Coquillett). In 1965, A. Díaz Nájera discussed the validated specific level of *Ps. pruinosa* and proposed that *Ps. pruinosa* be changed to synonymy level of *Ps. signipennis*. However, *Ps. pruinosa* is still considered as a different species than *Ps. signipennis* in many international mosquito catalogues. We collected both immature and adult stages in Torreón, Coahuila, México, which is the type locality for *Ps. pruinosa* and we did not observe morphometric differences to separate the taxa of *Ps. signipennis*.

43 Improvements of "dual-cage" wind driven vanes and Florida style impingers for caged mosquito trials

Jacob Hartle, jacobhartle@gmail.com, Derek Drews and Grifith S. Lizarraga

Field trials with caged bioassay mosquitoes are challenging because of their dependency on meteorological conditions, especially the wind. Both wind speed and direction can be obstacles that will potentially produce poor results or increase the amount of labor necessary to conduct a representative study or caged trial. Having the necessary tools to move cages without having physical obstructions can change the frequency of missing the target that results by a sudden change of wind direction and/or speed. This presentation will cover the construction, materials and advantages of an improved "dual-cage" wind driven vane and a Florida Latham-Barber (FLB) style droplet collector (impinger).

Progress and Products of the Deployed War-fighter Protection Program I

44 Developing new public health insecticides, application technology and repellent systems through the Deployed War-fighter Protection (DWFP) Research Program

Douglas A. Burkett, douglas.burkett@osd.mil and Graham White

The DWFP program develops novel methods to protect US Military personnel against threats posed by disease-carrying insects, especially mosquitoes and sand flies. Administered by the Armed Forces Pest Management Board (AFPMB) with >$5 million/year, the DWFP research portfolio focuses on 3 areas: novel insecticide chemistries/formulations, application technology, and personal protective systems. Since 2004, the DWFP program has awarded >60 competitive grants (PIs from academia, industry, and military entomologists) and boosted efforts by 7 labs of the Agricultural Research Service, United States Department of Agriculture (ARS-USDA) program on Veterinary, Medical & Urban Entomology (see next 3 Abstracts). Beyond R&D, the objective is to find industry partners and get useful products into the market/military stock system. This presentation summarizes DWFP program accomplishments, highlights noteworthy product developments, and reveals how the IR-4 program expedites EPA registration of PH pesticides of value to DWFP goals.

45 Multiple approaches provide new insights on mosquito repellents

Joseph C. Dickens, joseph.dickens@ars.usda.gov, Jonathan D. Bohbot, Nicolas F. Durand, Alan Grant and Jillian Sanford

Multiple approaches have begun to reveal much concerning the mode of action of mosquito repellents. Behavioral studies involving multimodal stimuli demonstrate the importance of various sensory modalities in the orientation of mosquitoes to their hosts. Electrophysiological studies reveal olfactory or gustatory receptor neurons sensitive to chemical signals and show potential effects of repellents on their activities. Knowledge of the cognate ligands for specific ORs and the ability to express these ORs heterologously has provided a platform for testing effects of known repellents at the molecular level and discovery of novel compounds with behavioral activity. I will discuss studies in our laboratory using multiple approaches to understand the action of insect repellents as well as some recent results from other laboratories aimed at understanding the mode of action of mosquito repellents.

46 Insecticide screening and strategies for delivery of dsRNA for vector control

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The search for new insecticidal active ingredients for vector control involves 2 main approaches. The first is the screening of large numbers of experimental compounds (synthetic and natural products) using a primary high throughput screen (HTS) bioassay using *Aedes aegypti* larvae. Highly active compounds are then evaluated in secondary topical adult (*Ae. aegypti*) bioassays. Bioassay data are analyzed using structural-activity relationship (SAR) methods to identify desirable characteristics. Analogs of active compounds are then evaluated for activity against adult mosquitoes. The second approach is the targeting of critical genes/proteins to develop molecular (genetic) biopesticides through RNA interference (RNAi). Constructs are designed, produced and evaluated for efficacy using various delivery strategies. Preliminary results suggest that: (1) chemical screening using bioassays combined with SAR analysis is useful in identifying potential toxicants for vector control and (2) targeting critical genes/proteins through RNAi offers exciting possibilities for novel pesticide development.

47 Novel insecticidal barriers and aerosol applications to protect communities from disease vectors

Seth C. Britch, seth.britch@ars.usda.gov, Kenneth J. Linthicum, Robert L. Aldridge, Todd W. Walker and Muhammad Farooq

The Deployed War-Fighter Protection Program leverages new and existing materials into improvements for the Department of Defense (DoD) pest management system. Personnel deployed in support of US military operations in hot-arid zones are urged to use personal protective measures (PPM) such as DEET or treated bed nets and clothing to protect against arthropod disease vectors and nuisance insects. However, irregular use of PPM coupled with widespread substandard sanitation in

operational environments result in routine exposure to insect threats. We initiated a research program to develop techniques to substantially reduce disease vector and nuisance insect populations in hot-arid combat zones, thereby reducing, but not eliminating, insect threat loads regardless of PPM. Here we survey >30 field experiments investigating insecticide treatment of natural and artificial surfaces and ultra-low volume/thermal fog aerosol pesticide applications using existing spray equipment and US EPA-approved formulations against mosquitoes, filth flies, and sand flies. We describe the evolution of these techniques through combinations of equipment, materials, chemicals, locations, timing, and configuration, and we show the progression in our understanding of their abilities and limitations in a range of environments. Finally, we propose how the techniques could be synergized in the DoD pest management system, or any structured pest management system, and fielded immediately.

Integrated Pest Management

48 Black flies and the critically endangered Whooping Crane: Is there a link?
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Reintroduction of the critically endangered Whooping Crane, *Grus americana*, was initiated at Necedah National Wildlife Refuge in Necedah, WI in 2001. The cranes began attempting to nest at this site in 2005. An undesirable phenomenon of an unusually high incidence of nest desertion has been observed in each subsequent year. Significant populations of black flies (Diptera: Simuliidae) have been observed on the nesting birds and around the nest sites. The primary pest species have been identified as *Simulium annulus* and *S. johannseni*. At the request of the US Fish and Wildlife Service and the Whooping Crane Eastern Partnership, larvicide applications have been conducted with the biological larvicide *Bacillus thuringiensis* var. *israelensis* (*Bti*). Effective larval mortality was observed over 32 mi of river representing the primary larval habitat of the pest species. Water temperatures in this habitat were 1-2°C. Adult populations of the pest species were significantly reduced on the refuge as compared to the baseline year of 2009. Biologists determined that 6 of 20 first-time nests were incubated to full term in 2011, as opposed to 0 of 43 for the previous 6 yr. This work represents the first time that a correlation has been made between black fly populations and Whooping Crane nesting success. Furthermore, this is the first time that *Bti* has been used to suppress black fly populations that are attacking an endangered species.

49 Designing constructed wetlands to reduce mosquito production: the role of emergent macrophytes
William Walton, william.walton@ucr.edu**,** David Popko, Dagne Duguma and Justin Richardson

The large macrophytes (i.e., *Phragmites*, *Typha*, *Schoenoplectus californicus*, *S. acutus*) planted commonly in constructed treatment wetlands create conditions that reduce the effectiveness of integrated mosquito management (IMM) programs. An alternative species to the large macrophytes, which reach 3-3.5 m in height, is alkali bulrush (*S. maritimus*), which is comparatively smaller (1-1.5 m in height) in stature and possesses characteristics that are less likely to compromise IMM for constructed treatment wetlands. The results of several studies that compare mosquito production from the large vs. small macrophytes will be discussed.

50 Florida's Subcommittee on Managed Marshes: 29 years, 44 members and still pumping!
Doug Carlson, doug.carlson@irmosquito2.org

Florida's Subcommittee on Managed Marshes, which was created in 1983, is a legislatively-established subcommittee of the Florida Coordinating Council on Mosquito Control. SOMM's role is to provide technical expertise on saltmarsh management plans taking into account both mosquito control and natural resource interests in these environmentally sensitive habitats. This paper will provide an update on the committee's status and review several issues with which this 29 year old interagency committee is currently dealing.

51 Mosquito-borne disease management in coastal Australia: Can urban planning assist in reducing the risks?
Cameron E. Webb, cameron.webb@swahs.health.nsw.gov.au and Richard C. Russell

Mosquito-borne disease management in coastal Australia faces many challenges. Increasing urbanization is bringing the community closer to productive mosquito habitats but environmental management of coastal wetlands is often in conflict with effective mosquito control strategies. Broadscale mosquito control activities are restricted, resulting in annually abundant pest and vector mosquito populations, and large scale estuarine wetland rehabilitation projects are increasing the availability of productive mosquito habitat. Balancing the desire for environmental conservation with the need to protect the health of human communities requires integrated urban design strategies combined with targeted research. Local authorities are looking to use planning instruments to minimize the impacts of local mosquitoes, such as the incorporation of buffer zones between residential allotments and mosquito habitats. However, the effectiveness of these strategies is often site-specific and is determined by the size and vegetative structure of buffer zones, as well as the make-up of the local mosquito fauna. Potentially important onsite mosquito habitats are also being created through water sensitive urban design strategies intended to increase water conservation through above- and below-ground water treatment and storage. These issues will be discussed and illustrated by local case studies.

52 Volusia County Mosquito Control's utilization of a management program (Lucity) to enhance IMM efficiency
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In the current economic climate, it is more important than ever for Volusia County Mosquito Control (VCMC) to provide essential services while minimizing costs. VCMC decided to digitally track work tasks to ascertain these costs of services to better serve the public. In 2008 VCMC implemented a maintenance management program (Lucity) to track our resources and assets. VCMC functions were discussed, with dozens of tasks identified and work methods developed. Tasks were associated with assets and tracked through our GIS databases. Services performed by VCMC are similar to many integrated mosquito management programs, with surveillance and treatments comprising the bulk of our program. In April 2008 we

began tracking the time for each task and applying the actual VCMC cost for personnel and equipment and immediate benefits were realized. Initial benefits of Lucity provided accurate pricing, based on actual expenses, for other municipalities who contract services. VCMC holds monthly productivity meetings and yearly work plans provide an ongoing system of review. Several years of using this maintenance management system, in conjunction with the county's extensive GIS tools, has enabled VCMC to prioritize tasks and assign resources, enhancing the effectiveness and efficiency of our surveillance and control measures.

53 Practical environmental partnerships in Volusia County, Florida

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Volusia County Mosquito Control (VCMC) operates as a division within the Department of Public Works, and deploys an integrated mosquito management (IMM) program comparable to that of many other professional agencies and districts within the United States. In complement with the responsibilities of implementing an IMM program, VCMC has also established strong relationships with entities including, but not limited to, the St. John's Water Management District and Canaveral National Seashore that further enhance the quality of life for the populace of Volusia County. Details of collaborative efforts between VCMC and our partners will be discussed.

54 Comparison of biochemical and molecular tests for detecting the altered acetylcholine esterase resistance mechanism

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Insecticide resistance to organophosphates and carbamates can be the result of changes in acetylcholine esterase activity conferred by the ACE-1 mutation. Detection of this altered target site mutation is important in guiding informed decisions for resistance management. In this study we compared a competitive enzyme assay with a PCR assay utilizing restriction enzymes. Both assays detect the ACE-1 mutation in *Culex quinquefasciatus* and show good agreement. The benefits of each assay are presented.

55 Cloning and transcription profiling of mitochondrial ATP synthase in *Aedes taeniorhynchus* (Diptera: Culicidae)

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The cDNA of mitochondrial ATP synthase coupling factor 6 precursor from *Aedes* (*Ochlerotatus*) *taeniorhynchus* (Weidemann) was cloned and sequenced. The full-length mRNA sequence (522 bp) for mitochondrial ATP synthase coupling factor 6 precursor from *Ae. taeniorhynchus* (AetMASCF) was obtained which encodes an open reading frame of 321 bp (i.e., 106 aa). To detect whether AetMASCF is developmentally regulated, a quantitative real-time polymerase chain reaction (qPCR) was used to examine AetMASCF mRNA expression levels in different developmental stages of *Ae. taeniorhynchus*. AetMASCF was differentially expressed in egg, larval, pupal, and adult *Ae. taeniorhynchus*. The mRNA transcription levels of AetMASCF mRNA expression in response to a heat shock and permethrin treatment in female *Ae. taeniorhynchus* were determined. In addition, a phylogenetic tree for AetMASCF and mitochondrial ATP synthase coupling factor 6 precursor from other insect orthologues was constructed using UPGMA method with the MEGA 5.05 program.

Behavior/Biology

56 Seasonality and daily flight activity of *Stomoxys calcitrans* (Diptera: Muscidae) on dairy farms in Saraburi province, Thailand

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Knowledge of seasonal abundance and flight activity patterns are required to design effective management programs for insect pests of humans and livestock. The seasonality and daily flight activity of *Stomoxys calcitrans* were examined by sampling 2 dairy farms in Saraburi Province. Data was assessed throughout 1 yr with Vavoua traps from September 2010 to August 2011. Total numbers of *S. calcitrans* showed a significant difference between farms. This species occurred throughout the year, and more males were collected than females at both farms. The greatest number of *S. calcitrans* was captured in September 2010 at both farms, while the lowest number in farms 1 and 2 occurred in July 2010 and February 2011, respectively. Both sexes were active from early morning to late evening. The daily flight activity of male *S. calcitrans* peaked during 1100 - 1300 h while female activity peaked around 1200 - 1400 h. The abundance of *S. calcitrans* captured was positively correlated with temperature, relative humidity, and light intensity.

57 Vertical oviposition preferences of *Aedes albopictus* in field and controlled studies

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After first being detected in New Jersey in 1995, the Asian tiger mosquito *Aedes albopictus* (Skuse) has spread rapidly across the state and is now found in all but the furthest northwest corner of New Jersey. The question we focus on in this research is to determine if *Ae. albopictus* shows height preference in oviposition. To answer this, in 2008 and 2009 we placed artificial containers in the field at 2 sites in Trenton, NJ. Five trees were chosen in each site, with 5 heights (0, 1, 2, 3, and 4 m) in each tree. These cups were sampled by placing a sheet of seed germination paper inside the cups as an oviposition substrate. In 2011, oviposition heights were controlled at 0 m or 4 m, with mosquitoes released into an artificial habitat with only 1 height available. Analysis of larval samples from each height in 2008 and 2009 along with an analysis of total eggs deposited at each height showed a clear preference by *Ae. albopictus* to oviposit at heights near ground level in a natural setting, although oviposition was observed at all heights. Analysis of 2011 data is ongoing.

58 Statewide larval surveillance: defining the distributions of *Aedes albopictus* and *Ochlerotatus japonicus* in Virginia

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Determining in-state distributions of *Aedes albopictus* and *Ochlerotatus japonicus* is important because of their potential as vectors of viruses to humans and domestic animals. *Aedes albopictus* and *Oc. japonicus* can transmit West Nile virus and

have been known to transmit eastern equine encephalomyelitis and La Crosses viruses in the laboratory. To update incomplete Virginia distribution maps for these species, a state-wide larval survey was conducted during June, July, and August 2011. During this survey, 163 larval samples were collected from artificial containers (mostly tires) in 90 different cities and counties throughout the state. A total of 3,967 individual larvae were collected and identified. *Aedes albopictus* comprised 42% (1,684) of the catch and *Oc. japonicus* 39% (1,564). Species composition and ratios were calculated at each sampling site and analyzed with their respective elevations, latitudes, and nearby human populations. It was observed that *Oc. japonicus* has a positive correlation with elevation, while *Ae. albopictus* has an inverse correlation to elevation.

59 Mosquitoes with olfactory co-receptor knockdown can still detect host

Nicolas F. Durand, nicolas.durand@ars.usda.gov and Joseph C. Dickens

For host finding and selection, female mosquitoes use odors of their host. To define the precise behavioral role of olfactory receptors in host detection, we studied behavior of a transgenic strain of *Aedes aegypti* in which expression of the olfactory co-receptor, Aaeg\Orco, had been knocked down. We observed the behavior of female mosquitoes toward the hand of a human volunteer under both white and red light conditions in a laboratory olfactometer in order to separate visual and olfactory stimuli. In each experiment, transgenic mosquitoes were able to detect the human host. Our results indicate that female *Ae. aegypti* are able to find their host in absence of visual stimuli and, moreover, with a loss of a key component of their olfactory system.

60 Olfactometer studies of *Aedes albopictus* responses to volatiles from flowering plants

Dan Kline, danielkline35@cox.net**,** Eric Rohrig and Peter Teal

For the past 2 years, we have been conducting a phenological survey of the flowering plants of north central Florida. Naturally occurring, landscape, and nursery plants were all included in this survey. Olfactometer studies using both male and female *Aedes albopictus* were conducted against intact flowers of many different flowering plants. Many plants caused positive responses by our mosquitoes, but the 2 flowering plants which resulted in the best responses were the “butterfly bush” (*Buddleja davidii*) and golden rod (*Solidago* spp). Additional olfactometer studies were conducted with these 2 plant types using intact flowers, solvent extracts of whole flowers, and individual compounds/blends that were isolated and identified by gas chromatography/mass spectrometry. The results of these olfactometer studies will be presented.

61 Comparison of blood and nectar feeding by Colorado mountain *Aedes* mosquitoes at 3 different altitudes

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Three groups of 4 Metropolitan State College of Denver students conducted timed and coordinated interval catches of female *Aedes* mosquitoes attempting to feed on flowers and human bait during the last 2 h of daylight on 2 evenings in the Gore Range of the north central Colorado Rockies. Meadows at 3,280 m, 3,130 m and 2,940 m elevation were sampled. After reaching a peak in catch numbers at 40-60 min pre-scotophase, all mosquito activity dramatically ceased at the onset of scotophase. Biting and nectar feeding occurred in similar peaks, but nectar feeders represented less than 10% of the biting catch. Species diversity of both nectar and blood feeding mosquitoes decreased with increasing altitude: *Aedes hexodontus* was by far the predominant mosquito in all collections and it was the only species captured during an additional biting catch at 3,530 m. Also collected were *Ae. cataphylla*, *Ae. communis*, *Ae. excrucians*, *Ae. increptis*, and *Ae. pullatus*.

62 Response of female *Aedes aegypti* (L.) to polyvinyl chloride (PVC) to prevent oviposition in breeding sites

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Aedes aegypti is an important vector of dengue fever (DF). The *Ae. aegypti* egg is the stage most numerous of the cycle life. The egg has a chemically resistant chorion. Egg chorion pad keeps it wet and fixed in the breeding site. To date, *Ae. aegypti* eggs have been generally ignored as an object for control programs. Polyvinyl chloride (PVC) is a versatile polymer, which is inexpensive and durable. It is odorless, stable and inert, resistant to chemicals, and recyclable. This research was aimed at evaluating the response of *Ae. aegypti* to the properties of PVC acting over sticky exochorionic compound. Our rationale was that sticky exochorion substance would not stick upon smoother plastic surfaces. Under insectary conditions, gravid mosquito females were released and egg-laying containers with vinyl films were placed for 24 h, 5 repetitions were conducted. Results showed that most of the eggs (80%) were laid over the water surface, 10% were sunk, and the remaining 10% were glued onto the plastic film. Egg hatchings were checked for floating and sunken eggs the following days showing 100% mortality. Similarly, glued eggs dried out and the embryos were dead.

63 Seasonal variation and nocturnal biting patterns of *Aedes aegypti* (L) and *Aedes albopictus* (Skuse) vectors of dengue fever in northern Thailand

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Aedes aegypti (L) and *Aedes albopictus* (Skuse) are vectors that effectively transmit dengue fever and chikungunya in Thailand. Sweeping hand-net and aspirator were used to collect adult *Aedes* mosquitoes in urban and rural areas, Chiangmai, northern Thailand. Studies were conducted 2 d per evaluation from December 2009 - November 2010 during 0600-2300 h. Results showed that both *Ae. aegypti* and *Ae. albopictus* were found at higher densities in rural area than in urban area, particularly the latter species was 45 times higher. Seasonal prevalence and biting pattern of these 2 species differed in both areas: *Ae. aegypti* were found most abundant in hot dry- and wet-season in rural and urban areas; it had wide range of biting time (06.00-23.00 h) with distinct peak at 09.00-12.00 h; *Ae. albopictus* showed a distinct peak at 1500-1800 h. Moreover, *Ae. aegypti* collected in rural area showed greater nocturnal biting pattern than *Ae. albopictus*.

64 Pharmacological studies of odorant receptors in mosquitoes reveal strategies for improvement of repellents
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Pharmacological studies of neuronal odorant receptor (OR) modulation by insect repellents is an emerging field with potential practical application for the development of novel compounds with improved activities for human protection. We show that DEET and IR3535 behave as insurmountable antagonists of ORs, and that modulation of OR activity is not restricted to antagonism and agonism, but also includes synergism. This knowledge of the molecular mechanisms underlying OR blockade, activation, and hyperactivation will be fundamental to the development of novel strategies for the control of mosquito behavior.

65 Ectosymbionts on Colorado mountain mosquitoes: Orchid pollinia and larval water mites on biting *Aedes*
Michelle L. Wiegert, mwiegert@mscd.edu, Scott Hill and Robert G. Hancock

In late July following a winter of record snowfall, biting catches of *Aedes* spp. mosquitoes were made in subalpine meadows at different elevations in an east-facing mountain drainage in north central Colorado. Captured females were frequently found with large stalked pollinia from bog orchids in the genus *Habenaria* attached to their eyes and/or bright red larval mites (likely *Arrenurus* spp.) attached to their thoracies. Collections were made at 4 elevations at sites ranging from 2,940 m to 3,530 m. At each higher site, the distance to and relative amount of boggy terrain decreased with increasing elevation. Preliminary results indicate pollinia abundance to be less than 2% with no clear relationships between elevation and pollinia abundance or mosquito species and pollinia abundance. Mite abundance and prevalence were considerably higher than other reported values from similar areas in the US Rocky Mountains as they exceeded 10% and 13%, respectively. The impacts of sustained and high water flow in the drainage due to snowmelt is discussed.

66 Species composition of the mosquito fauna of western Uganda
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The mosquito species composition for several locations in Uganda was described during routine arboviral surveillance and outbreak investigations from the mid-1930s to the early 1970s. However, civil instabilities in the 1970s and 1980s halted routine arboviral disease investigations and mosquito species records in Uganda have not been updated for more than 40 yr. During recent arboviral surveillance and zoonotic disease investigations in western Uganda conducted by Uganda Virus Research Institute and the US Centers for Disease Control and Prevention (CDC), mosquitoes were collected in 5 locations in western Uganda: Sempaya, in Semliki Forest, Kibale Forest, Bwindi Impenetrable Forest, and Mweya and Maramagambo Forest in Queen Elizabeth National Park. Seventy-three species were identified in Sempaya including 5 species described in Bundibugyo District for the first time: *Aedes* (*Stegomyia*) *aegypti formosus* (Walker), *Ae.* (*Stegomyia*) *metallicus* (Edwards), *Anopheles* (*Cellia*) *rivulorum* Leeson, *Uranotaenia* (*Uranotaenia*) *chorleyi* Edwards, and *Ur.* (*Uranotaenia*) *pallidocephala* Theobald. Twenty-eight mosquito species were identified in Kibale Forest, 41 in Bwindi Impenetrable Forest, 36 in Mweya, and 51 in Maramagambo Forest. This is the first description of the mosquito fauna for these 4 locations. Mosquito species composition and the implication for arboviral transmission for these 5 locations will be discussed.

67 Mechanisms of mosquito larvae and pupae mortality induced by Acoustic larvicide© treatments
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Acoustic larvicide© was discovered and patented by New Mountain Innovations. Larval death occurs when sound energy of sufficient power is introduced into the water habitat of any species of mosquito larvae at the resonant frequency of its dorsal tracheal trunk, that trunk will rupture, and the larvae will immediately or eventually expire. The subsequent interaction of the ruptured trunk and the migration of the air cause various types of trauma to tissues and organs. This paper will discuss the results of damage to various tissue types and how it is expressed in both larvae and pupae. Instantaneous death occurs when the applied frequency directly matches the resonance of the trunk and is of sufficient force to cause massive trauma to the point where the cuticle ruptures allowing gas to escape, the larvae becomes negatively buoyant, sinks, and drowns. The other mechanisms are more complex and communicate through subsequent instars displaying different manifestations which this presentation will cover in detail.

Latin American Symposium II

68 *Aedes aegypti* pupal indices in premises and public spaces during wet and dry season in Girardot, Colombia
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Girardot is a tourist and dengue endemic city in Colombia. We analyzed *Aedes aegypti* pupal indices in premises and public spaces during a wet and dry season. From 20 randomly selected clusters, all water containers in 1,944 premises and 124 public places were inspected. The number of pupae was estimated using the sweeping method. The pupae per person index (PPI) and the pupae per hectare index (PPH) were calculated. The most productive pupal collection sites were domestic water containers during both in the wet (93.6%) and dry (97.6%) seasons, while public spaces provided only 6.4% and 2.4% in each season, respectively. At the premise level, the most productive containers were low tanks (water containers >20 L) used for cloth washing purposes; wet=79% and dry=75% of the total of pupae. In low and high, large water tanks used for water storage, an increase in the number of pupae was observed between the wet (8.7%) and dry season (22.4%). Vector control measures should be directed to intervene and control large water containers used for washing clothing as well as low and high water containers during dry season.

69 Entering and exiting preferences of *Lutzomyia longiflocosa* in rural houses of the Sub-Andean region of Colombia

Olga L. Cabrera, olgalucabrera@yahoo.com, Erika Santamaria and Raul Pardo

Lutzomyia longiflocosa is the most probable vector involved in the major epidemics of cutaneous leishmaniasis recorded in the Sub-Andean region of Colombia. The aim of this study was to identify the entering and exiting preferences of this sand fly species in houses. Two experiments were designed and conducted. To determine entering preferences (Experiment I), collection methods were set up in the 2 types of openings found in rural houses of the region with sticky traps in eaves outside the house and big cages inside rooms to cover small gaps of doors and windows. The proportion of sand flies entering each type of opening from 2100 - 0100 hr was recorded. For exiting preferences (Experiment II), the same collection methods as used in Experiment I were used but with the sticky traps inside the rooms and the big cages outside. Groups of wild *Lu. longiflocosa* females (mean= 70 sand flies), previously marked with fluorescent powders and fed on a hamster, were released inside the rooms. The proportion of marked females found in the traps was recorded during the same period of time used in the first experiment. Two hundred *Lu. longiflocosa* females were caught in Experiment I. Most females entered through openings in the eaves (70%) and it was an apparent they preferred to enter the eaves. In Experiment II, 51% of 415 marked females were recovered. Results were consistent with those of Experiment I suggesting that *Lu. longiflocosa* females enter and exit houses mainly through the eaves.

70 Entomological surveillance for the prevention and control of malaria in the Amerindian Territory of the Caura and Erebato River basins, Bolivar State, Venezuela

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Entomological surveillance in remote areas carried out by locally trained people is a major contribution to the national malaria control program, reducing costs and increasing coverage. Two villages (Santa Maria de Erebato and Boca de Nichare) were selected to conduct the surveillance based on malaria prevalence, presence of a health post and satellite internet access. Two members of each village were trained on mosquito trapping methods, handling and identification of mosquitoes at subfamily level, preservation, data recording and posting. Training and collections started in May 2009 and the Mosquito Magnet™ trap was used to collect mosquitoes monthly from 1730 to 0630 h. Every 4 hrs, the trap was checked and the net with trapped mosquitoes was removed. Field supervision was carried out twice a year and regular supervision was done via email and Skype. In Santa Maria de Erebato, the most abundant species collected was *Culex quinquefasciatus*. *Anopheles nuneztovari* was collected once. In Boca de Nichare, *An. darlingi* was the most abundant species (85.5%) collected followed by *An. oswaldoi*, *An. nuneztovari*, *An. braziliensis* and *An. benarrochi*. *Culex* (Melanoconion) sp., *Aedes scapularis* and *Mansonia pseudotitillans* were also collected. *Anopheles darlingi*, *An. nuneztovari* and *An. oswaldoi* were active throughout the night, and mosquitoes were more abundant during the rainy season.

71 Morphological and molecular identification of *Anopheles* (*Kerteszia*) present in two endemic foci of malaria in Colombia

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Some *Anopheles* species in the subgenus *Kerteszia* are known as "bromeliad malaria" vectors because the immatures of this subgenus are found almost exclusively in bromeliads. In Colombia, although 7 *Kerteszia* species have been reported, doubts remain regarding their distribution and classification. The *Kerteszia* subgenus is distinguished from other subgenera by distinctive morphological characteristics, but within this subgenus we are hampered by the absence of morphological keys, errors in some species descriptions, and the existence of cryptic species. The aim of this study was to establish, based on morphological characters and mDNA (COI) and rDNA (ITS2) molecular markers, which *Kerteszia* species were present in 2 endemic foci of malaria in the Departments of Tolima and Nariño, Colombia. Five individuals from 6 localities were sequenced for the 2 genes. The molecular analysis, NJ-K2P tree and distance matrices, revealed *An. pholidotus* from Tolima as a single haplogroup, distinct from *An. boliviensis*, which exhibited 2 haplogroups (lineages), *An. boliviensis* A and B. These lineages were indistinguishable by morphological diagnostic characters. In the Department of Nariño, *An. neivai* was found as a single haplogroup, despite having differences in the spots of vein R4+5. These results confirm the presence of cryptic species in the *Anopheles* subgenus *Kerteszia* and indicate the need for further studies into their biology and possible morphological variation.

72 Diversity and co-occurrence of phlebotomine sand flies (Diptera: Psychodidae) and potential reservoir hosts for *Leishmania* sp. (Kinetoplastida: Trypanosomatidae) in northern Mexico

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Sand flies are the vectors of *Leishmania* spp., which in turn are maintained in the wild as a zoonosis requiring a mammalian reservoir host. Despite the medical importance of studies aimed to assess co-occurrence of 3 biotic components (vectors, parasites and hosts), to date there have been no studies addressing this phenomenon in northern Mexico. There are few reports of cases of leishmaniasis, sand fly vectors, and/or reservoir hosts, and these are geographically, as well as temporally, isolated. The aim of this study was to conduct a survey of sand fly species and their co-occurrence with reservoir hosts in 6 selected locations of the northern Mexican states of Nuevo León and Tamaulipas. Sampling was conducted from April to September 2010. Sand flies were captured using CDC light traps and mammals were trapped in Sherman traps. A total of 561 sand flies of 12 species were collected in all 6 locations, with *Lutzomyia shannoni* being the most abundant species. Rodents were represented by 78 individuals of nine species, *Sigmodon hispidus* being the most common. Analyses of alfa-

diversity (species richness, dominance and heterogeneity) and beta- diversity (similarity) were calculated among locations. In addition, the co-occurrence of vectors and *Leishmani*a reservoirs was computed.

73 Efficacy of long-lasting insecticide treated nets against *Lutzomyia longiflocosa* (Diptera: Psychodidae), species involved as vector of cutaneous leishmaniasis in the Colombian Andes

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Long-lasting insecticide treated nets (LLINs) are a promising method for the indoor control of leishmaniasis. Nevertheless, few studies have been conducted on the efficacy and effectiveness of these nets on sand flies. This study evaluated the residual lethal effect of 3 LLINs (Interceptor, Netprotect and Permanet) unwashed and after 10 washes on *Lutzomyia longiflocosa*, a species involved in the transmission of cutaneous leishmaniasis in the sub-andean region of Colombia. The washing method of the LLINs was the "traditional washing" method in the study region where nets are widely used. Groups of 20 - 30 wild, unfed *Lu. longiflocosa* females were exposed for 3 min to each treatment using the World Health Organization method. The test was replicated 5 times. Mortality, knock down (KD), and lost legs were recorded. All of the unwashed LLINs caused mortality higher than 80%. After 10 washes, the Permanet treatment caused the highest mortality (96%). The Netprotect and Interceptor produced less than 80% mortality. KD effect in unwashed LLINs was higher for Permanet (79%) and Netprotect (77.6%) treatments. After 10 washes, the KD effect was reduced slightly for the Permanet and Netprotect treatments and increased for the Interceptor (unwashed= 67%, 10 washes= 78). Females exposed to all unwashed LLINs lost a higher number of legs compared with the control. This effect did not change after 10 washes. Autonomy as a possible explanation for this effect is discussed.

74 Update of knockdown resistance (1014) frequencies in *Culex quinquefasciatus* from Nuevo León, México

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The knockdown resistance (Kdr) target site for pyrethroids and DDT is linked to point mutations in the sequence of the para-type voltage-dependent sodium channel gene. This has been reported in many insect species and is characterized by a reduced sensibility of the insect's nervous system to these compounds. *Culex quinquefasciatus* is an important vector of different encephalitis viruses. We analyzed strains of *Cx. quinquefasciatus* (2011 and 2012) from Nuevo León State, México. In this study, using polymerase chain reaction, a molecular tool based on test genomic DNA of each mosquito sample, we found that the Kdr mutation (leucine to phenylalanine at position 1,014) was present in some samples. The current emphasis in resistance research is on the early detection of the molecular mechanisms of resistance for the rational resistance management, with a view toward controlling the development and spread of resistant vector populations through better design of control programs using insecticides.

75 Recycling of nematodes, *Romanomermis culicivorax*, in larval sites of *Culex quinquefasciatus*

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The establishment of post-parasitic nematodes in larval sites of mosquitoes is an alternative application method to guarantee long-term control of larval mosquito populations. Four larval sites for *Culex quinquefasciatus* were established with a substrate of 10 cm of gravel (pebbles) as well as 2 additional larval sites with a soil substrate. Two hundred post-parasitic nematodes (100 males and 100 females) were applied to 2 gravel sites and 100 nematodes (50 males and 50 females) were added in the other 4 sites (2 with gravel and 2 with soil). Nineteen d after the addition of nematodes, 500 mosquito larvae were added to each of the larval sites as well as 20 larvae in a sentinel trap to assess the potential activity of nematodes. After 5 d the trap was recovered and the mosquito larvae were dissected to establish prevalence and intensity of infection. During the first 100 d, mosquito larvae were added to the sites in sentinel traps weekly. After 100 d the mosquitoes were added and evaluated every 2 wk. After 250 d the interval was increased to 3 wk. The recycling study continued for 468 d during which time the prevalence ranged from 30 to 45%. The major intensity of infection was observed in larval sites with a gravel substrate.

76 Laboratory and field evaluation of the larvicide oil, Banole W, against the malaria vector *Anopheles pseudopunctipennis* in Monterrey, northeastern Mexico

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Malaria still poses a public health risk in Mexico. Larviciding of anopheline breeding sites with liquid 50% temephos and *Bacillus thuringiensis* var. *israelensis* are the currently used mosquito control measures. *Anopheles pseudopunctipennis* is the main *Plasmodium* vector in Mexico. This study was aimed to determine the laboratory and field effectiveness of the larvicide oil, Banole W. Mixed, field-collected larval populations were tested in the laboratory with the following larvicide doses: 0.25, 0.5, and 1.5 ml/m^2. Field trials with same doses were conducted in cages placed in the river bank using mixtures of all *An. pseudopunctipennis* instars. Daily records for mortality of percent emergence inhibition were recorded for 4 wk. Laboratory results showed 99.0% mortality up to day 2 with 1.5 ml/m^2; 98.7% and 96.7% mortalities were recorded up to 8 d with doses 0.5 and 0.25 ml/m^2, respectively. Field results showed 100% mortality after 2 d with doses 1.5 and after 3 d dose 0.5 ml/m^2, respectively. Banole W showed promising results; however, long-term studies are needed to better determine its efficacy in the field.

77 Laboratory and field evaluation of the larvicide oil, Banole W, against the West Nile virus vector *Culex quinquefasciatus* in Monterrey, northeastern Mexico

Ewry Arvid M. Zarate-Nahon, saro84@hotmail.com, Rocio Ramirez-Jimenez, Rosa Maria M. Sanchez-Casas, Luis A. Ibarra-Juarez, Esteban M. Diaz-Gonzalez, Jorge J. Rodriguez-Rojas, Wilfredo M. Arque-Chunga, Eduardo A. Rebollar-Téllez and Ildefonso Fernandez-Salas

Since its detection in Mexico in 2002, West Nile virus has been maintained at endemic levels in the country. However, in 2009, a human death was recorded in Monterrey city, supporting the suspicion that this virus is present but undetected since the Nuevo Leon State Health Department does not have an active surveillance program. Abundant *Culex quinquefasciatus* breeding sites are found in urban settlements. However, granular temephos 1% to control larval populations are not reliable for these polluted breeding sites. This study aimed at determining the effectiveness of the larvicide oil Banole W to control immature populations of *Cx. quinquefasciatus*. Young and old laboratory-reared larvae were tested in the laboratory using the following Banole W larvicide oil doses: 0.25, 0.5, and 1.5 ml/m^2. Field trials treating mixed larval stage populations and with same doses were conducted in discarded tires in backyards. Daily records for mortality and percent emergence inhibition were recorded for 4 wk. Laboratory results for younger larvae exhibited 73% and 67% mortality up to day 8 when using 0.5 and 0.25 ml/m^2, respectively. Older larvae had 95% mortality up to 9 d with a dose of 1.5 ml/m^2. Field results showed 100% mortality after 9 d with dose 1.5 ml/m^2. Mortality of 100% was also recorded with dose 0.5 and 0.25 on days 18 and 24, respectively.

78 Food source identification of *Culex quinquefasciatus* by molecular characterization of Gen Cytb

Elizabeth Ruiz, Â´ruizmarvez@gmail.com, Nubia E. Matta, Ligia I. Moncada and Fredy A. Colorado

Recognizing host-preferences of hematophagous insects is important to the understanding of their role in the transmission of insect-borne pathogens. *Culex quinquefasciatus* is an ideal biological model because it is an ornithophilic vector of arboviral and parasitic pathogens. In Colombia, 12 West Nile virus-positive equines were detected in a serological survey conducted in Cordoba and Sucre Departments. The aim of this project was to analyze the variables for the standardization of technique of gene amplification cytochrome b (Cytb), in order to identify the blood meal source of *Cx. quinquefasciatus* in a population of Central Marengo-Agricultural University of Colombia. The DNA was from the abdomen of wild caught mosquitoes, and the gene regions amplified by Cytb were sequenced. Mosquitoes fed on birds [*Gallus gallus* (50%)]; mammals [*Sus scrofa* (34%), *Bos taurus* (7%), *Homo sapiens* (7%)]; and reptiles [*Hemidactylus* spp. (2%)]. These results suggest that *Cx. quinquefasciatus* is a generalist in its feeding behavior and may have an important role in the transmission of leucocytozoon blood parasites detected in *Gallus gallus*. The methodology standardized and practiced in this research is relevant because it can be utilized for studies of vectorial incrimination of other blood-sucking insects.

Progress and Products of the Deployed War-fighter Protection Program II

79 Transferring vector equipment testing results into a smart phone application

Wesley Hoffmann, clint.hoffmann@ars.usda.gov, Bradley K. Fritz, Todd W. Walker and Muhammad Farooq

The USDA-ARS-Aerial Application Technology Project and the US Navy's Naval Entomology Center of Excellence have done extensive testing of over 80 different hand-held, truck-mounted, backpack, and thermal spraying equipment designed to spray material for controlling insects that vector human diseases. While the results from all these tests have been published in the *Journal* of the AMCA, the information is spread across several publications making finding the exact information needed for a particular sprayer applying a particular product at specific operational levels difficult at best. To address this issue, a smartphone application (app) for the iPhone, iPad, and Android platforms was developed to allow users to access all the test results through a simple, searchable database. The app guides the user through a process by which the user specifies a particular nozzle or sprayer, and operating conditions, and spray material then determines the expected droplet size for that application. User feedback on the usability of the apps will, within the next 12 mo., be analyzed and will drive appropriate updates. The goal of these and of any future updates will be to assure that the apps continue to effectively serve the many and varied needs of the user communities.

80 Etofenprox for flying vector control

Mark Breidenbaugh, mbreiden@kent.edu and Bill Reynolds

A developmental grant to industry from the Deployed War-Fighter Protection Program in 2009 lent support to EPA registration of the new mosquito adulticide etofenprox (Zenivex). The extremely low mammalian toxicity, no need for a synergist, and overall new chemistry are a few of the reasons for military interest in this public health pesticide. Efficacy testing to support aerial applications was conducted at several locations. For example, in Williston, ND, a single application of etofenprox at mid-label rate was made in 2009 over 24,000 acres to control mosquitoes using an Air Force C-130 modified for aerial spraying. Pre-spray landing counts were recorded at 100+ mosquitoes/per minute and NJ light trap collections were over 300 females in 12 h. Post-spray, caged mosquitoes exhibited a 95% mortality rate within 24 h. Additionally, 2-h post-spray landing rates dropped to 0. Applications with other aircraft types were made in Florida and Utah with similar results and are discussed. The use of Zenivex would likely expand if an "all crops tolerance" were added to the product label.

81 Rodent baits for controlling phlebotomine sand flies against leishmaniases

Richard Poche, richard@genesislabs.com , Diana Perry and David Poche

Systemic insecticides have proven successful for controlling ectoparasites on rodents, including sand flies. Research over the past 15 years at Genesis has evaluated 20 potential compounds of potential interest for killing adult and larval sand flies,

such as *Phlebotomus papatasi* and *P. argentipes*, vectors of leishmanias in the Old World. The insecticides imidacloprid and fipronil have proved to be most effective against sand flies by this delivery method. However, the regulatory challenge is obtaining EPA approval for extending label claims for products already registered for vectors such as ticks and fleas, to include control of sand fly vectors of leishmanias of medical importance OCONUS (outside continental USA). During 2011, data were submitted to the EPA in an attempt to achieve that goal, for rodent bait with imidacloprid to become available to the US Department of Defense for use against Old World sand fly vectors of leishmaniases. Although research is the cornerstone to product development, the regulatory channels of making bait available for use are equally challenging.

82 Florida Fly Trap: from invention to deployment for filth fly control

Joseph Diclaro, joseph.diclaro@med.navy.mil**,** Jeff Hertz, Roberto Pereira and Philip Koehler

Combinations of commercial fly baits, traps, and insecticidal cords were evaluated against the house fly, *Musca domestica*. Among the most promising devices, Trap n' Toss™ fly traps with a 46-cm cord (6 mm diam) dipped in 2.5% imidacloprid and looped around the trap killed 70-90% of flies at 24-48 h, while bait-treated fly cords alone caused similar fly mortality rates and eliminated fly annoyance. To improve trap performance, *M. domestica* responses to colors and patterns were evaluated in light tunnel assays, and by electroretinograms (ERG) of the fly's vision. Compound eye and ocellar ERG responses to reflected light were similar, mostly to white and blue followed by yellow, red, green, and black. Behavioral assays showed that flies were attracted to white and blue light but were repelled by yellow. Addition of black line patterns enhanced the attractiveness of blue visual targets, whereas yellow lines decreased attractiveness. Three blue prototypes visually attractive to flies (box, triangle, pentagon-shaped with black cord treated with imidocloprid bait) were evaluated in field cages; each killed >70% of flies in 24 h. Over a period of 2 mo, the blue device with treated black cord killed >95% of 40,000 flies released in a cage, without decreasing efficacy. This system has been patented, and the blue device is being produced for military field evaluation and commercialization.

GPS/GIS

83 GIS solutions for mosquito control operations

Ryan Pierson, ryan@elecdata.com and Chad Minteer

New enterprise GIS technology and traditional desktop GIS technology are evolving to meet the needs of a rapidly growing pool of users. As this GIS technology continues to be enhanced, the sharing and updating of GIS data is becoming much simpler to manage and easier to use. In mosquito control, creating and sharing GIS data related to pesticide use, surveillance activities, and other field operations can be very powerful, yet very simple. This presentation will demonstrate how enterprise GIS technology and desktop GIS technology can help mosquito control agencies operate more efficiently, while maintaining highly accurate maps and recording field activities such as pesticide use. Methods for sharing and updating the GIS data within the mosquito control organization will be highlighted. Appropriate distribution of select GIS data to the public using these new GIS tools will also be discussed. Never has it been simpler to create, maintain, and share maps and GIS data.

84 Sentinel™ GIS product updates and enhancements

Ryan Pierson, ryan@elecdata.com and Linda Dean

Sentinel™ GIS software, designed specifically for mosquito control operations, provides field and office software tools to record mosquito control activities, create associated maps, and generate standard reports. Built upon industry-standard Esri® GIS technology, these tools meet many of the new NPDES record-keeping and reporting requirements. This presentation will provide information about Sentinel™ GIS software product enhancements and updates that have been completed, or are nearing completion. This presentation will also provide a case study that describes how using Sentinel™ GIS software increased productivity and efficiency, thus reducing operational costs, for one local government entity.

85 Selection and development of a GIS solution (MapVision) for the Tangipahoa Mosquito Abatement District

Dennis Wallette, dennis@tangimosquito.org

This presentation describes the criteria used in the selection of a new geospatial information system (GIS) by the Tangipahoa Mosquito Abatement District. The motivations and rationale behind setting the various criteria used in the selection process are discussed, as are the goals and potential uses by the District for the finished product. The project coordination between the District and Leading Edge Associates is enhanced through the use of a project management (PM) process that includes components such as on-site visits, weekly online meetings via the web, emails, and a web-based error reporting system. The design process and timeline are discussed, and final product will be demonstrated.

86 Implementation and analysis of a real-time NEXRAD-based precipitation mapping system in Indian River County, FL

Gregory Ross, gkross@ufl.edu

In 2008, the Indian River Mosquito Control District in Indian River County, FL designed and implemented a GIS-based, real-time precipitation mapping system. The system uses data from the freely available NWS Precipitation Analysis web service to map district-wide precipitation totals daily, with the ability to produce real-time maps on an hourly basis. The radar data maps, in conjunction with locally-acquired rain gauge data, are used by the district larval and adult surveillance programs to enable timely and accurate surveillance routing and treatment efforts. An analysis was also performed to determine differences and similarities between the radar-based data and ground-based rain gauge data.

87 MapVision web-based technology for vector control operations
Mike Reynolds, mreynolds@leateam.com and Bill Reynolds

MapVision® is a web-based GIS and GPS mapping system designed to consolidate multi-source surveillance data in order to develop and deploy strategic larviciding and adulticiding response applications. In real-time or near real-time, surveillance data from landing rate counts, trap counts, larval inspections, and citizen complaints are projected over satellite and animated maps to provide management a broad vision of the adult and larval mosquito populations. From the surveillance data, treatment response strategies are developed and deployed for all ground and aerial larviciding and adulticiding assets, and adulticiding response applications. This is accomplished via real-time GIS and GPS technologies. MapVision® offers 11 customizable modules to meet client needs.

88 Satellite imagery and spectrum analysis for potential mosquito breeding source identification and operational deployment

Brian Reisinger, breisinger@wvmvcd.org**,** Min-Lee Cheng and Tianyun Steven Su

In 2010, West Valley Mosquito and Vector Control District contracted aWhere, a company that specializes in satellite imagery analysis. aWhere has created a web-based image database called MADIS (Mosquito Abatement Decision Information System). The purpose is to use satellite imagery and light spectrum analysis to identify, categorize, and deploy staff for the purpose of source reduction. Several member districts of the Mosquito and Vector Control Association of California are participating in the pilot program in 2011, by testing the capabilities of the system and the information it provides. The initial effort has concentrated on mosquito breeding sources only.

89 Marsh mosquito mayhem made easy: use of Geo Pro in Cameron Parish, LA
Josh Hightower, mosketer1@camtel.net

Cameron Parish Mosquito Control began using Geo Pro data entry program this year. We are able to enter landing rates, trap counts, treatments, service requests, and larval surveillance in real time with the use of Juno Trimble SC hand-held computers and portable wireless hotspot cards issued to our inspectors. We are also able to upload all spray truck missions from our Monitor 4 GPS equipment showing a map of where they sprayed and all details of the mission. Airplanes equipped with Adapco GPS systems can also be uploaded. Our airplane is not equipped with this system, so all aerial data is entered by hand. All data is sent to our Geo Pro website which has unlimited storage and is easy to use. It allows us to find current or historical data very easily and allows the director to check landing rates and trap numbers as they are entered in real time from any computer with internet access. The use of Geo Pro has reduced paper work, made our record keeping more complete and accurate, and has helped us make adulticiding decisions much earlier in the day than we did in the past.

New Product Trials

90 ORIGIN 3-6-9 as a potential repellent in *Aedes albopictus*
Richard Duhrkopf, rick_duhrkopf@baylor.edu

ORIGIN 3-6-9 is a combination of amino acids and fatty acids being investigated for its effect on mosquitoes. Cages of adult *Aedes albopictus* were used to assess the effect of the presence of this chemical on the skin in attraction and blood feeding of females. In cages where the exposed skin had ORIGIN 3-6-9 sprayed on it, fewer female mosquitoes landed and probed and none fed when compared with females subjected to skin without the compound.

91 The effect of contact with ORIGIN 3-6-9 in *Aedes albopictus*
Alix Chen, Alix_Chen@baylor.edu

The purpose of the experiment was to study the effects of exposure of mosquitoes to ORIGIN 3-6-9. Filter paper pieces saturated with various concentrations of a stock solution were put at the bottom of small cages of newly emerged adult *Aedes albopictus*. There were significant differences between the control and experimental. Adults coming into contact with the solution died within minutes. The data confirms that the product is an effective contact poison.

92 AquaDuet™ - An advanced water-based formulation proving you can have it both ways

George Wojcik, WojcikG@portsmouthva.gov**,** Jacob Hartle, Derek Drews and Grifith S. Lizarraga

Change takes time…and a reason. For Portsmouth Mosquito Control, that reason was cleaner handling and performance. When AquaDuet became registered in 2011, they were quick to jump at the chance to work with a "cleaner" product. Portsmouth Mosquito Control evaluated 3 rates of AquaDuet under a mosquito caged trial with locally collected species. AquaDuet was diluted into a 1 to 1 product-water ratio to produce a bigger cloud that can carry more droplets to the targeted area. This presentation will highlight the trial results of AquaDuet via ground ULV.

93 The effect of ingestion of ORIGIN 3-6-9™ in *Aedes albopictus*
Richard Duhrkopf, rick_duhrkopf@baylor.edu

ORIGIN 3-6-9 is a combination of amino acids and fatty acids being investigated for its effect on mosquitoes. Equal numbers of male and female adult *Aedes albopictus* were put into small cages. Sucrose was added to various concentrations of a stock ORIGIN 3-6-9 solution to produce a 5% sucrose solution available for the adults to feed on. Mortality was assessed daily for a 7-d period. Adults in cages subjected to concentrations ranging from full strength to 1:10 showed significant mortality within 48 h. Adults in cages with a concentration of 1:100 showed little mortality.

94 Larvicidal potential of ORIGIN 3-6-9™ in *Aedes albopictus*
Richard Duhrkopf, rick_duhrkopf@baylor.edu

ORIGIN 3-6-9 is a combination of amino acids and fatty acids being investigated for its effect on mosquitoes. *Aedes albopictus* larvae were put into 50 ml water with food and various concentrations of ORIGIN 3-6-9. Mortality was assessed daily for a 7-d period. Mortality at concentrations from 1:50 to 1:500 was total within 24 h. At concentrations less than 1:500, larvae survived.

95 TrapTech Mosquito Lure™ added to CDC miniature light trap greatly enhances the catch of *Aedes japonicus*
John F. Anderson, john.f.anderson@ct.gov, Susan McKnight and Francis Ferrandino

The relatively recently introduced and established mammalian and human biting mosquito from Asia, *Aedes japonicus*, is increasingly becoming abundant in parts of Connecticut and elsewhere. To improve upon the trap catches in CDC miniature light traps baited with carbon dioxide, we tested various baits in CDC traps placed in a wooded area in Windsor, CT, and compared numbers of *Ae. japonicus* captured in these and other traps. In 2010, significantly more *Ae. japonicus* were collected in CDC traps containing r-1-Octen-3-ol/ammonium bicarbonate (TrapTech Mosquito Lure, Bedoukian Research, Inc., Danbury, CT) compared to traps baited with carbon dioxide, acetone/ethanol/L-lactic acid/dimethydisulfide, L-lactic acid/r-1-octen-3-ol/propionic acid/butyric acid/valeric acid, ammonium lactate, and no bait. The use of segregating traps set at 2-h intervals baited with the TrapTech revealed *Ae. japonicus* to be attracted to traps for the 2-h period beginning at sunset through the next 3, 2-h intervals. In 2011, larger numbers of *Ae. japonicus* were captured in CDC traps baited with carbon dioxide and the TrapTech than in CDC traps baited with TrapTech only, carbon dioxide only, or without bait as well as gravid trap baited with hay infusion water and the Sentinel Mosquito Trap baited with BG lure. In summary, CDC miniature light traps baited with TrapTech Mosquito Lure and carbon dioxide were superior in catching *Ae. japonicus compared to all* other traps tested.

96 Efficacy of a new slow-release larvicide containing the chitin synthesis inhibitor novaluron
Robert Dupree, rob.dupree@tumaini.ca and Ken Mickleson

Field trials were conducted in 2010 at 5 locations in the United States and Canada to assess the efficacy of a slow-release larvicide containing novaluron. Results indicate excellent product performance with 100% inhibition of emergence (IE) for 90 d at test sites in Canada and Wisconsin. One hundred percent IE was also observed for up to 130 d at test sites in Florida and Georgia.

Risk Assessment Symposium I

97 Opening remarks: Dynamic arboviral risk assessment, mosquito control and environmental health
Alice Anderson, andersonal@ecu.edu

Risk analysis is not a concept that intuitively makes sense. There have been many attempts to simplify this extremely complex concept, yet the public generally wants an informed and practical assessment, not a simplified one when it comes to risk of vector borne disease to human health. This symposium is a collection of research reports for a variety of vector-virus systems that focuses on scientific discussion of some of the components involved in pathogen transmission by mosquitoes. The goal of these investigations and many others is to pick apart the threads that weave the level of risk in mosquito borne disease with a hope of improving risk assessment and prediction, targeting management practices, and protecting public health.

98 Can Horton hear the Whos? Scale in vector-borne disease
Cynthia Lord, clord@ufl.edu, Barry Alto, Sheri Anderson, Roxanne Connelly, Jonathan Day, Stephanie Richards, Chelsea Smartt and Walter J. Tabachnick

The epidemiology of vector-borne pathogens is affected by mechanisms and interactions at different scales, from individual level molecular processes to ecosystem interactions. This is of particular interest in the development of models to understand pathogen dynamics and in risk assessment. We illustrate this using a key aspect of vector-borne disease: transmission of the pathogen between vectors and vertebrate hosts. A model of mosquito infection is expanded to illustrate the types of studies needed. Each mosquito has a number of virions needed for infection sampled from a gamma distribution and ingests a number of virions in its blood meal sampled from a separate gamma distribution. The parameters of the gamma distributions affected the number of infectious mosquitoes and the shape of the response curve. Assumptions about individual level characteristics (parameters) affected population level characteristics (number of infectious mosquitoes). Vector competence of different mosquito species is a component of risk assessment, and this demonstrates that the interactions between scales will affect risk assessment and should be investigated further. Although complex, it is critical that interactions at different levels of scale are understood in order to fully integrate laboratory or small-scale field studies into an improved understanding of disease transmission at all scales, with the ultimate goal of improving risk prediction and reducing vector-borne disease.

99 Targeting at-risk populations for public health interventions
Andrew Haddow, adhaddow@gmail.com and Agricola Odoi

Continued reductions in the yearly budgets of public health agencies has underscored the need to develop strategies to target those populations at the highest risk for developing arboviral infections with prevention and education efforts. Our research has focused on the development of methodologies, using freely available software programs, to detect what populations are at high risk of developing La Crosse virus infection. We have used these tools at the national, state, county, and census tract levels to develop risk maps, detect hot-spots, determine the most appropriate spatial level to report disease, and recently to

explore the demographic and socioeconomic factors predictive for developing La Crosse virus infection in West Virginia. The use of such tools and methodologies will allow targeted interventions by public health officials to reduce transmission of a variety of vector-borne disease causing pathogens.

100 La Crosse encephalitis virus risk in western North Carolina

Brian Byrd, bdbyrd@wcu.edu**,** Theo Tamini, Laura White, Alan Goggins, Charles Sither and Gideon Wasserberg

La Crosse encephalitis virus (LACV) is the most common human arboviral disease in North Carolina. Although the incidence of disease appears to be increasing, the specific factors that influence disease emergence remain sufficiently unpredictable. Here we discuss the results of an ecological study conducted in 2010 to evaluate if and how anthropogenic disturbance affects vector abundance and gonotrophic status within the LACV sylvatic system. In this study we compared entomologic indices between historical LACV case residences and nearby forest patch habitats. In sites characterized by low numbers of artificial containers (low disturbance), the total mosquito abundance was lower in the peridomestic sites as compared with the forest habitat. However, in sites characterized by a high number of artificial containers (high disturbance) mosquitoes were more abundant in the peridomestic habitat. Similarly, the proportion of gonotrophically active mosquitoes was higher in the highly disturbed peridomestic habitat. These results suggest that local scale anthropogenic impacts may influence LACV transmission. This study and relevant surveillance data are discussed in the context of public health risk assessment and management.

101 Mosquitoes and people: Dengue virus risk assessment in south Texas

Christopher Vitek, vitekc@utpa.edu and Frank Dirrigl

The prediction of risk factors that can influence disease transmission is critical for controlling outbreaks of vector-borne disease. The lower Rio Grande Valley is a subtropical chaparral habitat that borders Mexico and has sporadic reports of dengue virus (DENV). Despite similar environments and habitats, northern Mexico has a greater prevalence of DENV than the lower Rio Grande Valley. In the lower Rio Grande Valley, *Aedes aegypti* and *Ae. albopictus* may play prominent roles in the incidence of dengue fever. This study identified habitat preferences and abundance patterns of these 2 mosquito species in sites throughout the lower Rio Grande Valley. Public awareness of DENV and behavior influencing risk of exposure to potential vectors were also examined. Oviposition traps were used to collect mosquito eggs at trapping sites in the lower Rio Grande Valley. Eggs were hatched and larvae identified to determine the local prevalence of *Ae. aegypti* and *Ae. albopictus*. Guided surveys were conducted with residents in areas with a high density of mosquitoes to assess the potential risk of exposure to the vectors. These areas potentially hold a greater risk for the inhabitants that live or work nearby. Risk patterns were identified based on disease vector distribution, while human behavior did not show a clear association with mosquito activity. Additional research is planned for a long term analysis of dengue risk in the lower Rio Grande Valley.

Operations

102 A new invasion by *Aedes albopictus* in the San Gabriel Valley, Los Angeles County, CA

Kelly Middleton, kmiddleton@sgvmosquito.org**,** Tera Sorvillo, Angela Brisco, Melvin Cook and Kenn K. Fujioka

Aedes albopictus was detected in September 2011 within the San Gabriel Valley Mosquito and Vector Control District for the first time since 2001. A door-to-door survey uncovered a substantial population within a 1/4 mi radius of the initial identification. Here we discuss our effort to determine how widespread *Ae. albopictus* is distributed within our District, and our successes and failures at surveillance and control.

103 Helicopter crash: Emergency response and crisis management

Mark E. Smith, mmcd_mes@mmcd.org

In the past three years, the Metropolitan Mosquito Control District (MMCD) has established an emergency response plan in the event of a major accident or chemical spill. Simulated emergencies have been conducted to aid our staff in responding appropriately. This plan and staff training played a significant role in 2011 when an MMCD-contracted helicopter crashed into a suburban lake while conducting mosquito control applications. This crisis management training, along with support of the control material manufacturer, led to the successful handling of this emergency situation. Effective communication and transparency, during and after this incident, helped to protect MMCD's professional reputation and maintain trust of the citizens we serve.

104 Implementing "sustainability" into Clarke's service operation: Lessons learned

Michelle Selander, mselander@clarke.com

Having established sustainability goals for all business divisions, implementing changes into the Clarke service operation has been one of the most challenging. Changing the way we think, manage, and execute a traditional operational program into one that reduces environmental impact and waste while increasing efficiency and effectiveness has been a learning curve. In this presentation we will share our learning experience in our journey to be more sustainable.

105 Trapping surveillance at Beach Mosquito Control District

Dale Martin, martin_dale@comcast.net

Trapping is a very important part of controlling of adult mosquito populations. Beach Mosquito Control maintains a wide range of surveillance traps. These traps are divided into 3 basic categories: main, auxiliary, and research/study. The main traps are updraft/miniature light traps, canopy traps, and exit traps. Auxiliary traps include gravid traps, resting boxes, and landing rates. Research/study traps are perimeter traps for barrier treatment and a rotary trap. Planned studies may include a second line of traps farther inland. The use of establishing the setup for the different time intervals are operated and maintained on a daily basis. Catch reports are maintained daily for both pre- and post-treatments. From the trappings reports,

the District has developed an action plan. This plan goes from 'low', no-action to 'extreme', aerial spraying. Determining the number of mosquitoes and species caught during a specific time period helps to assist with determining the best time to execute a mission and type of product to be used.

106 Development of aerial and ground larviciding techniques utilizing a 3-D spray model by DropVision AG® for control of *Aedes sierrensis* with VectoBac® WDG

Valkyrie P. Kimball, piper@msmosquito.com**,** Bill Reynolds and Stacy Bearden

Historically, treatment and management of *Aedes sierrensis* mosquito populations have been accomplished using ULV adulticides to control this mosquito species in oak woodland habitats throughout California. Over the past few years, area-wide larviciding methods have been developed using VectoBac® WDG for control of other *Aedes* container species such as *Aedes aegypti* and *Ae. albopictus* and it is hypothesized that similar treatment methods might be efficacious against *Ae. sierrensis* larvae in treeholes. To accomplish this, several different application strategies were evaluated involving aerial and ground application equipment. Additionally, because of the rugged terrain and vertical habitat of the treehole canopy, it was essential to optimize droplet densities and volume deposition. This was achieved using DropVision AG® software by integrating a 3-dimensional spray model and introducing artificial containers for droplet collection to evaluate post application mortality of the treehole larvae.

107 Tracking mosquito hatch-offs from US Fish and Wildlife managed islands

Joel Jacobson, jjacobson@citrusmosquito.org and June Johnson

The US Fish and Wildlife Service only allows inspection and monitoring throughout their Refuge Islands along Citrus County Florida's Gulf coast. Larviciding and adulticiding are forbidden. Outer islands are accessed by airboat and/or helicopter. Once onsite, CO_2-enhanced CDC traps are set up to monitor adult mosquito populations. Dipping for larva in low areas and tidal zones is used to predict future hatch-offs. Landing rate counts are performed to document and quantify current infestations in an effort to illustrate how the hatch-offs directly affect coastal inhabited areas. We are currently experimenting with several combinations hoping to mark the larva, through the ingestion of fluorescent dyes, in a way that will also mark the adults. Several fluorescent colors are to be used to identify larvae from the different islands. If the process works it will be as simple as using a black light to determine which larvae were trapped and where the hatch-off occurred. In addition, we are trying to find a way to transport ATVs to the larger islands for inspections. Currently we are trying a pontoon boat specially equipped to transport 2 ATVs.

108 Effects of environmental and physicochemical factors on adult mosquito management

Jennifer Bodin, jbodin2@gmail.com**,** Robert Peterson, Mark Breidenbaugh and Jerome J. Schleier

One of the more effective and widely used methods of managing insect vectors of human pathogens is the use of ultra-low-volume (ULV) insecticides. However, comprehensive and systematic studies of how environmental and physicochemical factors affect the efficacy of ground ULV applications of insecticides for adult vector management are lacking. To characterize the factors that influence efficacy, we used permethrin as the active ingredient in numerous field experiments in California, Louisiana, and North Dakota because it is the most commonly used material for adult mosquito control and has the broadest range of both water- and oil-based formulations. In this presentation, we will report the environmental and physicochemical factors that affect insecticide efficacy. We will focus on the interactions between formulation attributes and environmental factors.

109 Acoustic larvicide© vernal pond operational results against mosquito and midge larvae

Herbert Nyberg, sales@newmountain.com

Acoustic larvicide© was discovered and patented by New Mountain Innovations and occurs when sound energy is introduced into the water habitat of any species of mosquito larvae at the resonant frequency of its internal air volume, causing immediate or eventual death. Extensive field operations were conducted in the spring of 2011 applying Acoustic larvicide© treatments to vernal ponds with a Larvasonic™ Field Arm. The Larvasonic™ Field Arm is a battery powered, self-contained portable unit designed for use in various urban and rural mosquito habitats. Vernal ponds were treated and efficacy compared to similar untreated vernal pond habitats within a 1.5 km. The results of these comparisons will be presented.

Risk Assessment Symposium II

110 Vector competence of Florida *Aedes aegypti* (Diptera: Culicidae) for dengue virus

Stephanie Richards, richardss@ecu.edu**,** Sheri Anderson, Chelsea Smartt, David Bettinardi and Barry Alto

Dengue virus (DENV) is a globally important public health threat maintained in a human-mosquito epidemiologic cycle. In 2009-2010, Monroe County in southern Florida experienced focal outbreaks of DENV fever where DENV serotype 1 (DENV-1) was transmitted by local mosquito populations. *Aedes aegypti* is the primary vector of DENV and is the suspected vector in the recent Florida outbreaks. As DENV is so widespread and humans are the reservoir hosts, traveler-imported cases could contribute to its range expansion. Puerto Rico is one DENV-endemic region from which cases might be imported to Florida. Consequently, we assessed the vector competence of Florida *Ae. aegypti* for different DENV serotypes found in Florida (DENV-1) and Puerto Rico (DENV 1-4). Vector competence (infection, dissemination, and transmission) was assessed at 2 incubation periods (7 d and 14 d post-infection) for mosquitoes held at 28°C. These types of studies are essential to improve risk prediction of emerging and re-emerging arboviruses to focus mosquito control efforts on specific vector populations.

111 Temporal silencing of two *Culex pipiens quinquefasciatus* (Diptera: Culicidae) mosquito genes influences vector competence

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Infection with a mosquito-borne virus, such as West Nile virus (WNV), initiates a cascade of defense pathways, including the innate immune system. In *Culex pipiens quinquefasciatus*, gene products of the immune deficiency and Toll pathways have also been implicated in mounting a response to WNV infection. Previous work showed 2 specific genes from the 2 pathways, a leucine rich repeat (LRR-1) gene and a gram negative bacteria binding protein (GNBBP-1) gene, as being involved in this immune response. Expression knockdown studies using LRR-1 and GNBBP-1 revealed that interference in the expression of both of these genes was exacerbated by infection with WNV, suggesting an active role for WNV in the modulation of the mosquito's immune system. Additionally, knocking down the expression of LRR-1 resulted in low expression of the GNBBP-1 gene indicating that these genes are interacting, perhaps by LRR-1 controlling the expression of GNBBP-1. However, knockdown of GNBBP-1 only affected the GNBBP-1 gene expression. Here we report the effects of mosquito gene knockdown on WNV titer in all mosquito samples tested. A role for crosstalk between the 2 most studied mosquito immune response pathways is discussed.

112 Effects of variable mosquito mortality on transmission potential of arboviruses

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An important measure of epidemic potential of vector-borne diseases is vectorial capacity, which integrates entomological, pathogen, and contact parameters. We have shown previously that static estimates of this quantity can lead to under or overestimates of the transmission potential. By accounting for the dynamic interaction of time to dissemination of a virus through the mosquito and daily mortality of the mosquito, we can better estimate the true, dynamic transmission potential of an arbovirus. The next step is to determine how changes in daily survival rates of the mosquito affects this dynamic estimate. We will demonstrate how variations in the daily survival rate of the mosquito can alter the transmission potential of arboviruses such as dengue or chikungunya. By varying the survival rate, we can then extrapolate the transmission potential variance to seasonal fluctuations of mortality, temperature driven mortality, or vector control methods.

113 Age-associated mortality in West Nile virus challenged *Culex pipiens quinquefasciatus* in relation to environmental temperature

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Culex pipiens quinquefasciatus is a vector of filarial nematodes and arboviruses affecting public and veterinary health. It is often assumed that arbovirus infection has inconsequential effects on mosquito fitness. However, arbovirus infection has been shown in some instances to cause cytopathological effects on mosquito organs and changes in behavior. We investigated the effect of West Nile virus (WNV) infection on survivorship of adult *Cx. p. quinquefasciatus* females from 2 Florida colonies. Mosquitoes exposed to WNV that developed non-disseminated infections had significantly shorter life spans than individuals with disseminated infections or unexposed (control) mosquitoes. Life span and body titer of *Cx. p. quinquefasciatus* with disseminated infections were negatively correlated such that longer lived individuals had lower titers when they died. Correlations between life span and viral titer were observed at 32°C but not 28°C for both colonies of *Cx. p. quinquefasciatus*. These results suggest that WNV infection alters mosquito fitness and, hence, vector capacity, but these effects are contingent on the interaction with factors such as environmental temperature. This species is found in areas with temperature ranges beyond the 2 points used here, so these effects could impact seasonal and regional differences in *Cx. p. quinquefasciatus* vectorial capacity for WNV.

Equipment

114 Estimation of effective swath width for ultra-low volume application of pyriproxyfen for auto-dissemination

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A 2-yr study was conducted in an open field to estimate the swath width of ultra-low volume (ULV) application of an insect growth regulator (IGR), for auto-dissemination and larviciding. The 2010 study included application of BVA-13 oil, a NyGuard surrogate, seeded with fluorescent dye at 790, 585 and 292 ml/ha, replicated 4 times. The airborne spray (nL/cm^2) was quantified with fluorometery up to 180 m from the spray line. These distances when adjusted for wind direction ranged from 15 - 425 m. The distance at which the BVA deposition, decreasing with the distance, reached 0.288 nL/cm^2 (the minimum for auto-dissemination) was established as the effective swath width of 209 m. During 2011, NyGuard was sprayed at 790 ml/ha to 20 caged female *Aedes albopictus* (Skuse) at 4 ft above ground and empty paper cups on ground. Female mosquitoes were transferred to rearing containers having 20 larvae in 200 ml water. The larval mortality was observed for auto-dissemination. Water (200 ml) and 20 larvae were added to paper cups and larva mortality was observed as an indication of larviciding. The auto-dissemination data showed 36 - 41% mortality up to 180 m, not significantly different from control mortality of 24%. The ground cups had 96-100% mortality compared to 9% in control.

115 Potential use for electrostatic sprays in vector control

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One of the techniques for controlling mosquitoes, especially those transmitting the malarial parasites, is to spray surfaces inside houses on which mosquitoes rest either before or after biting. Traditionally this indoor residual spray (IRS) treatment used a persistent insecticide applied with a compression sprayer. The hydraulic spray equipment requires manual pumping and the insecticide is usually applied at 40 ml/m^2 on wall surfaces. Various other techniques, mostly using a much lower volume of spray applied with a knapsack motorized mistblower, have been tried, but with a high velocity air stream spray,

coverage is variable and deposition on the floor occurs. In the 1980s an adaptation of a hand-carried 'Electrodyn' sprayer (originally developed for treating cotton and other crops in semi-arid areas where water was difficult to obtain) was used to apply insecticide inside experimental huts in Tanzania. Further development of the 'Electrodyn' ceased for commercial reasons, so no further studies on electrostatic spraying for vector control were carried out. Renewed interest in re-examining the use of charged sprays has led to commercialization of such equipment for agrochemical applications. Initial development of new electrostatic spray equipment for controlling mosquitoes will be assessed in this presentation.

116 Development of the very efficient Mos-hole and DMS mosquito traps

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We developed 2 kinds of selective mosquito traps. The Mos-hole trap emits CO_2 obtained from burning liquid naphtha. The process principle was very unique in that some heat and moisture, which cannot be obtained by using dry ice, was generated as well. The trap has an acidic and CO_2-baited suction system. The color and shape of the suction trap was also very important for improving the mosquito capturing efficiency. The trap burns naphtha at a rate of 1.3 g/h ~ 3.0 g/h (CO_2:50 - 110 ml/min) and the collecting efficiency of mosquitoes in the trap was higher at the burning rate. The second trap, called DMS (Digital Mosquito Monitoring System), was developed for reporting the number of captured mosquitoes automatically, every day. This automatic reporting device uses CO_2 as a mosquito attractant and it has an IR array sensor for counting mosquitoes. We established a sensor network with several DMSs and 1 server. The server collected the data of each DMS via Internet or CDMA RF communication system. The data were analyzed in the GIS pest prevention information system and were sometimes used as a reference for the next pest control activities. The DMS system emitted CO_2 at a rate of ca 300 cc/min, and was very effective at attracting and counting mosquitoes. By using 2 kinds of mosquito traps at the same time, we could determine the mosquito population size increase and decrease at certain areas.

117 Improvements of "dual-cage" wind driven vanes and Florida-style impingers for mosquito caged trials

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Mosquito caged field trials prove to be challenging because of its dependency in meteorological conditions, especially the "wind". Both the wind speed and direction can be an obstacle that will potentially make for poor results or increase the intensity of labor necessary to conduct a representative study or caged trial. Having the necessary tools to move cages without having physical obstructions can change the frequency of missing the target that result by a sudden change of wind. This presentation will cover the construction, materials and advantages of an improved dual cage, wind driven vane and a Florida (FLB) style droplet collector (impinger).

118 Digital image analysis for counting adult mosquitoes

Banugopan Kesavaraju, banu@slcmad.org and Sammie Dickson

Mosquito control agencies use CO_2-baited traps more for surveillance and these traps attract lot more mosquitoes than a conventional NJ light trap. The marshes north east of the Salt Lake City international airport are ideal habitats for both flood water mosquitoes such as *Ochlerotatus dorsalis* and marsh mosquito species such as *Culex tarsalis*. CO_2-baited traps in these areas capture an average of approximately 2,000 mosquitoes per trap per night. The high numbers of mosquitoes captured in these traps present a logistical problem in counting them. ImageJ is an open source software developed with support from NIH and has been used to count a wide array of pictures from bacterial cultures to mosquito eggs. We configured ImageJ to count mosquito adults from pictures that were taken by spreading them on white plastic photo developing trays. In the best possible setting, the average difference between the count estimated by ImageJ and a manual count was ± 200. The R squared value for a regression between manual and ImageJ count was 0.93 indicating that the values were highly predictable. To evaluate the repeatability of the software, 5 pictures of the same number of mosquitoes was compared, after shuffling the mosquitoes on the trays between pictures, which showed that the ImageJ counts were highly repeatable. A macro file with the best configuration and the instructions to configure ImageJ will be presented.

119 DropVision technologies for adulticide and larvicide applications

Mike Reynolds, mreynolds@leateam.com and Bill Reynolds

DropVision® is a droplet measuring system designed to analyze droplet spectra through image analysis of droplets contained on Teflon and magnesium oxide coated slides. There are 3 versions designed to measure adulticiding and larviciding spectra; these include DropVision® Basic, DropVision®-AG, and DropVision®-FL (Fluorescence).

120 Real-time mobile weather observations optimizing chemical spray operations

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Recent technology developments have allowed for the integration of a cost-effective ultrasonic anemometer and GPS into 1 compact sensor package. An ultrasonic anemometer has no moving parts which makes it attractive for installation on moving vehicles. Using the simultaneous input from a built in GPS allows the reduction of the apparent wind vector to a true wind speed and direction output. One can immediately see the operational advantages a device such as this will have on mosquito chemical spray operations and other agricultural pest control uses. This presentation will discuss the importance and benefits this technology brings to operations and how it is presently being used for both mobile operations as well as fixed point observations.

Abstracts

Bats, Birds and Fishes: Allies in the Mosquito Wars

121 Why care about bats? An overview of bat biology/ecology, with emphasis on the ecological/economic values of bats as insect/mosquito predators
James Eggers, jeggers@batcon.org

Bats are essential to the health of our natural world and human economies. As primary predators of night-flying insects, they protect farm crops, forests and humans. New research suggests bats save US farmers billions of dollars a year by limiting crop losses and reducing pesticide use.

122 White-Nose Syndrome ravaging North American bat populations: History, problems, current status, future needs
Jim Kennedy, jkennedy@batcon.org

White-Nose Syndrome (WNS) is a poorly understood but devastating disease of bats. Well over a million animals have succumbed since its discovery in a cave near Albany, NY in 2006. Three endangered species are currently threatened by WNS, and it could cause regional extinction of one of North America's most common bat species if a way to halt its progress is not discovered soon. At present, hibernation caves in 19 states and 3 Canadian provinces are affected. Human economies are also at risk. Lack of funding is one of the major impediments in understanding this mysterious disease.

123 Austin's Congress Avenue Bridge bat colony and the architecture of a bat-friendly bridge
Fran Hutchins, fhutchins@batcon.org

Austin reveres its bridge bats. Bats are Austin's official animal. Statues celebrate them. However, it was not always so. What's now the world's largest urban bat colony was once on the verge of extermination; then Bat Conservation International came to town and convinced Austinites they had little to fear and much to gain from the bats in their midst. Now about 1 ½ million Mexican Free-tailed bats spend their summers in a maternity colony under the Congress Avenue Bridge with a whole city celebrating and protecting them. A little truth goes a long way.

124 Bat towers for mosquito control: A history story
Lawrence Hribar, gringo1122@hotmail.com

On Sugarloaf Key in Monroe County, FL, is a well-known ruin from the Florida land boom of the 1920s and 1930s: the Perky bat tower. Very little is known for sure about the history of the bat tower. It was constructed on the orders of developer R.C. Perky, who planned to build a resort on Sugarloaf Key. Mr. Perky had several problems to solve prior to opening his resort, and the biggest was the hordes of mosquitoes in the area. Apparently Mr. Perky was the victim of a con artist, who charged him an exorbitant sum of money for a "bat lure." An apocryphal story holds that bats were transported to the tower but they all flew away during the first night. The tower was constructed according to plans provided by Dr. Charles Campbell of Texas. As many as 14 bat towers were constructed worldwide; 3 still stand in the United States.

125 Design and promotion/use of bat houses for local insect/mosquito control, and overcoming "bat-phobia"
Dianne Odegard, dodegard@batcon.org

Bats face many threats, from White-Nose Syndrome to wind energy turbines. Another threat to bats that is unseen and often not well understood is the loss of roosts in buildings. Bats, like other species of wildlife, have lost traditional habitat due to spreading urbanization, and, like other species, have adapted to our buildings and our bridges. Some people are very tolerant of bats roosting in their barns or attics; others are not. When bats are excluded, artificial roosts placed strategically and prior to exclusion can keep them in the area where they can continue to control the insects that plague us. Education is the key to co-existing with bats in our neighborhoods, and can turn fear into interest and appreciation, often in an instant.

126 Possible implications for mosquito control operations if certain bats become federally-listed as T&E species
William H. Meredith, William.Meredith@state.de.us

One possible outcome in trying to contend with the devastating outbreak of White-Nose Syndrome among bats involves some thinking by some parties to perhaps federally-list certain bat species under the Endangered Species Act as threatened or endangered species. While this might be helpful in preventing further decline in certain bat populations or with their population recoveries, it could also have detrimental consequential impacts to mosquito control operations, particularly for adulticiding. Federal listing as a T&E species not only helps to protect a species' numbers per se, but as part of such listing also their critical habitats. If part of such critical habitat designation involves protecting food resources for a federally-listed species, and with mosquitoes of course being food items of some importance for bats, complications could then arise in some situations or settings relative to controlling or reducing mosquito populations. As such, any federal listing of bats as T&E species will have to be carefully crafted not to impose (or let others impose) undue or unwarranted restrictions on mosquito control operations, and as such not interfere with or diminish mosquito control core functions. This will require good communication, cooperation and collaboration among many parties.

127 Is mosquito control for the birds?
Joseph Conlon, conlonamcata@gmail.com

It has been known for many years that bird species like Purple Martins consume large numbers of flying insects. Proponents of their use in mosquito control are quick to cite J.L. Wade, an amateur bird enthusiast, who reasoned that an average 4 oz adult Purple Martin, due to its rapid metabolism, would have to consume its body weight per day, amounting to 14,000 adult mosquitoes, in order to survive. This, and other tongue-in-cheek observations, has become entrenched in the public consciousness as a rationale for promoting Purple Martins and other birds as mosquito control tools, often supplanting other far more effective methodologies. This presentation will explore what roles, if any, avians play in effectively controlling mosquito populations.

128 Promotion/use of native or stocked fishes by mosquito control agencies

Chris Miller, cmiller@contracostamosquito.com and Craig Downs

An overview of rearing/stocking/use of larvivorous fishes for larval mosquito control, including the history of such efforts, types of fish species evaluated and in use, stocking densities, suitable habitats for use, effectiveness, value, and issues encountered (biological, ecological, legal, regulatory).

Adult Arthropod Control

129 Ground ULV and thermal fog applications against phlebotomine sand fly vectors of *Leishmania* in a hot-arid environment in western Kenya

Seth C. Britch, seth.britch@ars.usda.gov**,** Kenneth J. Linthicum, Robert L. Aldridge, Todd W. Walker, Muhammad Farooq, Jeffrey W. Clark, Joshua L. Bast, Scott W. Gordon, Thomas M. Logan, Francis Ngere, Daniel Ngonga, Vitalice Opondo and Clifford Chepchieng

Phlebotomine sand fly vectors of *Leishmania* continue to threaten US military operations in Africa, Southwest Asia, and the Middle East. Ultra-low volume (ULV) and/or thermal fog pesticide dispersal are potentially effective against sand flies, but operational guidance is thinly-based on mosquito control in temperate-tropical environments. Few studies have examined performance of ULV or thermal fog against mosquitoes in hot-arid environments, and no studies have investigated ULV or thermal fog to control sand flies in any environment. Sand fly bionomics are poorly understood, so timing and positioning of applications may not be optimal, and susceptibility of sand flies to US EPA-registered pesticides labeled for aerosol application is poorly known, so configuration of dispersal equipment and pesticide also may not be optimal. We conducted a series of large field experiments in a hot-arid region in western Kenya endemic for phlebotomine vectors and *Leishmania* using a range of pesticides and ULV and thermal fog devices in various configurations. We evaluated configurations in a variety of meteorological conditions against natural sand fly populations and caged colony-reared sand flies. We found both ULV and thermal fog applications to be highly effective against sand flies, but efficacy was not homogeneous among configurations or weather conditions. These initial findings will form the basis for developing effective operational guidance for sand fly control and further research.

130 Correcting field spray concentration and insect mortality data for sampler collection efficiencies and bioassay cage interference

Bradley K. Fritz, brad.fritz@ars.usda.gov**,** Wesley Hoffmann, Jane A. Bonds and Keith Haas

Evaluating the efficacy of vector control treatments rely on accurate measurements of insect mortality and amount of applied spray material. Building on the bioassay cage and rotary slide collection efficiency work by the authors, field trials were conducted to demonstrate how the combination of data from rotary sampler spray concentrations and caged insect bioassays could be corrected and analyzed. The spray concentration data, corrected for sampling inefficiencies, is used to estimate the amount of spray material penetrating into the cage to generate dose response relationships. The results demonstrate that actual spray exposure levels inside the cages are underestimated (76 to over 90%) if sampling efficiency and cage filtration are not considered. The underestimation is a function of the spray collection device used, the bioassay cage type, and the ambient wind speeds. While standardized samplers and/or bioassay cages would increase the comparability of different studies, corrections for the effects of wind speed still need to be made. Correcting field measured data using methods developed allow not only better comparisons between differing studies, but also better estimates of insect mortality versus actual spray concentration exposure levels.

131 Use of a fluorescent biomarker to demonstrate the effect of rodent-targeted insecticide applications on sand fly populations

Thomas M. Mascari, tmascari@agcenter.lsu.edu**,** Jeffrey W. Clark, Scott Gordon, Joshua L. Bast and Lane D. Foil

The fluorescent tracer technique (FTT) is a control-efficacy diagnostic tool that can be used in conjunction with rodent-targeted control methods against sand flies. The objective of field studies conducted in Kenya was to incorporate the fluorescent dye rhodamine B into rodent baits to determine the level of blood feeding by sand fly vectors of *Leishmania major* on targeted rodents and to demonstrate the effect of rodent baits containing the systemic insecticide ivermectin on the blood feeding success of sand fly populations. Bloodfed female sand flies were collected at sites that were treated with rodent baits containing rhodamine B alone were positive for the presence of rhodamine B, while no bloodfed females collected at the sites treated with rodent baits containing rhodamine B plus ivermectin were positive for the presence of rhodamine. The results of this study constitute proof of concept for targeted control of an epidemiologically significant portion of the population of the sand fly vector of *L. major*, and demonstrate the potential for the interruption of the transmission of *L. major* using applications of systemic insecticide-treated rodent baits.

132 Advances in mass rearing for mosquito species

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Recently, at the Insect Pest Control Laboratories (IPCL), major advances have been made in creating, developing, and testing new tools for mosquito mass rearing with the main goal to implement an SIT program for the mosquito species *Anopheles arabiensis* and *Aedes albopictus*. Because immature mosquitoes develop in water, developing appropriate tools for their rearing has been challenging. A rack system accommodating 50 larval holding trays was designed, produced, and tested for mass-rearing *An. arabiensis*. The production of larvae in these trays showed promising results as ca 4,000 pupae per tray were obtained in 6 d. A larva-pupa separator which combines cold temperatures and a water vortex has been

developed, allowing efficient separation of a 30,000 larvae-pupae mixture in 2 min without affecting survival. The adult oviposition cage has also been modified (adult emergence tubes, sugar-feeders, blood-feeding system, and oviposition feature). A new larval diet, optimal for all growth parameters of *An. arabiensis* using widely available and cost-effective ingredients, was also developed. All of the novel equipment is now being tested for *Ae. albopictus* in collaboration with Italy and La Réunion to improve where necessary. In addition to the development of mass-rearing technologies, protocols for irradiating "wild" *An. arabiensis* Dongola strain and for the sex separation process of the genetic sexing strain ANO IPCL 1 were formulated.

133 Evaluation of commercial spatial repellents against *Aedes albopictus* for potential military use during deployment

Aaron Lloyd, aaron.lloyd.ctr@med.navy.mil, Muhammad Farooq, Alden Estep, Joseph Diclaro and Daniel L. Kline

Spatial mosquito repellents provide protection to humans by deterring host-seeking activity. Effective repellents are vital for preventing vector-borne disease transmission in globally and domestically deployed forces. The spatial repellency response of *Aedes albopictus* (Skuse) to 4 commercial, off-the-shelf (COT) spatial repellents was evaluated in field settings in North Florida. COT's evaluated include: ThermaCell®, OFF!®, Lenteck®, and Bug Button®. The objective of this study was to determine the efficacy of COT spatial repellents and evaluate their durability for potential military use. A Biogents Sentinel® (BGS) trap was placed in 5 locations with a spatial repellent device suspended at the level of the BGS trap opening. The spatial repellent device was rotated to the next position for 5 repetitions; trap catch was collected every 12 h. Spatial repellent efficiency was evaluated by comparing the total number of mosquitoes collected in the BGS traps during a 12-h period. The number of adult mosquitoes repelled by the ThermaCell spatial repellent was significantly more than other spatial repellents with the exception of OFF!. These data indicate that COT's using repellent insecticide rather than botanicals are more effective at deterring *Ae. albopictus* from biting a host.

134 Resistance of *Aedes aegypti* to insecticides in Martinique (Caribbean) and implications for dengue vector control

Sebastien Marcombe, sebastien.marcombe@rutgers.edu, Frederic Darriet, Michel Tolosa, Philip Agnew, Manuel Etienne, MarieMichele Yp-Tcha, Andre Yebakima, Fabrice Chandre and Vincent Corbel

This study was designed to measure and understand the phenotypic impact of *Aedes aegypti* insecticide resistance on the efficacy of insecticide treatments at an operational scale in Martinique. Space spray applications of deltamethrin were performed in 9 localities to assess the impact of pyrethroid resistance on the efficacy of treatments. Efficacy was measured by monitoring mortality rates of naturally resistant and laboratory susceptible female mosquitoes placed in sentinel cages. Results showed high mortality rates of susceptible mosquitoes while resistant mosquitoes exhibited very low mortality. There was no reduction in either larval or adult field population densities after treatments. Further, we tested the potential of using alternative larvicides (spinosad, pyriproxyfen, and diflubenzuron) for the control of organophosphate resistant *Ae. aegypti* larvae. We also tested the use of a mixture of spinosad and pyriproxyfen to assess the residual efficacy of combining their different modes of action. Under field conditions, pyriproxyfen and *Bti* showed a residual efficacy of only 4 wk against *Ae. aegypti* populations while diflubenzuron and spinosad showed a residual efficacy of 16 wk. The spinosad and pyriproxyfen mixture remained effective for 18 wk, demonstrating the increased residual activity of the combination. This study emphasizes the urgency for further research to provide new tools and innovative strategies to manage insecticide resistance in dengue vectors.

135 Hit them twice, hit them hard, and hit them often: Keeping pressure on the tigers works!

Scott C. Crans, scrans@aesop.rutgers.edu, Ralph Strano, Sean Devany and Tadhgh Rainey

Low-volume application of the insect growth regulator S-methoprene immediately followed by adulticiding was employed in an urban setting experiencing severe *Aedes albopictus* nuisance. Over an 18-wk study period adult mosquito populations were closely monitored in 2 Union County, NJ neighborhoods.

136 Genetic control of insects using RIDL: A new tool for mosquito control

Derric Nimmo, derric.nimmo@oxitec.com, Andrew McKemey and Luke Alphey

Oxitec has developed strains of *Aedes aegypti* and *Ae. albopictus* which are homozygous for 1 or more dominant lethal genes, which are "sterile" unless provided with the repressor molecule tetracycline in the diet. This method, known as RIDL, is based on the sterile insect technique (SIT) which has been used successfully for the suppression or local elimination of several insect species in agriculture. Sterile male mosquitoes are released continually over a wide area to mate with the target pest population; no progeny result from these matings and the target population declines. Over the past 2 yr, field releases of RIDL *Ae. aegypti* have been conducted in the Cayman Islands, Brazil, Florida, and Malaysia. Results have shown that RIDL males could not only compete well with WT males for WT females but also suppress a population under field conditions. We will present data to show the potential of RIDL as an effective new tool for the control of mosquitoes.

137 Evaluation of push-pull systems to reduce exposure to vector insects in military environments

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Developing and implementing effective vector control programs in military deployment environments can be a challenge. Vector control measures need to be easy to implement, as long-lasting as possible, and adaptable to a wide variety of conditions. To meet the needs of a military population, efforts to develop novel vector control strategies are ongoing. Currently, a number of US military laboratories are engaged in researching various aspects of push-pull vector control systems against a variety of vectors of military importance. This presentation will address the research efforts that are underway and present results to date.

138 Structure-activity relationship study in some trifluoromethyl phenyl carboxamides

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Development of new, safe public health insecticides is critical to offset the reduction of insecticide products because of concerns over the negative impacts to the ecosystem. Through funding made possible by the Deployed War-Fighter Protection Program, we are developing new insecticide candidates based on the premise that trifluoromethyl phenyl carboxamides will be potent against disease-spreading pests yet safe or have relatively low toxicity for humans and other animals. We have designed and synthesized a set of 20 trifluoromethyl phenyl carboxamides for initial screening. The screening consisted of toxicity assays with *Aedes aegypti* larvae and adults and repellency assessment by evaluation of the minimum effective dosage (MED) using adult female *Ae. aegypti* and *Anopheles albimanus*. Two compounds after 24 h and 6 after 48 h, all *para*- and *meta*-substituted, produced 100% mortality against activity of *Ae. aegypti* adults after 48 h. None of the *ortho*-substituted trifluoromethyl group showed toxicity. One *ortho*-substituted compound had a MED equal to DEET and another *ortho*-substituted was better against *Ae. aegypti*. Based upon these results, we plan to synthesize additional similarly structured compounds to better understand the basis of insecticidal activity and to lead us to develop further novel insecticides.

139 Recent research on permethrin-treated United States military uniforms

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History is replete with examples of arthropod-borne illnesses affecting the outcome of military conflicts. Therefore, protection of our US military is paramount when they are deployed on missions throughout the world. A part of the system to protect military personnel consists of wearing permethrin-treatment of field-worn combat uniforms. Since 1991, treatment was done in the field, but more recently the US Marine Corps (2007) and Army (2010) have transitioned to factory-treated uniforms. Since our previous report at the 76th AMCA, we have completed studies on a variety of different uniform constructions. In 2010, specimens of 50:50 nylon:cotton Army Combat Uniform factory-impregnated with permethrin were evaluated and these uniforms provided 99-100% protection from mosquito bites through 50 wash cycles. The qualification phase was also completed for the 65% rayon/25% *para*-aramid/10% nylon Fire-Resistant Army Combat Uniform. In 2011, we completed qualification of treated Army Aircrew Uniforms and have examined treated alternative (non-woven) experimental fabrics for their ability to prevent mosquito bites. The results of these studies will be presented along with a discussion of how they compare to the results with the treated combat uniforms that we have studied over the past 8 yr.

140 Practical implementation and environmental impacts of emerging control methods for *Aedes aegypti*

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Established approaches for control of *Aedes aegypti* principally involve source reduction (elimination of larval habitat), larviciding, and space-spraying. The emerging methods considered include the release of insects with a dominant lethal gene (RIDL), the release of strains infected with the bacterium *Wolbachia*, the deployment of lethal ovitraps, the introduction of the copepod *Mesocyclops* for larval control, and the use of insecticide impregnated fabrics for adult control. Requirements for the effective implementation of each of these approaches are described and the extent of the changes to established control operations and management are discussed in terms of benefits, issues, and practicality. The environmental benefits and risks of these newer methodologies are also reviewed. Insecticide resistance management is supported by the incorporation of non-chemical approaches within control campaigns, reducing selection pressure. Community engagement is key to the success of all approaches and the acceptability of each of the methods is reviewed in this context. RIDL and *Wolbachia* contrast in terms of potential environmental impact given that *Wolbachia*-infected strains persist in the environment whereas RIDL strains do not. Recent trials using RIDL have demonstrated that this is a practical approach and that it can be integrated with traditional operations to control *Ae. aegypti* effectively.

Little-known Mosquito Lore: The Sequel

141 DDT in USDA: The evolution of a concept

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DDT the chemical was discovered in the late 19th century as part of a revolution in organic chemistry. It was probably no coincidence that at the same time the revolution in medical entomology had begun, leading to USDA's classic achievements in the discovery of pathogen transmission by arthropods and description of the mosquito fauna of the Western Hemisphere. Muller's rediscovery of DDT as the first designer insecticide fulfilled a tremendous need in warfare, just in time for WWII. The US Department of War called on USDA to quickly develop defenses against the traditional apocalyptic disease threats of war: malaria, typhus, and plague. Working mainly in Orlando, FL, USDA succeeded beyond imagination, contributing toward saving millions of lives, winning a Nobel prize, the pollution of the planet, and the erection of the US Environmental Protection Agency. DDT came full circle from basic chemical discovery to miracle cure to the ultimate chemical pariah. USDA accompanied DDT along most of its path, erecting signposts of entomology that direct our entomological efforts to this day.

142 “More Feared than All the Armies in the World”: Insects, disease, and military history

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Insects and the pathogens they transmit have had a profound impact on military history, but this fact has often been overlooked by both military historians and the public. In this presentation, I focus on historical perception versus historical fact by examining episodes throughout military history that were profoundly affected by insects and disease.

143 The appalling *Anopheles gambiae* complex

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Anopheles gambiae remains the most complex and deadly mosquito in the world. Originally named in 1902 by Major Geoffrey Giles while helping Ronald Ross to identify mosquitoes, "*Anopheles gambiae*" is now known to comprise at least 7 sibling species, with incipient species and genetic forms responsible for most malaria transmission in the Afrotropical Region. Twice they have invaded other regions and been extirpated, but they continue evading and resisting our best control efforts in tropical Africa. This presentation summarizes the intriguing history of how these species and forms were recognized, named, fought, genetically understood, and yet prevail, highlighting what the *Anopheles gambiae* complex has taught us about vectorial capacity and speciation.

Disease/Vector Studies I

144 Dealing with the inherent tardiness of sentinel chicken surveillance (or not)

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The most intense transmission of West Nile virus (WNV) to sentinel chickens yet observed in Indian River County, FL was documented July-November 2010. No human or horse cases were reported. There were 50 confirmed WNV-positive sentinels, with seroconversions exceeding 100% in 6 of 8 flocks. This high level of activity precipitated 4 public notifications of WNV risk. The first 2 notifications by local agencies (Indian River Mosquito Control District and the Indian River County Health Department) were based on local vector and rainfall surveillance that anticipated additional peaks of excessive transmission to sentinels, and potentially to humans. The Florida Department of Health (DOH) did not consent to issuance of a "Mosquito-borne Illness Advisory" and a "Mosquito-borne Illness Alert" until later, after the peak of WNV transmission. This episode illustrates the need for local surveillance managers to proactively monitor vector mosquito activity and rainfall patterns in real-time, as a means of interpreting the significance of sentinel seroconversions that are always identified after-the-fact. In the absence of other local surveillance data the use of arbitrary trigger levels of seroconversion may be inadequate for timely issuance of public health alerts.

145 Use of resting boxes as a tool to augment mosquito and arbovirus surveillance

Min-Lee Cheng, mcheng@wvmvcd.org**,** Tianyun S. Su, Jennifer Thieme, Roseann Catan, D. Mian, Aaron Pomerantz and Alec Gerry

Modified resting boxes were deployed in selected rural and urban locations. In comparison to EVS or Reiter traps, resting boxes collected large numbers of newly emerged adult males and females, in addition to gravid, non-gravid, and blood engorged females of several species of mosquitoes that are common to each specific location. Some gravid females recovered from resting boxes also were found to carry West Nile virus. Resting boxes are economical and easy to set out, and non-selective of species or the physiological status of adult mosquitoes. When properly placed, they serve as a useful tool in the mosquito and arbovirus surveillance program.

146 Effect of environmental temperature on the vector competence of *Culex tarsalis* for Rift Valley fever virus

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Environmental temperature has been shown to affect the ability of mosquitoes to transmit numerous arboviruses and Rift Valley fever virus (RVFV) in particular. Because *Culex tarsalis* is the most efficient laboratory vector of RVFV of the species tested to date, we evaluated the effect of incubation temperatures ranging from 14-26°C on their infection, dissemination, and transmission rates for this virus. Mosquitoes were allowed to feed on viremic hamsters and engorged mosquitoes randomly allocated to cages placed in incubators maintained at 14, 18, 22, or 26°C. Infection rates detected in these mosquitoes increased with increasing holding temperature. Similarly, the percentage of mosquitoes with a disseminated infection after a particular extrinsic incubation period (7, 14, or 21 d) increased with increasing incubation holding temperature, even after adjusting for the apparent increase in infection rate. The effects of environmental factors, such as ambient temperature, need to be taken into account when developing models for viral persistence and spread in nature.

147 Evaluation of a RAMP/RT-PCR West Nile virus (WNV) detection system in mosquito pools

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We evaluated the sensitivity and efficiency of a commercially available WNV antigen detection assay (RAMP WNV test, Response Biomedical Corp., Burnaby, British Columbia, Canada) and real-time RT-PCR using a proficiency panel consisting of WNV-spiked mosquito pools and negative control pools. The panels were sent to 20 mosquito abatement districts that processed the pools in RAMP buffer and tested them with the RAMP assay, then sent the panel to molecular laboratories for confirmation by RT-PCR. Using the manufacturer's suggested RAMP positive cut-off of ≥30 RAMP units, no distinction could be made between negative and WNV positive mosquito pools. However if a cut-off of ≥50 RAMP Units was used, a clear distinction could be made between negative pools and pools with viral titers of $\geq 10^4$ PFU/mL. RT-PCR results varied among laboratories. With few exceptions, pools returning a RAMP score of ≥100 were confirmed with RT-PCR, while pools returning a RAMP score of 50-99 appeared to be at the limit of RT-PCR detection. Therefore, we recommend using a positive cut-off of 50 RAMP units with no RT-PCR confirmation to maximize speed, efficiency, and economy. A more conservative approach would be to implement a positive cut-off of 100 with an additional "grey zone" range of 50-99 RAMP units. Pools scoring within the grey zone could be submitted for RT-PCR confirmation with the understanding that they may or may not confirm with RT-PCR and thus may be interpreted as equivocal.

148 First active West Nile virus (WNV) surveillance network for Greece, May-November 2011

Alexandra Chaskopoulou, andahask@ufl.edu, Makis Dovas, Serafeim Chaintoutis and Philip Koehler

In 2010 Greece underwent a large West Nile virus (WNV) epidemic which was followed by another one in 2011. No active vector and arbovirus surveillance system was in place in Greece before the epidemic in 2010. We initiated a small-scale WNV surveillance study with sentinel animals in 2011 (May-November) in the region of central Macedonia, one of the areas with the highest number of human cases, to gauge for virus activity and to better assess the relative importance of vector species. Despite the small range of the surveillance network, we were able to detect WNV enzootic circulation 1 mo prior to the onset of any human cases for 2011. An isolate of WNV from 1 chicken was collected in early July 2011 and characterized by nested RT-PCR amplification and subsequent sequencing of a portion of the NS3 gene. The sequence was identical to that of the Nea Santa-Greece-2010 WNV lineage 2. This was the first molecular detection of WNV in central Macedonia during the summer of 2011. The long-term objective of our study is to design within the following years an optimum, large-scale arbovirus surveillance program that may increase our understanding of the disease transmission cycle and help the local authorities to design a local WNV response plan based on the disease transmission levels.

149 Arbovirus activity in the United States: 2011

Roger S. Nasci, rsn0@cdc.gov, Nicole P. Lindsey, Jennifer E. Lehman, J. Erin Staples and Marc Fischer

ArboNET, the national arbovirus surveillance network, collects data on human disease cases, arboviral infections among viremic blood donors, veterinary cases, sentinel animals, dead birds, and mosquitoes. Weekly updates distributed during the transmission season assist public health and mosquito control agencies in identifying high risk areas. Annual summaries of the data are used to evaluate disease burden and track national and local trends over time. Human disease cases resulting from domestic arboviruses are nationally notifiable conditions, and the national arboviral surveillance case definitions were revised in 2010. This presentation will provide a summary of the 2011 surveillance, including data showing that: 1) West Nile virus remains the most commonly reported arboviral disease in the United States with transmission characterized by focal outbreaks; 2) St. Louis encephalitis virus enzootic activity and human disease cases remain at very low levels nationwide; 3) eastern equine encephalitis virus case numbers remain characteristically low, but enzootic activity and potential human risk are widespread throughout the eastern United States; and 4) in some states in the southeast and Midwest, La Crosse virus causes more disease than West Nile virus, with most La Crosse encephalitis cases occurring in children.

150 Efficacy of carbon dioxide and synthetic lure-baited light traps for attracting *Anopheles gambiae* in Liberia

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The *Anopheles gambiae* complex is a group of mosquitoes in Africa that has adopted a strong propensity for feeding on humans, thereby making it one of the most efficient vectors of malaria. As part of a larger malaria surveillance study, we evaluated incandescent, ultra violet light-emitting diode (LED) and ultra violet light traps baited with a combination of CO_2, generated from sugar-fermented yeast, and a synthetic lure to attract host-seeking mosquitoes, especially malaria vectors. Seven traps configured with different attractant combinations were placed at 4 sites in 3 counties of Liberia for 5 consecutive nights during January, March, May, July, September, and November 2011. Over 3,500 mosquitoes, representing 60 species from 12 genera were collected; the majority were identified as *Coquillettidia metallicus*, *Culex vansomereni*, *Anopheles ziemanni*, *An. gambiae*, and *Ficalbia malfeyti*. Preliminary results indicate that UV light traps baited with a synthetic lure and CO_2 capture significantly more *An. gambiae* compared to incandescent CDC or LED baited with lure only traps.

151 Japanese encephalitis virus surveillance in culicine mosquitoes (Diptera: Culicidae) in South Korea

Terry A. Klein, terry.klein@us.army.mil, Heung-Chul Kim, Ratree Takhampunya, Won-Ja Lee, Penny Masuoka, John Grieco, John S. Lee, Brian Evans, Jung-Yong Yeh and Dong-Kyu Lee

Japanese encephalitis virus (JE) is a serious arboviral pathogen, resulting in >35,000 cases and 10,000 deaths annually. Prior to a mandatory Republic of Korea (ROK) childhood vaccination policy, periodic outbreaks of >1,000 cases and mortality rates from 10-25%, occurred annually. After implementation of a vaccination policy, 0-7 cases were reported through 2009. In 2010, an outbreak of 26 cases (6 deaths) occurred as a result of a very late rainy season and large numbers of *Culex tritaeniorhynchus*. Reduced late season rainfall in 2011 resulted in low numbers of *Cx. tritaeniorhynchus* and few cases of JE. From 2008 through 2010, a total of 150,805 culicine female mosquitoes were captured by Mosquito Magnet®, blacklight, and NJ light traps in the ROK. Culicine mosquitoes were identified to species, placed in pools, and screened for flaviviruses. A total of 92 pools of *Cx. tritaeniorhynchus*, 2 pools of *Cx. bitaeniorhynchus*, and 4 pools of *Cx. pipiens* from 6,845 pools of mosquitoes were positive for JE. The overall JE minimum field infection rates (number of positive mosquitoes/1,000) for *Cx. tritaeniorhynchus*, *Cx. bitaeniorhynchus*, and *Cx. pipiens* were 1.67, 1.02, and 0.36, respectively. Japanese encephalitis is a local civilian and military health threat and a significant concern for non-immune (unvaccinated) US soldiers, civilians, and family members deployed to the ROK.

Larval Control

152 Efficacy evaluation: aerial applications of Altosid 5% to control area-wide populations of domestic mosquitoes

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In recent years, *Aedes albopictus* and *Ae. aegypti* populations have become increasingly problematic because of expanding ranges (*Ae.albopictus* especially), increasing population size, and threat of disease transmission. These factors have resulted in a sharp increase of demand for public-agency mosquito control services within residential areas historically not requiring such services. Unfortunately traditional mosquito control techniques have proven to be largely ineffective when applied to

domestic mosquitoes for a number of human- and mosquito-behavioral reasons. Towards this end, the Manatee County Mosquito Control District evaluated the efficacy of aerially-released Altosid® 5% (Wellmark International) over a 125-acre residential community to target larval mosquito habitats using spray techniques designed to promote spray drift yet simultaneously allowing settling and deposition. Efficacy of such applications was measured using: 1) sentinel larvae mortality and 2) pre- and post-spray larval population dynamics collected via ovitraps over a 6-mo period within treatment and control areas. Results of 3 consecutive aerial treatments will be discussed with emphasis upon chemical efficacy, spray-system configuration, and chemical selection.

153 Catch basin field trial in Florida with FourStar® Microbial Briquets

James F. Clauson, jamesclauson@comcast.net and Dale Martin

Catch basins are unique and prolific producers of mosquito larvae. Beach Mosquito Control District located in Panama City Beach, FL, has over 5,000 catch basins, the majority of which produce mosquitoes. In efforts to rotate and evaluate pesticides, BMCD conducted a field evaluation of FourStar Sustained Release 180-day Microbial Briquets. FourStar briquets contain the proven active ingredients of *Bacillus sphaericus* (*Bsph*) and *Bacillus thuringiensis israelensis* (*Bti*). We treated 17 catch basins, and surveyed them every Wednesday for 4 mo. Results were evaluated by counting the larvae and counting the emergence of adult mosquitoes.

154 Mesocosm studies on spinosad

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Between the bench-top lab beaker and the full-scale, area-wide control program is the mesocosm. We describe mesocosm studies on spinosad over a 2-yr period focusing on 3 mosquito species, *Aedes albopictus*, *Ae. aegypti*, and *Culex quinquefasciatus*. LC_{50} and LC_{95} estimates will be reported. Those data will be used to estimate the diagnostic concentrations to be used for insecticide resistance monitoring.

155 Natular™ formulations update

David McLaughlin, dmclaughlin@clarke.com and Ben Goudie

Now, 3 yr after registration, Clarke shares some of the more recent highlights and learnings about Natular's 6 formulations. Information will include WHOPES reviews and the importance of quality controls in the manufacturing process of Natular.

156 Host-parasite interactions between mosquitoes and mermithid nematodes

Randy Gaugler, gaugler@rci.rutgers.edu**,** Yi Wang, Mohammad Shamsheldean and Manar Sanad

Mermithid nematode research was a dynamic field of study 30 years ago as workers attempted to develop these parasites for mosquito control. The emergence of *Bacillus thuringiensis* var. *israelensis* in the 1980s as an inexpensive and effective biological insecticide however, eroded this rationale for their study and the field faded. Nevertheless, mermithids appear well suited for colonization biocontrol in which limited numbers of antagonists are released to establish and recycle, thereby providing long-term control. This approach requires a greater understanding of mermithid biology than we presently possess. Our lab is currently investigating life cycle parameters of *Romanomermis iyengari* and *Strelkovimermis spiculatus* in tests against *Culex pipiens pipiens* larvae. Emphasis has been placed on understanding how the infective stage, which lives 24-36 h, synchronizes with the host. We find egg hatch is highly regulated by a combination of chemical and physical cues derived from mosquito larvae. Hatch is also dependent upon host stage, with 2nd instars preferred, as well as host density. Despite earlier reports, host finding is directed rather than random. When parasite development is complete, *R. iyengari* emerges from the mosquito prothorax, whereas *S. spiculatus* invariably emerges peri-anally. Protandry occurs in *R. iyengari* but not *S. spiculatus*. Mating clusters are regulated by females.

157 Resistance development of *Culex quinquefasciatus* to spinosad: A preliminary study

Tianyun Steven Su, tsu@wvmvcd.org and Min Lee Cheng

A *Culex quinquefasciatus* colony was established from surviving late instar larvae and pupae 2 d post-treatment of a semi-field microcosm test on Natular™ G30 (a granular formulation of spinosad containing 2.5% active ingredients at 12.5 lb/acre), and the initial LC_{50} and LC_{90} against Natular G30 were determined in the laboratory. Selection pressure was applied at $LC_{70\text{-}90}$ levels to 10,000-15,000 late 3rd instars each generation. Susceptibility changes were determined every other generation along with susceptible laboratory colony and natural population collected from the same location where the microcosm test was conducted. Some tolerance to spinosad (resistance ratio < 5.0) was indicated from generation F1 to F9 in this selected population. Resistance ratios, however, increased significantly from generation F11to F15, being 7.3 - 13.2 at LC_{50} and 7.5 - 20.1 at LC_{90}.

158 FourStar® Microbial Briquet field efficacy trials - Gem County Mosquito Abatement District, Emmett, ID

Jason R. Kinley, director@gcmad.org

During the 2011 mosquito control season, FourStar® 45- and 90-day Sustained Release Microbial Briquets were used in many unique *Culex pipiens* (L.) and *Cx. tarsalis* (Coq.) habitats in the Gem County Mosquito Abatement District to determine efficacy. Trials began in early May and continued until the end of September. Mosquito development sources included abandoned swimming pools and ornamental ponds in suburban settings and stock watering troughs, roadside retention areas, stock ponds, and marshes in rural settings. Efficacy over time was evaluated and efficacy at the larval stage and pupal stage was determined.

159 Natular™ field study

Ann Moser, amoser@co.grant.wa.us

A 5-wk field study of Natular™ G30 was performed in Grant County, WA the summer of 2011. The application of the G30 was done using a turbine thrush 510 aircraft. The results showed very good control of mosquito larvae throughout the study.

160 Efficacy of area-wide larviciding techniques in urban areas

Gregory M. Williams, gwilliams@hudsonregionalhealth.org, Ary Farajollahi, Dina M. Fonseca and Sean Healy

Large-scale (>100 acre) applications of VectoBac WDG (*Bacillus thuringiensis*) were made in urban areas of Trenton, NJ with truck-mounted low-volume equipment. Evaluations were conducted with the Curtis Dyna-Fog LV8 and Buffalo Turbine CSM2 mist sprayer. Product penetration, larval mortality, and residual efficacy were all measured with bioassay cups of *Aedes albopictus* larvae placed in the field prior to each application. Impact on adult mosquito populations was measured with BG Sentinel trap counts. Performance of the applications was compared to untreated controls.

Little-known Mosquito Lore: The Sequel (continued)

161 The untold story of Ronald Ross

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Sir Ronald Ross is best known for his work on malaria transmission, for which he received the Nobel Prize. Ross, however, was not always a scientist. He was an established mathematician and poet before he became a physician and joined the British Army. This presentation will trace Ross's early life and how he got to the point of the "great malaria discovery" and Mosquito Day.

162 The war between the states: Public health perspectives

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Movies like "Gettysburg" and Ken Burns "Civil War" graphically portrayed the carnage visited upon the participants in the War Between the States. To be sure, the horror of outdated Napoleanic frontal assault against the improved weaponry of the belligerents accounted for much of the bloodshed. Nevertheless, deaths from disease far outnumbered combat casualties and profoundly influenced preparations for and the outcomes of many campaigns. This talk will explore the state of the medical art at the outbreak of the war and examine the influences various communicable diseases exacted on the combatants and their ability to execute the war's strategies and tactics. In addition, various factors contributing to the prevalence of disease in the troops will be examined.

163 Malaria in the New South: The early development of state mosquito control efforts

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In the 20th century southern agriculture had recovered from the impact of the Civil War and society was struggling with adapting to a new urban industrial culture while retaining many of the social structures of the past. Largely because of poverty, medicine in the South had not changed as much as in northern cities and public health efforts were frequently underfunded. In the 1920s the experiences of the military and the Panama Canal Commission strongly suggested that vector borne endemic diseases like malaria could be controlled. The Rockefeller Foundation and the Public Health Service conducted a series of large-scale malaria control trials in several southern states which established that a combined approach of patient management and vector control would produce the best social value. State governments then began to encourage mosquito control efforts. New larvicides were studied and adult control techniques were enhanced, malariologists began to work for state governments and teach in state universities. Cutbacks in the depression era slowed development in the 1930s but federal programs and war prosperity reinvigorated the efforts before mid-century. The lessons that discontinuing consistent efforts at control and research in times of fiscal constraint has high costs is perhaps applicable a century later.

Disease/Vector Studies II

164 Responses to the discovery of the Asian tiger mosquito (*Aedes albopictus*) in southern California, 2011

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The Asian tiger mosquito, *Aedes albopictus*, is well known as a competent vector for dengue, chikungunya, and several encephalitis-causing viruses. It is an aggressive daytime-biter native to southeastern Asia. In the US, the first population of *Ae. albopictus* was documented in Texas in 1985. Since then, this species has spread north and east and is now well-established in many eastern and southeastern states. Studies have suggested that *Ae. albopictus* is responsible for the recent outbreaks of dengue in south Florida. In California, isolated *Ae. albopictus* occurrences were identified at least 4 times between 1971 and 2004. In all cases, however, focused control efforts appeared to be successful in preventing its local population establishment. Here we report on the unexpected discovery of *Ae. albopictus* in southern California in 2011. The mosquito was initially observed in early September during a requested service visit to a mobile home park in El Monte, Los Angeles County. Eggs, larvae, and adults of *Ae. albopictus* were collected and identified during the follow up surveillance throughout this small community as well as in an extended area. This presentation will highlight the collaborative multi-agency effort to assess the extent of the infestation and the development of control strategies with the goal of eradication.

165 Occurrence of invasive mosquitoes and exotic viruses in Germany

Norbert F. Becker, norbertfbecker@web.de**,** Hanna Jöst, Christina Czajka, Katrin Huber and Jonas Schmidt-Chanasit

The German Mosquito Control Association (KABS) has been conducting a mosquito surveillance program for almost 3 decades. A total of 48 established species (47 autochthonous and 1 alien species, *Aedes japonicus japonicus*) as well as *Ae. albopictus*, a non-established species, have been recorded. In a cooperative program between KABS and the Bernhard-Nocht Institute, Hamburg, Germany, mosquitoes have been mass-trapped and screened by real-time PCR for the presence of arboviruses and other pathogens/parasites. Three arboviruses namely Sindbis, Batai, and Usutu virus have been isolated, mostly from *Culex* spp. In 2011, the Usutu virus caused a mass of death in the bird population in south-west Germany; hundreds of thousands of Black Birds (*Turdus merula*), but also species such as House Sparrows (*Passer domesticus*), Starlings (*Sturnus vulgaris*), as well as Kingfisher and Finches died. Furthermore, filariae such as *Setaria tundra* have been detected in mosquitoes.

166 Identification of biologically active volatile cues from preferred and non-preferred hosts of the malaria mosquito, *Anopheles arabiensis*

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Anopheles arabiensis is one of the major vectors of malaria. The vector capacity of *An. arabiensis* is related to its propensity to blood feed on human hosts. *Anopheles arabiensis* may, however, feed on alternative non-human hosts. The non-human hosts serve as dead end hosts, since the *Plasmodium* parasites cannot survive in them. This has led to the idea of zooprophylaxis to reduce the transmission of malaria. We conducted a blood meal analysis to determine preferred and non-preferred hosts of *An. arabiensis*. Our results showed that *An. arabiensis* mosquitoes blood fed on cattle, sheep, and goat, while they avoided chickens even though these were available as hosts. Mosquitoes use odor cues emanating from their preferred hosts to locate and obtain a blood meal. To obtain a better understanding on how odor cues regulate host choice in *An. arabiensis* we made aeration extracts from their preferred hosts and non-preferred hosts, and identified the biologically relevant cues using GC-EAD and GC-MS analysis. Our results revealed the presence of several GC-EAD active compounds in the aeration extracts collected from the preferred hosts, including alcohols, aldehydes, and phenols, a few of which were host specific. Non-preferred host specific GC-EAD active compounds were also identified, with only a few being shared between preferred and non-preferred hosts. These compounds might enable identification of novel attractants and repellents, which can be used to control *An. arabiensis*.

167 Communal bird roosts as transmission foci for arboviruses

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Arbovirus transmission is typically patchy over space and time. These transmission patches or foci develop where and when the density of vector-host contacts is sufficiently high. For bird-amplified arboviruses such as West Nile virus (WNV) and eastern equine encephalitis virus, communally roosting passerine birds may attract sufficient host-seeking mosquitoes to provide a discreet geographic venue for arboviral amplification. A theoretical transmission model was generated using Stella modeling software to determine the expected transmission dynamics of a mosquito-borne arbovirus within a communal roost of American Robins (*Turdus migratorius*). Communal robin roosts in Colorado were then sampled for engorged mosquitoes and evidence for local WNV transmission in order to observe actual transmission dynamics for WNV. Density of blood-engorged ornithophilic mosquitoes, WNV antibody prevalence rates in mosquito blood meals derived from robins, and WNV infection rates in mosquitoes were monitored during the period of peak WNV transmission (July - September). Results are discussed.

168 Development of the Florida Medical Entomology Laboratory Arboviral Epidemic Risk Assessment Models by using two environmental parameters

Gregory Ross, gkross@ufl.edu**,** Jonathan Day and Roxanne Connelly

The Florida Medical Entomology Laboratory Arboviral Epidemic Risk Assessments have been developed during the past 10 yr through research projects funded by the Florida Department of Agriculture and Consumer Services. These research projects have allowed the development and implementation of 2 arboviral epidemic risk models that track surface water and act as proxies allowing us to forecast mosquito flight, dispersal, and blood feeding behaviors along with arboviral [St. Louis encephalitis virus (SLE), West Nile virus (WNV), and eastern equine encephalitis virus (EEE)] amplification and transmission levels. An understanding of the relationship between rainfall, vector dispersal, and SLE/WNV amplification allows us to use Modeled Water Table Depth data collected at an 11.0 km^2 resolution to track water table depth and surface water accumulation as a predictor of mosquito movement, mosquito reproduction, viral amplification, and disease transmission risk. The Keetch-Byram Drought Index (KBDI) represents a continuous reference scale for estimating the dryness of soil layers and is used to monitor surface water at a 4.0 km^2 resolution throughout Florida. The KBDI data are used to predict mosquito movement, mosquito reproduction, viral amplification, and epidemic transmission risk for EEE and, to a lesser degree, SLE, and WNV throughout Florida.

169 Surveillance and distribution of mosquito vectors and associated species in Guam and nearby Mariana Islands

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Mosquito specimens from Guam and nearby Mariana Islands deposited at the Smithsonian Institution, National Mosquito Collections were examined for their taxonomic identities, and their associated collection data were recorded. Recent field collected specimens from various locations were also identified, and their habitats and collection information were noted. An extensive literature search for historical records of various mosquito species was also conducted for these islands. About 40

species and 4 subspecies, in 8 genera (i.e., *Aedeomyia, Aedes, Armigeres, Anopheles, Culex, Lutzia, Mansonia*, and *Toxorhynchites*) were determined from surveyed islands. Updated mosquito checklists of these islands, as well as their mosquito-borne pathogens, were also noted.

170 Relationship analyses of human West Nile virus (WNV), confined livestock operations, and playa lakes in Texas

Christena Stephens, myotis9@msn.com

A total of 432 human West Nile virus (WNV) cases occurred with 28 fatalities in the Panhandle and South Plains region from 2002 to 2008 in 41 counties. Of significant interest was determining if these WNV cases were spatially clustered near major ecological and economic features of playa lakes and confined livestock operations (CLOs). An important role of spatial statistics is to account for spatial dependence and search for spatial patterns in geographical data. Cluster investigations have long been an important tool in epidemiology and spatial statistics. To quantify WNV prevalence in the region for clustering around CLOs and playa lakes, SaTScan™ and ArcGIS™ were used in conjunction to determine spatial clustering. Spatial clustering results indicate that a spatial correlation and dependence exists in the geographical data between human WNV cases, beef cattle operations, and playa lakes.

Education/Public Relations

171 An efficient model for bringing your educational outreach message to middle schools

Neil Wilkinson, nwilkins@fgcu.edu**,** Brian Murphy and Eric Jackson

Connecting with the community you serve is an essential element to any comprehensive mosquito control operation. Bringing your message to schools is one way to create strong relationships with the schools that reside within your district;, however, the time commitment of staff conducting educational outreach is often too great for many districts. This new approach brings a well-designed educational outreach program with a broad environmental science theme and a focus on local insects highlighting mosquitoes to middle school classrooms with the classroom teacher providing most of the instruction.

172 What's going on down there? Short studies: Factors affecting larvicide performance in catch basins

Grifith S. Lizarraga, glizarraga@clarke.com**,** Jacob Hartle and Derek Drews

Larvicide formulations may be unique, but all are subject to the same common factors in a catch basin that can have significant impact on performance. We conducted short studies on these factors and report here suggestions that can help provide the best performance in catch basins.

173 So what happened to the PHEREC and its services?

John P. Smith, docmx8@gmail.com

This will be an overview of what became of the Public Health Entomology Research & Education Center (PHEREC) located in Panama City, FL. It will include answers to the following questions having surfaced since closure on June 30, 2011. Why was PHEREC closed? Where are the scientists now? Who provides the services once delivered at PHEREC? What is the best way to make contact for assistance? And more...

174 *Wing Beats*: Step by step

Stephen L. Sickerman, sickerman@comcast.net and Jack Petersen

Wing Beats magazine is the official quarterly trade journal of the American Mosquito Control Association and the Florida Mosquito Control Association. The editors encourage members to submit manuscripts for publication. The technical processes required to publish each issue will be discussed including: reviewing and proofing manuscripts; placement and layout of digital text, photographs and other graphic elements and bringing the issue to press and into the reader's mail and e-mail box.

175 Evaluation of dengue prevention education in Key West, Florida

Jooi Vyas, jxv120@case.edu**,** Elizabeth Gazdick, Todd Warner, James Matthias, Kimberly Pattison, Daniel Tisch, Danielle Stanek, Ronald Blanton, Carmen Perez, Emily Zielinski-gutierrez, Carina Blackmore, Christopher Tittel, Robert Eadie, Andrea Leal and Michael S. Doyle

Key West, FL, experienced autochthonous transmission of the viral mosquito-borne disease dengue in 2009 and 2010, with nearly 100 cases reported. This launched large-scale, multi-agency efforts to engage residents in prevention activities. A population-based evaluation of knowledge, attitudes, and behaviors toward dengue prevention was undertaken in July 2011, consisting of 557 household interviews and inspections for *Aedes aegypti* larvae. Domestic inspectors from the Florida Keys Mosquito Control District (64.8%) and local newspaper articles (64.6%) were identified as the most frequently recalled sources of dengue information. Many respondents (83.5%) were able to identify standing water as a source for the mosquito vector, and the vast majority recognized infected mosquitoes as the transmission mode. Respondents who had exposure to dengue educational messages scored statistically significantly higher than respondents who did not recall exposure to any educational messages. However: 1) less than half of respondents (43%) were aware that dengue cases in Key West had been hospitalized, though 59% considered dengue a serious problem for Key West; and 2) one-third of respondents also were not able to name specific symptoms of dengue illness. Multivariate analysis will be presented to more thoroughly describe the population's knowledge, attitudes, and practices concerning dengue. Results are being used to improve health communication strategies in the Key West area.

176 DNA barcoding of the mosquito genus *Culex* (Diptera: Culicidae)

Jacques Dubois, j.dubois@nhm.ac.uk**,** Richard C. Wilkerson, Maria-Anice M. Sallum, Desmond Foley, Ralph E. Harbach, Ian J. Kitching, Ravinder Bhatia, Filiz Gunay, Gregor J. Devine, Seth Irish, Theresa Howard and Yvonne-Marie Linton Linton

Culex is a large cosmopolitan genus of mosquitoes. Several species are vectors for arboviruses (e.g., West Nile, St. Louis and Japanese encephalitis viruses) and filarial worms that cause disease in humans. To facilitate effective management of both mosquitoes and diseases, accurate identification of vectors is a key element. Within the framework of the Mosquito Barcoding Initiative, which aims to produce identification tags for 80% of all currently recognized species of Culicidae (3,531 species), and in conjunction with an ongoing integrated morphological and molecular systematics study of the tribe Culicini at The Natural History Museum in London, we carried out barcoding of *Culex* species to provide reliable identification tools. To achieve our sampling, we relied heavily on archive specimens in major museums of the world. We investigated the utility of the COI barcode region for species identification across the genus *Culex* and other members of the tribe Culicini. We discuss the power of resolution of DNA barcoding and its limitations for reliable identification of specific and subspecific taxa and members of cryptic species complexes, as well as the use of barcodes as a possible tool to uncover genetic variability that may lead to the discovery of new taxa.

177 Molecular systematics of the mosquito tribe Culicini (Diptera: Culicidae)

Jacques Dubois, j.dubois@nhm.ac.uk**,** Yvonne-Marie Linton Linton, Ian J. Kitching and Ralph E. Harbach

The tribe Culicini is composed of 4 genera including *Culex,* which is cosmopolitan and comprises 768 species classified in 26 subgenera. Several of these species are vectors for arboviruses (e.g., West Nile and Japanese encephalitis viruses) and filarial worms that cause disease in humans. Within the framework of an integrated morphological and molecular systematics project, we carried out the first fully integrated study on the phylogenetic relationships within this tribe to investigate and understand the evolution and diversification of this group. Selected species of the tribe Culicini representing all the different genera, subgenera, and species groups were sequenced and several molecular markers analyzed. We discuss their variability and the phylogenetic signal held by the different markers and by combining their information, we aim at describing the phylogenetic relationships between the members of this species-rich group and suggest possible evolutionary scenarios to explain such a biodiversity.

***Aedes albopictus* Symposium**

178 Demographic variables and their predictive ability for assessing presence

Taryn Crepeau, taryn.crepeau@co.monmouth.nj.us**,** Kristen Bartlett-Healy, Sean P. Healy, Ary Farajollahi, Isik Unlu, Randy Gaugler and Dina M. Fonseca

The goal was to determine which demographic variables could predict the presence of *Aedes albopictus*. Previous data from the ATM study indicated that poverty level was significantly correlated with *Ae. albopictus* abundance. Since poverty level is often associated with other demographic variables, we tested several social and population based demographics, to determine if these could be used to select areas for *Ae. albopictus* control.

179 Adult surveillance: BG-Sentinel™ trap and BG-Lure™ is the best system

Daniel L. Kline, dan.kline@ars.usda.gov

Sampling the adult mosquito population is important to understanding the biology and ecology of the target species, specifically population density and distribution patterns. This information is also important in order to understand the impact of various control interventions on the adult population. It is essential that the selected sampling method give results that are constant, standardized and reliable for the detection and monitoring of changes in adult populations. Recently, a new mosquito trap (the BG-Sentinel trap) and lure have been developed to capture adult female *Aedes aegypti*. This trap has proven to be a very effective surveillance tool for that species. It is used in conjunction with the BG-Lure, which is a blend of mosquito attractants consisting of lactic acid, ammonia, and caproic acid, substances which are found on human skin. The blend is constantly emitted in a fixed ratio from a long-lasting multi-component dispenser. Various configurations of this trap/lure system were tested in a series of comparative experiments against a standard CDC trap (used by the local mosquito abatement program) and a propane powered trap in a suburban neighborhood in Gainesville, FL. The BG-Sentinel Trap/BG-Lure system was found to be the best surveillance tool for adult *Ae. albopictus*. Carbon dioxide was not required to capture adult *Ae. albopictus* when this trapping system was used.

180 The pros and cons of egg counts

Dina M. Fonseca, dinafons@rci.rutgers.edu**,** Rafael Valentin, Taryn Crepeau, Sean P. Healy, Ary Farajollahi and Isik Unlu

Ovitrapping is a cheap and widespread method to obtain information on the presence and abundance of *Aedes albopictus* and especially in Europe is often used as the sole surveillance method. We studied populations of *Ae. albopictus* in 3 groups of 1,000 houses each in Mercer and Monmouth counties, NJ, USA, during the entire active season (May through October/November) of 2009, 2010, and 2011, using both ovitraps to survey eggs and BG Sentinel™ traps to survey adults. Because in New Jersey *Ae. atropalpus, Ae. japonicus*, and *Ae. triseriatus* will also oviposit in the ovitraps, in 2009 we hatched as many eggs as possible and raised the larvae to 3rd instars for identification. In 2010 we developed and employed a quantitative multiplexed PCR high throughput strategy to do the same. We summarize the new methodology and present information on the usefulness of egg numbers to test control strategies, the population dynamics, and the onset of the winter diapause in *Ae. albopictus*. We present ways of addressing the shortcomings of surveying *Ae. albopictus* using ovitraps and maximizing their usefulness.

181 Surveys of immature stages

Isik Unlu, iunlu@mercercounty.org**,** Ary Farajollahi, Anna Corichi, Randy Gaugler, Dina M. Fonseca, Gary G. Clark and Dan Strickman

Natural and artificial containers are common larval and pupal habitats for a variety of mosquito species. A larval/pupal mosquito survey of container-inhabiting mosquitoes was conducted in a study site consisting of approximately 1,000 parcels (residences) in the city of Trenton, NJ, during 2009. Each parcel was inspected for containers holding mosquito larvae and/or pupae. Eight mosquito species were collected during the surveys. A total of 20,039 container inspections were performed during parcel-to-parcel inspections. Of those inspections, 520 containers were infested with mosquito larvae. *Aedes albopictus* was the most frequently encountered species, being found in 237 (46.1%) of all positive containers. August was the peak month for *Ae. albopictus*-positive containers and parcels. *Aedes albopictus* larvae preferred tires, buckets, and plant saucers as container types. For mosquito control agencies that use removal of water holding containers and larviciding to reduce *Ae. albopictus* populations, our results indicate that effective control should target the aforementioned containers.

182 Population dynamics and host preference of adults

Ary Farajollahi, afarajollahi@mercercounty.org**,** Andrea Egizi, Sean P. Healy, Isik Unlu, Taryn Crepeau, Kristen Bartlett-Healy, Gary G. Clark, Dan Strickman, Randy Gaugler and Dina M. Fonseca

Aedes albopictus, the Asian tiger mosquito, is an invasive species in North America with considerable nuisance and public health implications. The species has expanded its range into northern temperate areas and has seriously challenged conventional mosquito control practices. A paradigm shift in integrated mosquito management practices is greatly needed for the establishment of novel and effective control strategies. Understanding the population dynamics of *Ae. albopictus* is important to determine application timing and to assess the likely impact of vector control interventions. We conducted a weekly surveillance program using BG-Sentinel™ traps from May through October of 2008-2011 in multiple study plots located in central New Jersey. The BGS trap was an essential surveillance tool which collected large numbers of *Ae. albopictus* (male and female) in various gonotrophic stages (unengorged, engorged, gravid). Blood meal analyses showed a predominance for human hosts, followed by cats, dogs, possums, etc. and even white-tailed deer in more suburban locations. Weekly trapping helped determine seasonality of *Ae. albopictus*, extent of local production, and effectiveness of vector control interventions.

183 Insecticide resistance status

Sebastien Marcombe, sebastien.marcombe@rutgers.edu**,** Ary Farajollahi, Sean P. Healy and Dina M. Fonseca

Aedes albopictus, the Asian tiger mosquito (ATM) is an introduced invasive species in the US responsible for a significant proportion of service requests to local mosquito control programs. ATM was first detected in New Jersey in 1995 but is now one of the most common pest mosquitoes responsible for many service calls that result in the application of insecticides. However, to date no information is available on the insecticide resistance status of the ATM population in New Jersey and the possible impact of insecticide resistance on future ATM control operations. The present study was developed to examine the insecticide resistance status of New Jersey ATM populations in comparison with a susceptible laboratory strain and to ATM populations from Pennsylvania and Florida. Larval and adult bioassays were implemented following WHO standard protocols. We chose a range of insecticides representing classes or types of insecticides with different modes of action currently or historically used in NJ for mosquito control (organochlorines, organophosphates, pyrethroids, carbamates, insect growth regulators and bioinsecticides such as *Bti* and spinosad). Our aim was to evaluate the toxicity, resistance, or cross resistance patterns, and possible mechanisms involved in resistance in field populations of ATM.

184 Cost-benefit analysis of an area wide pest management program

Donald S. Shepard, dshepard@brandeis.edu**,** Yara Halasa, Eve Wittenberg, Dina M. Fonseca, Ary Farajollahi, Sean P. Healy, Randy Gaugler, Kristen Bartlett-Healy, Dan Strickman and Gary G. Clark

Area-wide pest management (AWPM) is recommended for controlling urban mosquitoes such as *Aedes albopictus*. While several evaluations of effectiveness exist, information on costs is lacking. Economic evaluation is important to help inform policy makers and obtain appropriate resources. We are conducting an economic evaluation for an AWPM in New Jersey as part of a controlled design (AWPM vs. control). We analyzed financial documents and time allocation of staff implementing the programs in 2009 and surveyed random samples of households in the target areas annually by a combination of mailed, telephone and in-person interviews. Sample sizes ranged from 437 (2008) to 591 (2010). Estimated benefits were reduced losses in potential hours of yard and porch activities in an average summer week because of mosquitoes based on a difference-in-difference analysis and the willingness to pay (WTP) for an effective mosquito control program. Potential hours lost per week due to mosquitoes in AWPM areas between the base year (2008) and the second intervention year 2010 declined by 7%±3.7% (mean±SEM) compared to control areas, indicating a strong trend towards program effectiveness (p=.10 with 2-sided t-test). The mean WTP for an effective program was an additional $9.54 per capita. Area-wide intensive implementation of recommended mosquito control protocols cost $29.40 per capita. Results indicate the public supports an AWPM program but customization is required to make it affordable.

Aerial Control/Aviation

185 Aerial ULV performance of Duet™ dual-action adulticide on post-flood mosquito broods in western Kentucky

Andy Lima, alima@clarke.com

Duet, a dual-action adulticide containing 2 active ingredients, prallethrin (1%) and sumithrin (5%), provides unique performance characteristics that prove beneficial in heavy infestations. Initial field and cage trial observations have shown

that the pairing of the 2 active ingredients causes "benign agitation", a non-biting excitation of mosquitoes. This has the potential to increase the contact of mosquito populations within the drift zone to ULV droplets, which can lead to greater control. The efficacy of Duet was demonstrated in an aerial area-wide mosquito suppression effort in western Kentucky during spring 2011. Flooding on the Mississippi, Ohio, and Tennessee rivers in April and May 2011 were among the largest and most damaging recorded during the past century. Mosquito populations increased to 3.3 times normal levels (2001 - 2010). During a 4 d mission (May 27 - May 30), control within spray blocks averaged 88% when Duet was applied at 0.8 fl oz/acre by fixed-wing aircraft. More than 45,000 mosquito specimens were collected and identified to species level from 47 trap sites during the mission. This presentation will detail operational logistics, local species abundance, application rates, and efficacy data.

186 Larviciding offshore islands reduces adulticidal treatment of populated areas adjacent to National Wildlife Refuges

Lawrence Hribar, gringo1122@hotmail.com**,** Edsell Fussell and Andrea Leal

The Florida Keys Mosquito Control District has conducted larvicide missions on uninhabited offshore islands to reduce the need to apply adulticides on nearby populated islands where private lands are interspersed with refuge lands. From 2003 to 2010, a marked reduction in adult mosquito numbers was seen on Big Pine Key, and to a lesser extent on No Name Key. Numbers of aerial adulticide missions flown on Big Pine Key, No Name Key, and the Torch Keys was 2, 1, and 2 in 2003; 9, 10, and 7 in 2004; 4, 4, and 2 in 2005; 6, 6, and 7 in 2006; 1, 0, and 0 in 2007; 3, 2, and 4 in 2008; 4, 3, and 4 in 2009; and 1, 1, and 3 in 2010, respectively. This is a dramatic reduction from prior years; from 1998 to 2002, 57 aerial adulticide missions were flown on Big Pine Key, 45 missions were flown on No Name Key, and 38 on the Torch Keys. Larviciding is an important component of an integrated approach to mosquito management.

187 Aerial ULV application of permethrin against adult mosquitoes over open field and medium density canopy habitat in a hot-temperate zone

Seth C. Britch, seth.britch@ars.usda.gov**,** Kenneth J. Linthicum, Robert L. Aldridge, Todd W. Walker, Muhammad Farooq, Wesley Hoffmann, Bradley K. Fritz, Christopher T. Parker, Mark Breidenbaugh, Phillip Townsend, Donald Teig and Jerry Kerce

Although aerial ultra-low volume (ULV) application of adulticides is a common adult mosquito control strategy, not enough is known about the fate of the pesticide or its efficacy over different habitats. Dye labeling of droplets is used to evaluate ULV applications, and, by inference, their efficacy. Placement of caged sentinel mosquitoes in the target area may also be used to confirm impact and efficacy of the pesticide. Simultaneous use of dye labeling and sentinel cages is less common. Previous studies of ground ULV applications with dye-labeled pesticides have shown that droplet collection and dye analysis results may not match patterns of mortality in sentinel mosquitoes co-located with droplet collection devices. In this study we investigated ULV applications of dye-labeled permethrin from a military aerial spray platform. We deployed an extensive grid of droplet collection surfaces co-located with caged sentinel mosquitoes across 325 acres of open field and moderate density woodland canopy habitats in a hot-temperate region of north central Florida. Patterns of droplet density and droplet spectrum, dye deposition (i.e., inferred active ingredient concentration per unit area on collection surfaces), and mosquito mortality were not cross-predictive and were not spatially congruent. Canopy habitat did inhibit deposition and mortality for some spray runs compared to open field habitat; however, wind patterns could overcome the resistance of canopy and lead to high deposition and mortality.

188 Operational aerial application of Zenivex™ E-20, Box Elder, UT

Ed Bredemeyer, ebredemeyer@central.com and Bill Reynolds

Box Elder Mosquito Control District, Central Life Sciences (CLS), and Vector Disease Control Inc. (VDCI) participated in a cooperative operational aerial application of Zenivex E20 (etofenprox) on the evening of September 7, 2011. The treatment block was 12,685 acres. Zenivex E20 was applied at the mid-label rate of .003468 lb active ingredient per acre. Mixed 1:1 with BVA ULV oil, Zenivex was applied at 0.6 fl oz /acre using a Cessna 402 equipped with 2-Micron Air™ AU4000 rotary atomizers. The aircraft was equipped with a Wingman GX™ drift optimization GPS system and an AIMMS-20™ onboard meteorology system. Pre-trap counts were monitored several nights prior to the application and 2-nights post-application. Landing rate counts (LRC) were taken the evening before, the night of, and the night following the aerial application in 5 locations within the treatment block. This established pre- and post-quantitative values of adult mosquito populations and provided peak activity times in order to time the application.

189 Studying aerial applications using Drop Vision® FL and Tinopal OB fluorescent powder mixed in adulticides

Jeffrey C. Stivers, jeff@cmcd.org**,** Marin Brouillard and Kelly Huff

Several different research/operational trials in which Tinopal® OB fluorescent powder was mixed with the adulticide were performed. Aerosol droplets were collected on Teflon-coated 1/8 in. slides in rotating impingers and then viewed using Drop Vision FL. These efforts will be discussed, and some preliminary data will be presented to demonstrate how Tinopal OB and Drop Vision® FL can be used to study down-wind drift of the applied material, determination of effective swath width, duration of the insecticide cloud, and possible correlation of droplet density, droplet numbers or DV.50 with mortality of caged mosquitoes.

190 Movement of adult mosquito sprays

Wesley Hoffmann, clint.hoffmann@ars.usda.gov**,** Bradley K. Fritz and Keith Haas

Effective control of adult mosquitoes through aerial sprays is influenced by the type of insecticide sprayed, how it is sprayed, and meteorological conditions. Field trials were conducted to evaluate the effects of spray droplet size on spray droplet

movement and resulting efficacy on adult mosquitoes. Two spray treatment were evaluated, 1 spray with a Dv0.5 of 25 µm and 1 with 100 µm, based on the HSWT tests of rotary atomizers. Each spray application was made ~300 ft upwind of the first row of samplers. The insecticide-laden spray cloud drifted through the spray block, then samplers were collected and a new set was placed for the next application. At each of the 16 sampling locations there were 2 bioassay cages with mosquitoes and 2 spinners: 1 Teflon®-coated for droplet sizing and 1 uncoated for deposition analysis. Mortality in the bioassay cages was assessed at 4 and 24 HAT. The tests showed that the smaller droplet sprays moved through the spray block more uniformly than the larger droplet spray. Caged mosquito mortality was well correlated with measured spray flux at each sampling location.

191 Aerial operational application of Zenivex™ E-20, Moses Lakes, WA

Dan Couture, dancouture@co.grant.wa.us and Bill Reynolds

Grant County Mosquito Control of Moses Lakes, WA, and Central Life Sciences participated in a cooperative operational aerial application of Zenivex E20 (etofenprox) in August 2011. The treatment block was 6,342 acres. Zenivex E20 was applied at the mid-label rate of .003468 lb AI/acre. Mixed 1:1 with BVA ULV oil, Zenivex was applied at 0.6 fl oz/acre using a Piper Brave turbine aircraft equipped with 2-Micron Air AU4000 rotary atomizers. The aircraft was equipped with a Satloc M3®. Drift optimization offsets were provided by AGDISP spray fate prediction software. Pre and post trap counts were monitored several nights prior to and following the application.

Harris County Symposium

192 The tenth anniversary of West Nile virus (WNV) in Harris County, TX, 2002-2011: evolution of mosquito control operations

Rudy Bueno, rbueno@hcphes.org

West Nile virus (WNV) has now been in Harris County, TX, for 10 seasons. Activity levels of WNV in mosquito populations were initially high from 2002-2006, light in 2007-2008, moderate in 2009-2010, and significantly increased to its highest level in 2011 since its introduction according to operational surveillance data. Since the introduction of WNV in Harris County in 2002, the Harris County Public Health and Environmental Services Mosquito Control Division has implemented new strategies to monitor and control disease outbreaks. These strategies include: comprehensive, countywide WNV surveillance of mosquito populations; timely disease diagnostics; vehicle tracking and chemical usage monitoring of ground treatment operations; insecticide resistance management and surveillance; aerial control; geographical information systems mapping and reporting; mosquito control operational area characterization; and applied research. The implementation of these strategies has increased the efficiency of disease detection and the response of control efforts. Highlights of these strategies will be described in the presentation.

193 A summary of West Nile virus (WNV) surveillance activities in Harris County, Texas 2011

Maximea E. Vigilant, mvigilant@hcphes.org**,** Martin Reyna Nava, Yvonne Randle and Rudy Bueno

Harris County Public Health and Environmental Services Mosquito Control Division (HCPHES-MCD) is responsible for trapping, processing, and identifying mosquitoes before they are submitted to Virology for testing. On a weekly basis, 268 operational areas are trapped using 134 CDC light traps set in the county's storm sewer system, and an equal amount of gravid traps on citizens' properties. Trapped mosquitoes are frozen prior to being identified to species. More than 13 different *Culex* and *Aedes* species are identified each week. *Culex quinquefasciatus*, *Aedes aegypti*, and *Ae. albopictus*, amongst others, are the species most commonly pooled for testing to determine their viability as vectors of West Nile virus (WNV) and St. Louis encephalitis (SLE). In 2011, *Cx. quinquefasciatus* has been the only species positive for WNV with 587 pools. On average, more than 20,000 female mosquitoes are collected weekly and more than 10,000 are pooled for testing. The weekly average pools for testing is approximately 500. Storm sewer traps have a greater average collection rate than gravid traps. More females are pooled for testing from the gravid traps, which also produces the greater number of WNV confirmed positives. Data collected within the surveillance section assist in directing live bird trapping, control measures operations including aerial spraying, ULV application, and inspections.

194 Ten years of West Nile virus (WNV) surveillance activities in Harris County, TX, (2002 - 2011)

Martin Reyna Nava, mreyna@hcphes.org**,** Yvonne Randle, Vence Salvato, Maximea E. Vigilant and Rudy Bueno

Harris County, TX, an endemic area for St. Louis encephalitis (SLE) since 1964, modified its collection and testing methodology to prepare for the arrival of WNV in 2002. The first WNV and SLE activity occurred June 10, 2002 with the detection of a WNV-confirmed Blue Jay and an SLE positive live bird serum. The first WNV mosquito isolate was detected on June 11, 2002. A month later, the first WNV human case was reported. In the 10-yr period, 15.4% of the avian sera were HI positive, and further IgM tests indicated that 7.3%, 24.9%, and 67.8% were positive for EEE, SLE and WNV, respectively. WNV confirmed dead birds totaled 17.5%. Thirty-four bird species were WNV positive, with Blue Jays representing 80% of those confirmed. Likewise, 13 mosquito species were WNV and/or SLE positive. *Culex quinquefasciatus* made up > 96% of the collections, followed by 41 other species. Both SLE and WNV positive pools had a normal curve reaching their peak at epi-week 31 and 32, respectively. WNV activity occurred on a yearly basis with sharp declines in 2007 and 2008. Finally, state-confirmed WNV human cases fluctuated throughout the period, but decreased overall since initial WNV detection.

195 Avian surveillance activities in Harris County, TX 2002 – 2011
Vence Salvato, Martin Reyna Nava, Yvonne Randle and Rudy Bueno

Harris County, Texas, an endemic area for Saint Louis Encephalitis (SLE) since 1964, modified its avian collection and testing methodology in preparation for the arrival of West Nile Virus (WNV). In 2002 Harris County added WNV testing to the live bird surveillance and started testing dead birds reported by citizens. The first WNV was found on June 10th, 2002 in a dead Blue Jay. In the 10-year period, 15.4% of avian sera tested HI Positive. Thirty-two species tested HI WNV positive out of seventy-four species tested be from 2002 to 2011. In the 10-year period, 17.5% of the dead birds tested were confirmed WNV positive. Thirty-six bird species we confirmed positive out of one hundred and fifty-four species tested from 2002 to 2011.

196 Impact of West Nile virus on arbovirus testing in Harris County, Texas

Yvonne H. Randle, yrandle@hcphes.org, Martin Reyna Nava, Cheryl Battle Freeman, Monique Jackson, Joyce Landry and Rudy Bueno

The emergence of West Nile virus (WNV) in the USA in 1999 and into Texas in 2002 brought about profound changes in testing for arboviruses at HCPHES Mosquito Control Division. The main focus had been detection of St. Louis encephalitis (SLE) virus in mosquitoes and birds. In 2001 the program was expanded to include detection of WNV. The resulting increased sampling doubled and eventually tripled the lab's workload. Because control measures are gauged by confirmed test results, the volume of WNV-positive samples obtained made it crucial to rapidly obtain results and curtail turn-around time. Between 2002 and 2005, modifications were made to the disease surveillance program and virology lab testing with surveillance and testing taking place over a 3-4 d period each week, providing results within 3 d after collection of mosquitoes. Another noteworthy fact is that WNV seems to be displacing SLE as the endemic arbovirus in Harris County. Though SLE was detected during 2002-2003, along with WNV, fewer numbers of SLE isolates have been detected during subsequent years. This may be indicative of simply a non-active period for SLE or perhaps, both viruses may not be able to co-exist in the same mosquito vector.

197 Harris County area profiling: A disease risk assessment project

Joseph L. Targhetta, jtarghetta@hcphes.org, Martin Reyna Nava, Odd S. Vesteng, Jon-Michael Pond and Rudy Bueno

Area profiling is a centralized SQL database that includes geographic, environmental, demographic, chemical treatment, public infrastructure, and mosquito collection data to enhance and provide a more efficient response to those communities where the likelihood for mosquito-borne diseases is greater. The project includes the creation of ArcGIS maps as a tool to record field data and its analysis. Areas are targeted based on a weighted WNV positive mosquito-bird-human case ranking system. Preliminary results show an increase in water inlets (SW county, N county) where there is a decrease in ditches (NW county). Likewise, there is an increase in ponds (NW county) where there are construction sites, indicating the risk for potential mosquito oviposition sites. Since 2008, 137 of 268 areas have been completed. All collected data is reported for each specific operational area as a disease risk assessment report and decision making tool. Furthermore, the acquisition of field data will also benefit local municipalities' public infrastructure programs by enhancing it to a greater detail.

198 The Area Profile Project as a disease risk assessment and other future applications

Elyse Heob, eheob@hcphes.org, Joseph Targhetta, Martin Reyna Nava and Rudy Bueno

The Area Profile Project (APP) characterizes operational areas of Harris County, TX by factors relevant to mosquito-borne disease. The value of the APP will be discussed. The area within the Interstate 610 loop freeway will be analyzed for trends that correlate mosquito species type, mosquito distribution, and disease prevalence to relevant area characteristics. These trends organize historic data into plans for future disease response. Other future applications of the APP include development of a thorough disease risk assessment, tools to maximize targeted resources, and models for other diseases/regions. The APP also yields internal benefits of readily accessible data updated on a real-time basis.

199 Use of GIS technologies for program enhancement since the introduction of WNV in Harris
Chris Fredregill

The introduction of West Nile virus in 2002 resulted in the expansion of our utilization of GIS technologies. All program elements have benefitted from these technologies that have streamlined data collection, storage, analysis and sharing between internal and external stakeholders. This presentation will focus on examples from throughout the organization that have proven useful to a multitude of users.

200 Evaluation of operational adulticides by field cage testing from 2005-2010 in Harris County, TX

Pamela M. Stark, pstark@hcphes.org, Jennifer H. Wiggins, Kyle Flatt and Rudy Bueno

Harris County Mosquito Control performs applied research on *Culex quinquefasciatus* specifically because of its proclivity to become infected with St. Louis encephalitis (SLE) and West Nile virus (WNV) and to transmit these diseases to humans. A priority emphasis has been on monitoring the effectiveness of the ground ultra-low volume adulticide program. This is achieved by comparing the mortalities of feral mosquito populations from specific mosquito control operational areas relative to the in-house susceptible Sebring colony strain. The field cage testing has resulted in the development and implementation of insecticide resistance management which involves a rotational strategy of an organophosphate (malathion) and a synthetic pyrethroid (resmethrin) to treat areas where WNV or SLE have been detected. This strategy of using a pyrethroid and an organophosphate has maintained the effectiveness of both adulticides as assessed by the resistance and efficacy study.

201 The practical implementation of an insecticide resistance management strategy in Harris County, TX
James Self, Ron Reed, Kyle Flatt and Rudy Bueno

The rotation of insecticides of different classes has long been recognized as a method of reducing the likelihood of resistance in pest populations. This presentation describes the development and implementation of a dual use system that has been employed in Harris County, Texas, since 2005. Future improvements are also discussed as part of the ongoing developmental process in our efforts to most effectively control disease vectors in Harris County.

202 The evolution of public education activities in response to West Nile virus (WNV) in Harris County, TX from 2002 to 2012
Rebecca Riley, rriley@hcphes.org

Harris County Public Health and Environmental Services Mosquito Control Division (HCPHES-MCD) is responsible for the trapping, processing, and identifying mosquitoes before they are submitted to virology for testing. On a weekly basis, 268 operational areas are trapped using 134 CDC light traps set in the county's storm sewer system, and an equal amount of gravid traps on citizens' properties. Trapped mosquitoes are frozen prior to being identified to species. More than 13 different *Culex* and *Aedes* species are identified each week. *Culex quinquefasciatus*, *Aedes aegypti* ,and *Ae. albopictus*, among others, are the species most commonly pooled for testing to determine their viability as vectors of West Nile virus (WNV) and St. Louis encephalitis . In 2011, *Cx. quinquefasciatus* has been the only species positive for WNV with 587 pools. On average, more than 20,000 female mosquitoes are collected weekly and more than 10,000 are pooled for testing. The weekly average pools for testing is approximately 500. Storm sewer traps have a greater average collection rate than gravid traps. More females are pooled for testing from the gravid traps, which also produces the greater number of WNV confirmed positives. Data collected within the surveillance section assist in directing live bird trapping, control measures operations including aerial spraying, ULV application, and inspections.

203 Utilizing media to communicate public health awareness messages in response to West Nile virus (WNV) in Harris County, TX: Then...and now!
Sandra Kachur, skachur@hcphes.org

2012 marks the 10th anniversary since West Nile virus (WNV) was first detected in Harris County, TX. Its arrival brought much media attention as people were eager to learn about the new disease. In the 10 years since its arrival, media relations have played an integral part in communicating mosquito control and prevention messages. Well-constructed and properly delivered media messages can inform and calm a worried public, reduce misinformation, and focus attention on what is most important. Quality media relations, partnered with public education programs, have contributed to a heightened awareness of mosquito control and its impact on public health throughout the years. Media today has evolved into a multi-faceted entity that has become a fundamental part of our life. This evolution has helped us be more effective, reach more people with important public health messages, and implement effective risk communication practices.

Poster Abstracts

Adult Control

P-01 Comparison study of collecting efficiencies of three selective mosquito traps from rural areas in Korea
Hoonbok Yi, yih@swu.ac.kr, Jae-seung Yu, Hyunjung Kim, E-huyn Shin, Jong Woo Nam and Ji Eun Sung

We used 3 kinds of mosquito traps (Black-hole, CO_2-baited Mos-hole with a newly developed attracting-solvent, and CO_2-baited Digital Mosquito Monitoring System or DMS) to determine their female mosquito collecting efficiencies in Korea. The Black-hole mosquito trap caught many insects, and few female mosquitoes. The trap uses UV-light, and the light seemed to attract other terrestrial and aquatic insects, such as the common flies, mayflies, and stoneflies. Even though the trap was developed to collect mosquitoes, female mosquitoes comprised less than 1% of all insects caught. Furthermore, its selective efficiency for female mosquitoes was relatively lower than other traps. The Mos-hole and CO_2-baited DMS traps had collecting efficiencies of over 80%. The 2 traps caught relatively lower numbers of other insects (less than 3% of total insects), including a few Coleoptera and Diptera, and their collecting efficiencies for female mosquitoes was much higher. Generally, mosquitoes disliked the UV light, but preferred CO_2 gas with the attracting-solvent. Female mosquitoes were also attracted to the acidic solvent with CO_2 gas. If we could use efficient and selective mosquito traps while fully understanding mosquito habits, we assume that we can keep biodiversity high around mosquito habitats as well as save money for insect pest control.

P-02 Insecticide resistance in the human bed bug: An evolving story
Jennifer R. Gordon, jgord13@gmail.com, Michael F. Potter and Kenneth F. Haynes

Susceptibility to pyrethroid and neonicotinoid combination insecticides was investigated in populations of *Cimex lectularius* collected from different regions of the United States. Initial colonies tested were never exposed to combination insecticides but were still resistant when compared to a susceptible strain. Next, strains were selected with an ET80, and susceptibility was evaluated against non-selected controls. Finally, cross resistance to different combination insecticides was examined. Results from the current study and the implications for future pest control will be discussed.

Behavior and Biology

P-03 A review of mosquito dispersal, with emphasis on *Culex tarsalis* in California rice fields
Mary A. Sorensen, marys@placermosquito.org

In California, rice fields provide ideal habitat for *Culex tarsalis*, the primary vector of West Nile virus. Mosquitoes dispersing from rice fields often affect nearby communities, making rice one of the major focuses for mosquito control in many areas of California. Much research has been done examining the dispersal habits of mosquito species emerging from rice fields in an effort to better target mosquito control efforts to specific distances around residential areas. Other studies have looked at behavioral cues and the role of wind in determining dispersal direction. California mosquito control agencies have strived to utilize dispersal information to guide control, however a uniform approach has not been adopted in the state. Current knowledge regarding dispersal distance, dispersal patterns, and behavioral cues for dispersal is reviewed, with emphasis on *Cx. tarsalis* in California rice fields, control implications, and future research needs.

P-04 Altered blood feeding behavior in La Crosse virus-infected mosquitoes
Fan Yang, yangfan@vt.edu, Bryan Jackson, Carlyle Brewster and Sally Paulson

Pathogen induced alterations of the feeding behavior of blood-feeding arthropods that result in an increase of transmission rate have been described for numerous parasite-vector systems. We have found that La Crosse virus infection altered the feeding behavior of both *Aedes triseriatus*, the primary vector, and *Ae. albopictus*, a possible accessory vector, by decreasing blood meal size and increasing the probability that infected *Ae. triseriatus* mosquitoes will take multiple blood meals within 1 gonotrophic cycle. This alteration in feeding behavior has the potential to enhance horizontal transmission. HPLC analysis of serotonin concentration from adult female *Ae. triseriatus* heads demonstrated that serotonin concentration was higher in infected mosquitoes compared to controls. Studies are ongoing to determine the role of serotonin in the altered feeding behavior of infected mosquitoes.

P-05 Bionomics of a mosquito community in southwest Louisiana: A five-year summary
Linda D. Canning, LCD@mcneese.edu, Benjamin M. Clark, Terry L. Sylvester, Caroline E. Hennigan, Josiah D. Land, Mukesh Wagle, Joseph T. Guidry, Alan M. Shudes, Joseph H. Dees, Harry A. Meyer and William H. Dees

A 5-year nocturnal periodicity study of mosquito community composition was conducted in the Sabine National Wildlife Refuge in southwestern Louisiana. Mosquitoes were collected during new moon phases before, during, and after sunset and sunrise, and at other intervals throughout the night. A modified-Centers for Disease Control mosquito light trap with a rotating collector was placed 1.5 m above ground, in an area with little to no competing light and where no pesticide applications were conducted. Studies were initiated in July 2006. During the study, 18 species were collected. *Aedes sollicitans*, *Anopheles crucians*, *An. quadrimaculatus*, *Culex nigripalpus*, and *Cx. salinarius* were the most commonly collected species. Data from this study will broaden our understanding of mosquito population dynamics and mosquito-borne disease pathogen transmission in southwest Louisiana.

P-06 Climatic factors affecting mosquito populations in southwest Louisiana
Linda D. Canning, LCD@mcneese.edu and William H. Dees

Long-term studies of nocturnally active mosquitoes in the Sabine National Wildlife Refuge (an intermediate salt/brackish/freshwater marsh) and in Moss Bluff (a freshwater marsh) in Louisiana have been conducted for more than 5 yr and are still underway. These studies involve collecting mosquitoes before, during, and after sunset and sunrise, and throughout the night using Centers for Disease Control mosquito light traps. Traps are placed 1.5 m above ground, in areas with little to no competing light. Meteorological conditions, specifically temperature and humidity, are monitored when mosquitoes are collected. To date, mosquito species have been collected during times of low and high relative humidity (23-95+% RH). On a given trap night, average relative humidity ranged between 54-95+% RH. Temperature showed greater effect on the distribution of species than humidity. Mosquitoes were collected when average nightly temperatures on a given trap night ranged between 8.8°C (low -1.5°C) and 31.4°C (high 38.9°C). No mosquitoes were collected when average temperatures were at or below 8.1°C on a given trap night. *Culex* spp. and *Culiseta* spp. were more prevalent at lower temperatures while *Aedes* spp. (except *Ae. canadensis*), *Coquillettidia* spp., *Psorophora* spp., and *Uranotaenia* spp. were more prevalent at higher temperatures.

P-07 Effects of botanical and aquatic organism extracts on mosquitoes, including an evaluation of oviposition behaviors associated with cage experiments
Joseph T. Guidry, jtg@mcneese.edu, Kaleigh A. Helo, Irvin J. Louque, Shreedu Pradhan, Omar E. Christian, Cecilia Richmond, Jill Hightower and William H. Dees

We evaluated the effects of plant and sponge extracts on mosquitoes, including oviposition preference and egg/larval survival. The plant species *Hypericum hypericoides* and *Hibiscus sabdariffa* were collected in southwest Louisiana; the marine sponge was collected in St. Thomas, US Virgin Islands. The organic extracts of plants and plant leaves, roots or fruit, and whole sponges were evaluated against *Aedes aegypti* mosquitoes. The crude methanolic or ethyl acetate extracts were added to distilled water and tested. Findings from these preliminary studies using different extracts will be presented. During tests to determine mosquito oviposition preferences to these extracts, we detected noticeable oviposition behaviors by mosquitoes in cage experiments that influenced test results (i.e., some inherent cage factor(s) influenced egg deposition). Mosquitoes deposited their eggs into oviposition cups in specific sections of 45.7 cm cube cages. We investigated this oviposition behavior by altering the number and placement of cups containing untreated distilled water. Results from these cage-factor investigations also will be presented.

P-08 Fish oil mixes and the Gravid Trap Attractants Project (GTAP)
William H. Dees, wdees@mcneese.edu and Matthew M. Yates

We present gravid trap attractant formulations used by different parish/regional mosquito control programs in Louisiana. Many of the formulations include fish oil as an additive. During the 2012 AMCA annual meeting, we will initiate a call for gravid trap attractant formulations from the mosquito control community. Persons using gravid traps are encouraged to submit their gravid trap attractant formulations to the Gravid Trap Attractants Project (GTAP). GTAP contact information: Dr. William Dees, Dept. of Biology and Health Sciences, Box 92000, McNeese State University, Lake Charles, LA 70609; Phone 337-475-5654, FAX: 337-475-5677, Email: wdees@mcneese.edu.

P-09 Sand fly problems and preliminary research on monitoring sand fly populations and their behavior in Greece
Alexandra Chaskopoulou, andahask@ufl.edu, Samiye Demir, Javid Kashefi and Philip Koehler

In this paper we will provide a literature review of the sand fly problems in Greece in relation to the state of leishmaniasis in the country regarding both human and canine cases, and the species of *Leishmania* involved. An analytical review of the distribution and prevalence of the sand fly species, along with information on their biology, ecology, and association with *Leishmania* transmission will be presented. Currently in Greece, the main efforts to control transmission are concentrated on treatment of the animal reservoirs. Even though human cases are detected and treated every year, humans are not implicated as an important reservoir of *Leishmania*. No vector control programs are currently in place. In 2011 preliminary field studies were conducted in Thessaloniki, Greece, in areas of increased *Leishmania* transmission, to determine the local sand fly fauna, assess their seasonal and spatial distribution, and investigate the behavior of the most important nuisance and vectoring sand fly species. Areas with increased sand fly activity were identified, and the flight activity patterns, flight height preferences, and resting locations of the sand flies were investigated. This information is important in maximizing the effectiveness of chemical control practices, such as ULV and residual treatments, by targeting the sand flies during periods and locations of maximum insect activity.

P-10 The effect of different light-trap covers on mosquito sampling
William H. Dees, wdees@mcneese.edu, Joseph T. Guidry, Camille F. Abshire-Degrado, Irvin J. Louque, Linda D. Canning and Sandy Allan

In the mid-1980s, silver metal covers on commercially-made Centers for Disease Control (CDC) mosquito light traps were replaced with black plastic covers. We conducted field tests to determine if this change in the material and color of the cover (i.e., silver metal vs. black plastic) affected the number and species of mosquitoes collected. Eighteen comparison tests using non-CO_2-baited CDC light traps were conducted in the months of July, August, and October 2009/2010. More mosquitoes were collected in traps with silver covers (n=560; mean=31) than in traps with black covers (n=437; mean=24). More females also were collected in traps with silver covers (n=504; mean=28) than in traps with black covers (n=367; mean=20). However, more males were collected in traps with black covers (n=70; mean=4) than in traps with silver covers (n=56; mean=3). Thirteen mosquito species in 6 genera (*Aedes*, *Anopheles*, *Coquillettidia*, *Culex*, *Psorophora*, and *Uranotaenia*) were collected during this investigation.

P-11 Water mites on mosquitoes collected in three different aquatic zones in southwest Louisiana
Alan M. Shudes, AMJS@mcneese.edu, Christopher J. Kirkhoff, Taylor P. Wood, Jessica C. Choate, Irvin J. Louque, Joseph T. Guidry and William H. Dees

We report data from ongoing investigations of larval water mites (Acari: Hydrachnida) parasitizing field-collected mosquitoes from southwest Louisiana. In our first investigation in September 2010, 1,014 mosquitoes representing 5 genera and 9 species were collected in Centers for Disease Control light traps near a freshwater marsh in Moss Bluff, LA. Forty-five mites were found infesting 38 mosquitoes. The following mosquito species (with the estimated percent parasitized) were identified: *Aedes sollicitans* (11.1%), *Anopheles crucians* (1.7%), *Culex* spp. (including *Cx. erraticus*, *Cx. restuans*, and *Cx. salinarius*) (4.7%), and *Uranotaenia sapphirina* (3.1%). All mites but 1 were attached to either the thoracic or the abdominal regions. In this investigation, 3 mosquito species, *Ae. albopictus*, *An. quadrimaculatus*, and *Psorophora columbiae*, were not parasitized by mites. In the second investigation, initiated in July 2011, we began investigating mites occurring on mosquitoes collected from saltwater, brackish-water, and freshwater marshes. To date, very few parasitized mosquitoes have been collected. We attribute this to current drought conditions occurring in south-central United States. From both studies, we have identified 2 morphotypes of mites in the genus *Arrenurus*.

Disease/Vector Studies

P-12 *Triatoma dimidiata* infestation and infection with *Trypanosoma cruzi* in a rural village of Yucatan Mexico
Edgar Koyoc-Cardeña, koyocaso@hotmail.com, Pablo Manrique-Saide, Javier Escobedo-Ortegón, Jorge C. Rodríguez-Buenfil, Mario Barrera-Perez, Enrique Reyes-Novelo, Guillermo Guillermo-May and Anuar Medina-Barreiro

Chagas disease is a zoonosis caused by *Trypanosoma cruzi* and is transmitted domestically by *Triatoma dimidiata* in Yucatan. The association between triatomine infestation (after active collections both intra and peridomiciliary and householders participatory-collections inside the houses), triatomine infection (PCR with Tc1 and Tc2 primers), and house/patio characteristics was investigated in 101 houses from Molas, Yucatan, Mexico. The study was carried out during the rainy season 2009 and the dry season 2010. Logistic regression was used to test for associations of infestation/infection with 11 household-level potential risk factors. A total of 200 *T. dimidiata* were collected in 35.6% of the premises, with higher abundances found in the peridomicile (73%). From all triatomines collected, 48% were infected with *T. cruzi* and found within 33.7% of the premises (54.1% and 45.9% intra and peridomiciliary, respectively). Both, infestation and infection rates were higher during the dry season (63% and 69%, respectively). The presence of chicken coops in the patios was significantly associated with both *T. dimidiata* infestation (OR = 4.10, CI 95% = 1.61-10.43, P = 0.003) and infection with *T. cruzi* (OR = 3.37, CI 95% = 1.36-8.33, P = 0.006). The results of this study reveal the importance of the peridomicile as source of *T. dimidiata* populations and a potential risk for disease transmission in this rural village of Yucatan Mexico.

P-13 Ecobiosocial determinants of dengue vector infestation in a dengue endemic neighborhood of Acapulco Mexico
Pablo Manrique-Saide, msaide@uady.mx, Azael Che-Mendoza, Felipe Dzul-Manzanilla, Mario Barrera-Perez, Wilbert Bibiano-Marin and Hector E. Leyva de la Cruz

We report ecological, biological, and social factors of *Aedes aegypti* infestation in Acapulco as part of a multi-country study on Innovative-Community-based Ecosystem-Management-Interventions for Dengue Prevention in Latin-America. Standardized household, neighborhood, and entomological surveys were carried-out in 20 clusters (2,000 households and non-residential private and public spaces) during the dry season, 2011. People's knowledge about dengue is good: 99% have heard about dengue, 92% know that is transmitted by mosquitoes, 86% considered it a serious disease, and 73% think it is preventable. They recognize government actions; however, few acknowledged personal (<10%) and community (<20%) protective actions/measures. *Aedes* breeding was important at the household-level. All clusters reported provision of water supply but 98% reported storing water in buckets, tanks, and plastic barrels, together the most productive containers (89% of total pupae). Exposure at the house-level to mosquito contact (and biting) seems very likely: indoor-collections showed adult *Aedes* in 40% of the houses and 60-70% had openings/incomplete walls and unprotected windows/doors open during the day. Adult females were collected in 80% of schools. Most dengue cases last year were reported from school-aged children with an apparent positive temporal association with rainfall/back-to-school period. Preventing mosquito-exposure in schools and homes could be very effective in reducing dengue transmission

P-14 Prevalence of *Pediculosis capitis* in children from a rural school of Yucatan Mexico
Pablo Manrique-Saide, msaide@uady.mx, Norma Pavía-Ruz, Jorge C. Rodríguez-Buenfil, Roodeth Herrera-Herrera, Pilar Gómez-Ruiz and Daniel Pilger

We conducted an analytical cross-sectional survey to estimate the prevalence and factors associated with active head lice infestation. In total, 140 schoolchildren aged 6 to 16 yr from a public school in Oxcum Yucatan, a rural locality in southeast Mexico, were examined by wet-combing. A structured questionnaire was used to collect information on host and surrounding environmental conditions. Head lice infestation was found in 19/140 (13.6%) children and was associated with lower income (OR 9.9, 95% CI 2.15-45.79, p=0.003) and higher frequency of hair washing (OR 8, 95% CI 1.58-50, p=0.012). Intersectorial control programs that take socioeconomic differences of children into account should be implemented.

P-15 Development of a passive trap for the control and surveillance of *Aedes aegypti* in and around the home
Andrew J. MacKay, hcj8@cdc.gov, Manuel Amador and Roberto Barrera

In communities where most homes lack adequate protection against mosquito entry, the majority of contact with host-

seeking *Aedes aegypti* is likely occurring within the home. Female *Ae. aegypti* remain indoors following successful blood feeding, then leave the home to oviposit. The home environment represents an important location for targeting *Ae. aegypti* adults in different physiological states, both for the purposes of control and surveillance. Available tools for sampling adult vectors in the home are costly, laborious, or are unsuitable for providing long-term, continuous collections. We developed a simple, low-cost, passive sticky trap to sample adult *Ae. aegypti* within the home and in the peridomestic area. We compared several trap designs and attractants in competitive assays under laboratory and semi-natural conditions. The most efficient model for sampling gravid females was a vertical box, open at the top, with a layer of hydrogel at the bottom as a source of water vapor. The addition of stimuli associated with host-seeking and carbohydrate-feeding behaviors enhanced the effectiveness of the trap. Trap efficacy was influenced by placement height and adjacency of dark surfaces. Future efforts will focus on assessing the relative efficiency of this device to sample vectors in homes in Puerto Rico.

P-16 Flood water mosquitoes of the greater Phoenix metropolitan area: What importance do they play?
Kirk Smith, ksmith@mail.maricopa.gov and John Townsend

Aedes vexans and *Psorophora columbiae* are our primary floodwater and nuisance mosquito species of Maricopa County. Since 2008 our routine surveillance trapping program has collected *Ae. vexans* in over 1,900 traps and *Ps. columbiae* in over 10,200 traps. Those traps exceeding our numerical threshold value for generating a fogging operation totaled 852 traps. Therefore, these 2 species alone play a significant role in our mosquito abatement program. However, little is known of their biology nor their importance as disease vectors. These issues will be discussed.

P-17 A comparison between two sampling methods for container-breeding mosquitoes in a La Crosse endemic area
Jacob E. Bova, jbova86@vt.edu, Sally Paulson, Carlyle Brewster and Dana Hawley

La Crosse virus (LAC) encephalitis is an emerging mosquito-borne disease in southwestern Virginia. The primary vector of LAC is *Aedes triseriatus*, the eastern treehole mosquito. Two other container-breeding mosquitoes, *Ae. albopictus* and *Ae. japonicus*, may serve as accessory vectors. An objective of this study was to compare 2 sampling methods, ovitraps and gravid traps, to assess mosquito population density in 3 different habitat types. Additionally, data on minimum field infection rates from the different trap types will be presented.

Education

P-18 Ponds, puddles, & people: A unit of study for fifth grade
Neil Wilkinson, nwilkins@fgcu.edu, Brian Murphy and Eric Jackson

This week-long unit of study for fifth grade is the hallmark program of the Lee County Mosquito Control District's educational outreach program. Each year hundreds of classes participate in the lessons that include lecture/discussions on mosquito biology, ecology, disease transmission, and control. Students participate in a lab that has them comparing and contrasting different species of mosquito and identifying common aquatic predators of mosquito larvae. As a culminating event, students create a 3-dimensional model of a mosquito and design their own pamphlets detailing what they learned during the program. This unit correlates well with many of the state mandated objectives for science.

P-19 Mosquitoes and other insects: A unit of study for seventh grade life science
Neil Wilkinson, nwilkins@fgcu.edu, Brian Murphy and Eric Jackson

This week long educational outreach program is designed for seventh graders. Students are introduced to insect taxonomy, learn about fascinating local insects, and then focus on mosquito biology, ecology, disease, and control. They participate in a lab that has them using microscopes to find basic anatomical features on mosquitoes and consider the function of some of those parts. They watch the 1942 Disney Studios film, *The Winged Scourge*, and evaluate it in light of current accepted mosquito control practices. Middle school teachers must be certified in science and generally teach many sections of the same science course each day. This middle school program is designed in such a way that the classroom teacher is trained in the content and they deliver much of the instruction, although they are provided intensive training before they conduct the lessons and all materials and supplies to complete the unit.

P-20 Determining the level of toxicity of *Bacillus sphaericus* to *Culex* mosquito larvae
Neil Wilkinson, nwilkins@fgcu.edu, Brian Murphy and Eric Jackson

High school biology classes are provided with a comprehensive unit that integrates lecture, film, discussion, inquiry, and a microbiology lab experience. Biology students are introduced to the idea of chemical and mechanical control of mosquitoes and are asked to consider alternative methods of control and to consider the benefits and limitations of all methods of mosquito control. They learn about the biology, ecology, and taxonomy of mosquitoes. They study the health effects of mosquito disease on society locally and globally. They work in teams to culture a bacterial mosquitocide, *Bacillus sphaericus*, which they later harvest and use to challenge mosquito larvae as they conduct a 10-fold serial dilution bioassay on the larvae. Later they calculate percent mortality for each dose, applying Abbott's formula if applicable and determine the lethal dose (LD_{50} and LD_{90}) of their test and compare their results to other groups and across classes. A Lee County Mosquito Control educator works with each individual high school class to conduct this unit and provides all equipment and supplies to carry out the lab.

P-21 High school chemistry: determining the susceptibility or resistance of *Culex* mosquito larvae to malathion
Neil Wilkinson, nwilkins@fgcu.edu, Brian Murphy and Eric Jackson

High school chemistry classes receiving this unit focus on the history of pesticides, some of the issues related to pesticide use and the continuing development of next generation pesticides. Examples are provided emphasizing how

some "pesticides" such as antibiotics, have significantly altered the course of human history. Students are introduced to the idea of resistance and discuss how resistance develops using real life examples. Working in teams, a resistance test is conducted using a lab colony of "nonresistant" mosquito larvae and malathion. Students practice safe laboratory technique to determine the lethal dose (LD_{50} and LD_{90}) for malathion. Their results are compared to results from field sites around Lee County to see if resistance is occurring on an actual World Health Organization resistance data form. The experience culminates with a discussion of mosquito disease issues both globally and locally, as well as an overview of current day mosquito control practices and related research.

P-22 Temporal and storage effects on characteristics of ultra-low volume droplets on Teflon coated slides
Muhammad Farooq, muhammad.farooq@med.navy.mil, Aaron Lloyd, Alden Estep, Todd W. Walker and Tony H. Hughes

In spite of increased use of automated measurement systems, microscope slides are the common tool for field measurement of droplets. However, significant changes in storage conditions and delays are expected between collection and analysis of droplets due to transport and processing. This study was designed to quantify the effect of storage and delay on droplet size over Teflon coated slides. This information will assist vector control professionals that support the war-fighter, in determination of accurate dispersal of insecticides and in the effective use of ultra-low volume applications associated with force protection methods. Treatments included 3 spray liquids (BVA-13, Kontrol 30-30, and Fyfanon), 2 wrappings of slides, (proper and improper) and 2 storing conditions (room and 45°C temperatures). All treatments were replicated 6 times. Droplets were measured at different intervals over the same spots on the slides over a period of 8 wk using DropVision slide analysis system. Regardless of the wrapping, the size of BVA-13, Fyfanon, and Kontrol 30-30 droplets on slides stored under heat, decreased to significantly smaller than the droplets on slides at room temperature after 24, 48, and 24 h, respectively. Droplets on slides stored inside room were statistically similar to initial size for 21-58 d.

Equipment

P-23 Molecular and morphological identification of *Aedes atlanticus* and *Aedes tormentor*
Bruce Harrison, skeeterdoc@gmail.com, Charles Sither, E. Hickman, Jeffery Brown, Brittania Bintz, Mark Wilson, Jung Kim and Brian Byrd

Aedes (*Ochlerotatus*) *atlanticus* (Dyar and Knab) and *Ae. (Ochlerotatus) tormentor* (Dyar and Knab) are well known as nuisance mosquitoes and potential vectors of eastern equine encephalomyelitis, Keystone, and West Nile viruses. Unfortunately, females remain difficult to identify using currently known characters. Because the adult female is the medically important life stage, improved methodology to distinguish these species will enhance surveillance efforts and provide a better understanding of their epidemiological importance. Molecular methods were employed to investigate the rDNA second internal transcribed spacer (ITS2) as a useful gene target to distinguish the 2 species. Briefly, DNA was extracted from known specimens and then PCR amplified using conserved ITS2 primers. The resulting amplicons were cloned using the pCR4-TOPO vector and *E. coli* (TOP10 strain). Analyses of the resulting sequences demonstrated minimal size difference but useful sequence heterogeneity (94% sequence similarity). Direct sequences of blinded specimens were then obtained and used to successfully validate a novel morphological character that now makes it easier, along with a previous character, to distinguish the 2 species. Furthermore, a novel Hpy188I restriction enzyme digest was developed that may also be used to separate the 2 mosquitoes. This study solved a significant problem in mosquito ecology/taxonomy that has existed for more than 60 yr.

Genetics

P-24 Comparative fine morphological structure of eggs of autogenous and anautogenous *Culex pipiens* mosquitoes
Belal A. Soliman, ba.soliman@yahoo.com, Maha Kamal Tawfick and Nahla M. Wassem

Scanning electron micrographs are used to illustrate descriptions of the eggs of autogenous and anautogenous *Culex pipiens*. Eggs of both forms are black and elongate-oval. Width is greatest at the anterior end; the posterior end is pointed. The micropylar disc is apparent with distinct edge. Boundaries of outer chorionic cells fields are angular. Size of both eggs, represented by length and width, is comparable. In both eggs, length is greater than width. Eggs of both forms are clearly distinguished from each other in that the outer chorionic reticulum of autogenous eggs is longer and thinner than that of the anautogenous eggs.

Larval Control

P-25 Comparative fine morphological structures of larvae of some culicine mosquito species (Diptera: Culicidae)
Nahla Wassim, kamalmaha2000@yahoo.com, Belal A. Soliman and Maha K. Tewfick

Morphological characters of feeding mouth parts and siphon of 4th instars of 5 culicine mosquito species were studied under scanning electron microscope. The filament of the lateral palatal brushes (LPB) of *Aedes caspius* larva shows a distal rake-like structure with pointed teeth. Morphology of filament of LPB of *Culex pipiens* resembles that of *Cx. antennatus* and *Cx. pusillus* in that the teeth of the filament are less pointed than those of *Ae. caspius*. In *Cx. perixiguus*, teeth of LPB are almost absent. The siphon of *Ae. caspius* bears prominent scales and spines compared to the fleshy siphon of *Cx. pipiens*, *Cx. antennatus*, *Cx. perixiguus* and *Cx. pusillus* bearing no clear scales. Scanning electron micrographs can be used as diagnostic tool for the different mosquito species.

P-26 Evaluation of a stable isotope method to mark larval mosquitoes in the field for adult dispersal studies
Gabriel Hamer, ghamer@msu.edu, Danielle J. Donovan, Michael Kaufman, Rebecca Hood-Nowotny, Tony Goldberg and Edward Walker

Understanding mosquito dispersal is critically important for vector-borne disease control and prevention. Mark-release-recapture methods using various marking techniques have made substantial contributions to the study of mosquito biology. However, the ability to mark mosquitoes in the field non-invasively and with life-long retention has remained problematic. Here, we describe a method to mark mosquitoes with stable isotopes. *Culex pipiens* f. *molestus* mosquitoes were provisioned as larvae in laboratory experiments with 15N-labeled potassium nitrate and 13C-labeled glucose. Larval enrichment was sufficient to differentiate marked adult mosquitoes from un-marked control mosquitoes and the natural source population from Chicago, IL using either δ15N or δ13C. Isotopic retention lasted for at least 55 d for adult male and female mosquitoes. There were no consistent effects of isotopic enrichment on immature mosquito survival or adult mosquito body size. We then applied this marking technique to *Cx. pipiens* mosquitoes in wetlands in suburban Chicago, IL, and for the first time, report successful isotopic enrichment of mosquitoes in the field. This stable isotope marking technique will facilitate studies of mosquito dispersal.

P-27 Evaluation of pyriproxyfen dissemination via *Aedes albopictus* from a point source larvicide application
Aaron Lloyd, aaron.lloyd.ctr@med.navy.mil, Muhammad Farooq, Alden Estep and Randy Gaugler

The Asian tiger mosquito, *Aedes albopictus* (Skuse), ranks among the most significant vector[s] of dengue and chikungunya. Relative to any other threats, vector control is the only way to combat these diseases. Autodissemination of an insect growth regulator (pyriproxyfen) from a point source treatment was evaluated in field settings in North Florida. The objective of this study was to investigate the possibility of pyriproxyfen dissemination from a treatment site to non-treated oviposition sites via the skip oviposition behavior of *Ae. albopictus*. The spray application was made to a tire pile (N = 100) using a Stihl® SR 420 backpack sprayer. One hundred autodissemination vases containing 250 ml oak infusion water were positioned in groups of 5 at 25 to 400 m in 4 transects surrounding the tire pile. Two sets of 5 control vases containing 250 ml oak infusion water were placed 1,500 m from the tire pile and 10 250 ml samples were collected directly from the tire pile. All vases were collected at wk 0 (4 h post-treatment), 1, 2, 4 and 6. Overall, there were no differences between the control and autodissemination vases. The tire pile vases had significantly less emergence ($p < 0.0001$) when compared to all vases.

P-28 Laboratory and semi-field evaluation of *Gambusia affinis* and temephos in control of mosquito larvae in central states of Sudan
Omer A. A. Salim, aa@yahoo.com, Hani Mohamadai and Ahmed E. M. Hassan

These laboratory and semi-field studies were designed to explore the larvivorous potential of *Gambusia affinis affinis* in control of *Anopheles* and *Culex* mosquito larvae, susceptibility of *Anopheles arabiensis* larvae to temephos, and ways these control measures might be employed in ongoing central states mosquito control programs. The fish experiments focused on feeding patterns. The mean number of larvae consumed by *Gambusia affinis* was 132 larvae during 24 h. The percentages of larval consumption were 98%, 86.2%, 77.4% and 63.6% for the 1st, 2nd, 3rd, and 4th instars, respectively. The number of *Anopheles* larvae consumed ranged between 46.7% and 100% (mean 72.2%) and *Culex* larvae ranged between 54.2% and 100% (mean 86.7%). On the other hand, temephos has been widely used throughout the Sudan since 1970s. However, the laboratory LC_{50}, LC_{95}, and LC_{99} values obtained were 0.012, 0.023, and 0.027 [mg/l], respectively while outdoor results were 0.017, 0.034, and 0.040 mg/l, respectively. These experiments suggest that *Gambusia* and temephos could be useful tools in the ongoing central states vector control programs. Further large-scale field studies should be performed.

P-29 Characterization of a controlled release formulation of novaluron
Paddy McManus, pmcmanus@uoguelph.ca, Lindsay Furtado and J.C. Hall

Mosquitoes pose a serious risk to public health around the globe as vectors of human pathogens such as West Nile virus. Since 2002, about 34,000 cases of West Nile viral infections in humans have been reported in Canada and the USA, resulting in hospitalizations and deaths. Consequently, it is extremely important to control mosquito populations especially at their breeding sites, i.e., standing water systems. A number of pesticides including novaluron, a member of benzoylphenyl urea family, are effective at controlling mosquitoes. A new slow-release, wax-based formulation containing novaluron has been developed by Pestalto Inc. to regulate the release of the AI in standing water. The novaluron formulation was added to a set of 12,000-L mesocosms. Mesocosms were divided into 5 groups: low novaluron concentration with added sediment, low concentration without added sediment, high concentration with added sediment, high concentration without added sediment, and no novaluron with added sediment. Each mesocosm was monitored for a variety of parameters. The concentration of released novaluron measured by HPLC over a 20-wk period was compared with *Aedes aegypti* bioassay results.

Latin American

P-30 *Aedes albopictus* in Colombia: Epidemiologic implications
Guillermo L. Rua-Uribe, gl_rua@hotmail.com, Carolina Suarez-Acosta, Viviana Londoño, James Sanchez, Raul Rojo and Betsy Bello

In 1998, *Aedes albopictus* was detected for first time in Colombia. Since that occurred, its distribution in the country has expanded. Recently, in May 2011, it was reported for first time in Medellín (Department of Antioquia), a city located at 1,538 meters above sea level the most populated dengue endemic area of Colombia. *Aedes albopictus* is a known vector

of dengue, yellow fever and other arboviruses in Southeast Asia, nevertheless its role as dengue vector in Colombia has not yet been established. The detection of *Ae. albopictus* in some Colombian cities brings new challenges for the dengue control program. These occur because: 1) *Ae. albopictus* shares the same developmental sites as *Ae. aegypti*, but also oviposits in natural sites like tree cavities, bamboo stumps and other outdoor breeding sites; 2) *Ae. albopictus* shows better capacity to transmit dengue viruses in the laboratory and can also be a vector of yellow fever and encephalitis viruses in equines and humans; and 3) this species transovarially transmits dengue viruses in the laboratory better than *Ae. aegypti*. With this panorama, actions are necessary to limit its distribution and diminish its impact on public health in Colombia, measures that the Secretary of Health of Medellín has recently implemented

P-31 Effect of climate variability on wing morphometric shape in *Aedes aegypti* (Diptera: Culicidae) from neighborhoods with high and low dengue incidence in Medellin, Colombia
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In Medellín, Colombia, dengue transmission is endemic and periodically epidemic, however, not all neighborhoods in the city have a similar incidence. In addition, there is evidence that climate variability affects the dengue transmission in Medellín. Such variations in space and time can be associated with changes in vectorial capacity (VC) of *Aedes aegypti*. In order to estimate the influence of the entomological component on the dynamics of dengue transmission in the city, we determined the size and geometric shape of the vector wings (an indicator of CV) in 16 neighborhoods (8 high and 8 low transmission levels) during different climatic periods (El Niño and El Niño +1 year). By using ovitraps, female mosquitoes were collected in the sampling site, after having gone through the whole development cycle of the mosquito in the ovitrap. These were withdrawn and the right wing was mounted on a plate and photographed for subsequent morphometric analysis. The control group was *Ae. taeniorhynchus*. Through analysis of 13 selected landmarks, we observed statistically significant differences in wing size between the different climatic periods. The results of this study allow better understanding of the dynamics of entomological transmission of dengue in Medellín, useful information for designing appropriate control strategies.

P-32 *Chironomus plumosus* control in Santa Catarina River, Monterrey, Nuevo León, Mexico
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All aquatic communities in Santa Catarina River were eliminated in 2010 by Tropical Storm “Alex”. Uncalculated numbers of individuals of the main colonizer, *Chironomus plumosus*, were present and many complaints from the public about the presence of many adults in houses and other public places were received in the office of the Secretary of Health of the state of Nuevo León. In response to that situation, we attempted to implement a control program to control *C. plumosus* larvae using spinosad and *Gambusia affinis*. Control activities were carried out in 4 sections of Santa Catarina River. At the outset of the program, spinosad was applied. One week later, spinosad was reapplied and 50 mosquito fish were released in the same sections. Samples of 3 sq meters of the bottom of the river were collected and the number of midge larvae present was recorded. Application of both spinosad and mosquito fish reduced larval midge densities in all sections of the river; the percent reduction was variable and depended on the section of the river. We found that mosquito fish can establish in the river.

Legislative/Regulatory

P-33 The Southern California Vector Control Environmental Taskforce: Balancing public health and environmental protection
Mike Saba, msaba@ocvcd.org, Amber Semrow and Robert Cummings

The core focus of integrated vector management (IVM) requires careful considerations of how to best protect public health while also managing to avoid or reduce adverse impacts to the environment, as natural resources are subject to state and federal regulations that often conflict with public health protection goals. Examples of common IVM strategies subject to restriction include: source reduction or physical control, some biological control methods, and pesticide applications. To address coinciding public health and environmental protection objectives, the Orange County Vector Control District (OCVCD) created the Southern California Vector Control Environmental Taskforce (Taskforce) in December 2007. The Taskforce is administered by the OCVCD and is composed of several local vector control agencies that work cooperatively with environmental resource agencies, municipalities, research institutes, private firms and other interests to: 1) raise awareness about local, regional vector control issues; 2) facilitate interagency coordination; and 3) advocate policy changes that aim to control the proliferation of vectors and the potential transmission of vector-borne diseases. Efforts undertaken by the Taskforce to achieve these objectives include annual forums, workshops, participation in stakeholder groups, and preparation of public comments on issues and projects relevant to vector control/public health and environmental conservation.

Management

P-34 Volusia County Mosquito Control's use of National Weather Service (NWS) data within an IMM program
Bruce Morgan, bmorgan@co.volusia.fl.us and Edward Northey

In 2008 Volusia County Mosquito Control began using National Weather Service (NWS) data to create rainfall maps that have made it possible to maximize time and resources associated with IMM. Through the use of NWS rainfall point data and interpolating it in ArcGIS, we create maps that provide VCMC with an alternative to an extensive in-house rain gauge system. NWS rainfall maps have proven to be an efficient way of determining the rainfall in the district and

facilitate resource application and management. Maps originally designed to improve IMM efficiency have now been adopted by other Volusia County divisions including Emergency Services, Fire Services, and Road and Bridges Drainage and Stormwater. These maps facilitate coordination of communication and assets between the respective divisions of Volusia County.

New Product Trials

P-35 Evaluation of the low-cost MAS-Trap for collecting *Aedes aegypti* (Diptera: Culicidae)
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Entomological surveillance of *Aedes aegypti* requires tools applicable to large-scale control programs. Trapping is a common practice in monitoring, and its effectiveness depends on the design and bait used. However, the high cost of these tools represents a general problem for these programs. MAS-Trap is a system based on use of local production materials for use in urban, suburban, and rural areas. The design uses a microbial source of CO_2 which is easy to prepare and access. The effectiveness of the trap was evaluated in Monterrey, Nuevo Leon, Mexico on semi-field and field trials. In addition to collection efficiency, the optimum time for production of microbial CO_2 was also established. We conducted regression and ANOVA analyses of data using the SPSS statistical software with a $P = 0.05$. Results indicate that MAS-TRAP has the potential to become an effective monitoring tool for the dengue vector, *Ae. aegypti*.

Other

P-36 *Withdrawn*

P-37 Ground and aerial applications of pesticides for mosquito control in the State of Florida, 1997-2010: Data aggregation and analysis
Peter Jiang, Yongxing.Jiang@freshfromflorida.com, Angela Weeks, Dave Daiker and Mike Page

Florida's unique ecosystem, namely, warm subtropical and tropical climate, abundant rainfall and extended coastline supports an extraordinarily rich fauna, including at least 80 species of mosquitoes. Chemical control, one of principal components of integrated mosquito management (IMM) in Florida, is frequently carried out in the areas with highly populated areas which may be adjacent to water bodies and wetlands either by ground or aerial applications. In order to enforce the label rate and ensure the proper usage of pesticides for mosquito control in Florida, the Florida Department of Agriculture and Consumer Services (DACS) mosquito control section, the leading state agency responsible for regulating, supervising mosquito control activities and enforcement of mosquito control law (Florida Statute 388), instituted a program that required about 60 state-approved mosquito control programs to submit monthly pesticide use records to the Department so that the chemical usage in the state for mosquito control would be tracked systematically. The resultant DCAS database contains detailed information including pesticide (product) name, active ingredients, total amount of product and active ingredient used, total acres treated, rate of application (lb/acre) and frequency of use by ground and aerial application, chronicling. In this paper, ground and aerial applications of pesticides for mosquito control in the state have been compiled and analyzed for the years of 1997-2010.

Public Relations

P-38 Social pollination: Can it ease the "sting" of negative press?
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Social pollination is defined as harnessing the power of online communities to strengthen your brand and communicate your message. These online communities (aka social networking websites) have become ingrained in everyday life for a large segment of the population. Sites like Facebook, Twitter, YouTube, and LinkedIn have millions of active users worldwide and are continuing to grow each day. In 2011, the Marin/Sonoma Mosquito and Vector Control District (MSMVCD) turned to social pollination as a way to combat the "sting" of negative press. In an effort to highlight the improvements in transparency, increase awareness and create an open dialogue between MSMVCD and its constituency, a social media campaign was launched. Our social media campaign consisted of a 3-step process. First, we built an online presence via social networking sites such as Twitter, YouTube, Facebook, LinkedIn and Yelp. Secondly, we promoted content across all channels. Thirdly, we connected with the media and the public. Once the campaign was launched, the focus shifted to staying actively engaged and posting relevant and interesting information. Using HootSuite as well as Facebook Insights we tracked user growth, engagement, demographics, exposure, and web traffic. While the success of a social media campaign may not be achieved overnight, MSMVCD anticipates that it will become one of our most powerful communication tools.

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Urbina, Carlos	Universidad Autonoma de Nuevo León, San Nicolas de los Garza, Nuevo León, Mexico	74
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Walton, William	University of California, Riverside, California, US	49
Wang, Yi	Rutger University, New Brunswick, New Jersey, US	156
Warner, Todd	Case Western Reserve University, Cleveland, Ohio, US	175
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Wasserberg, Gideon	The University of North Carolina at Greensboro, Department of Biology, Greensboro, North Carolina, US	100
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Wearing, Helen	University of New Mexico, Department of Mathematics and Statistics, Albuquerque, New Mexico, US	112
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Weeks, Angela	Bureau of Entomology and Pest Control, Florida Department of Agriculture and Consumer Services, Tallahassee, Florida, US	P-37
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Wilkerson, Richard	Entomology Branch, Walter Reed Army Institute of Research, Walter Reed Biosystematics Unit, Museum Support Center, Smithsonian Institution, Suitland, Maryland, US	40, 41, 71, 176
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Xue, Rui-De	Anastasia MCD, St. Augustine, Florida, US	31
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Yang, Fan	Agriculture and life science, Blacksburg, Virginia, US	P-04

Author Affiliations and Abstract Number

Author	Affiliation	Abstract No.
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AMCA AWARDS

HONORARY MEMBERS

1937	Leland O. Howard (USDA)	1965	Arthur W. Lindquist (KS)	1991	Kenneth L. Knight (NC)
1938	C. C. Adams (NY)	1967	Fred L. Stutz (FL)	1994	Harold C. Chapman (LA)
1944	Thomas J. Headlee (NJ)	1970	Robert L. Vannote (NJ)		Lewis T. Nielsen (UT)
	William B. Herms (CA)		Richard W. Fay (USPHS)	1998	Eugene J. Gerberg (MD)
	J. A. LePrince (USPHS)	1971	Christian T. Williamson (NY)		Glen C. Collett (UT)
	Louis L. Williams, Jr. (USPHS)	1972	Alan R. Stone (MD)	1999	Donald R. Johnson (GA)
1948	Robert D. Glascow (NY)		Edward S. Hathaway (LA)	2001	Fred W. Knapp (KY)
	Willard V. King (USDA)	1974	Theodore G. Raley (CA)	2003	E. John Beidler (FL)
1951	Lewis W. Hackett (CA)	1976	John A. Mulrennan, Sr. (FL)	2004	David A. Dame (FL)
	Robert Matheson (NY)	1979	Thomas D. Mulhern (CA)	2005	Donald J. Sutherland (NJ)
1955	Harold F. Gray (CA)		Austin W. Morrill, Jr. (CA)	2006	Martin S. Chomsky (NJ)
1958	Louis A. Stearns (DE)	1981	William R. Horsfall (IL)		
1964	George H. Bradley (USPHS/USDA)	1983	Anthony W. A. Brown (WHO)		

HAROLD FARNSWORTH GRAY MEMORIAL CITATION
MERITORIOUS SERVICE TO MOSQUITO CONTROL AWARD

This now discontinued award was presented to an active member of AMCA for exceptional service to the Association and to mosquito control or related vector control.

1964 Fred C. Bishopp (DC)

DR. THOMAS J. HEADLEE MEMORIAL AWARD

This now discontinued award recognizes a living member of the Association for outstanding service to the field of mosquito control, while simultaneously commemorating the name of a deceased member.

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1968 George H. Bradley (USDA/USPHS)

MEDAL OF HONOR

Next to honorary membership, the Medal of Honor is the highest award regularly given by AMCA. The only specific limitation for the Medal of Honor is AMCA membership, and nominees are selected on the basis of exceptional contributions to mosquito control or related fields. After 1982, the Board of Directors set a suggested maximum of one Medal of Honor per year.

1972	Maurice W. Provost (FL)	1982	Kenneth L. Knight (NC)	1997	Robert K. Washino (CA)
	William R. Horsfall (IL)		William C. Reeves (CA)	1998	John D. Edman (MA)
1973	Don M. Rees (UT)	1983	Harry D. Pratt (GA)	1999	Bruce F. Eldridge (CA)
	Thomas D. Mulhern (CA)		John A. Mulrennan, Sr. (FL)	2000	Judy A. Hansen (NJ)
1974	Anthony W. A. Brown (WHO)	1984	George T. Carmichael (LA)	2001	Gary G. Clark (USPHS)
	Donald L. Collins (NY)	1985	Norman G. Gratz (WHO)	2002	Lucas G. Terracina (LA)
1975	Daniel M. Jobbins (NJ)	1986	James R. Caton (CA)	2003	Robert J. Novak (IL)
	Arthur W. Lindquist (USDA)	1987	Jay E. Graham (UT)	2004	James D. Long (TX)
1976	Austin W. Morrill, Jr. (CA)	1988	Lewis T. Nielsen (UT)	2005	James W. Robinson (FL)
	Carroll N. Smith (USDA)	1989	Andrew J. Spielman (MA)	2006	John L. Clark Jr. (IL)
1978	James B. Kitzmiller (FL)	1990	Glen C. Collett (UT)	2007	E. John Beidler (FL)
	William D. Murray (CA)	1991	Harold C. Chapman (LA)	2008	David A. Dame (FL)
1979	Richard F. Peters (CA)	1992	D. Bruce Francy (CO)	2009	Dan Ariaz (NV)
1980	William E. Bickley (MD)	1993	Gilbert L. Challet (CA)		Gary Breeden (VA)
	John N. Belkin (CA)	1994	Ronald A. Ward (MD)	2010	Mir S. Mulla (CA)
1981	Stanley J. Carpenter (CA)	1995	T. Wayne Miller (FL)	2011	Dave Brown (CA)
	Roland E. Dorer (VA)	1996	Marshall Laird (New Zealand)		

MERITORIOUS SERVICE AWARD

Given to individuals for outstanding service, the contributions of the nominees must be considered outstanding as judged by their peers. Only AMCA members in good standing who are not past presidents of AMCA are eligible. After 1982, the Board of Directors set a suggested maximum of no more than two awards per year.

1972	Charles F. Scheel (IL)
	Donald L. Collins (NY)
	Theodore G. Raley (CA)
1973	Francis P. Creadon (CA)
	Vernon Conant (NJ)
	Austin W. Morrill, Jr. (CA)
1974	Leslie D. Beadle (USPHS)
	John H. Brawley (CA)
	John W. Kilpatrick (GA)
	T. Oscar Fultz (GA)
	Howard R. Greenfield (CA)
	Paul J. Hunt (FL)
	William C. McDuffie (USDA)
	Donald R. Johnson (GA)
	Helen Sollers-Riedel (DC)
1975	Lewis E. Fronk (UT)
	Joseph G. McWilliams (USN)
	Lewis J. Ogden (USPHS)
	Rajindar M. Pal (WHO)
	Kenneth D. Quarterman (USPHS)
	Herbert F. Schoof (USPHS)
1976	Robert A. Armstrong (MA)
	Osmond P. Breland (TX)
	George B. Craig, Jr. (IN)
	Claude M. Gjullin (USDA)
	T. Wayne Miller (FL)
1976	Donald J. Pletsch (Mexico)
	Glenn M. Stokes (LA)
	Luis M. Vargas (Mexico)
1978	Richard C. Axtell (NC)
1979	Marco. E. C. Giglioli (BWI)
1980	James D. Gorman (FL)
	Donald E. Weidhaas (FL)
	E. John Beidler (FL)
	Eugene J. Gerberg (MD)
1981	A. Ralph Barr (CA)
	Gilbert L. Challet (CA)
	Edgar A. Smith (VA)
1982	Hugo A. Jamnback (NY)
	Donald R. Johnson (GA)
	Harold D. Newsome (MI)
	James V. Smith (GA)
1983	Richard F. Darsie (CO)
	Ronald A. Ward (DC)
1984	Samuel G. Breeland (FL)
	Donald J. Sutherland (NJ)
1985	John C. Kuschke (NJ)
	James R. Caton (CA)
1986	C. Lamar Meek (LA)
1987	John C. Combs (CA)
1988	Chester G. Moore (CO)
	Margaret Parsons (OH)
1989	John S. Billodeaux (LA)
	Edgar S. Bordes, Jr. (LA)
1990	Richard D. Morton (WA)
	Lucas G. Terracina (LA)
1991	David A. Dame (FL)
1992	Jerry Mix (TX)
1993	William E. Hazeltine (CA)
1994	Sally A. Wagner (MI)
1995	Frederick W. Wagner (KY)
1996	Donald J. Sutherland (NJ)
	Ronald A. Ward (MD)
1997	Roger S. Nasci (CO)
	Thomas J. Zavortink (CA)
1998	James D. Long (TX)
1999	Hilton B. Munns (CA)
2000	Leroy J. Bohn (VA)
	Dreda McCreary (VA)
2001	Charles T. Palmisano (LA)
2002	Thomas G. Floore (FL)
	Sherry McLaughlin (TX)
2003	Wayne L. Kramer (NE)
	John L. Clarke, Jr. (IL)
2004	Yadira N. Rangel (Venezuela)
	James W. Robinson (FL)
2005	Major S. Dhillon (CA)
	William H. Meredith (DE)
2006	William J. Sames (WA)
2007	Henry R. Rupp (NJ)
2008	Allan Inman (CA)
	Manuel Lluberas (FL)
2009	Joe Conlon (FL)
2010	Norbert Becker (Germany)
2011	Harry Savage (CO)
	L.A. Williams (SC)

PRESIDENTIAL CITATION

The Presidential Citation recognizes individuals not eligible to receive other awards but who are eminently deserving of special recognition by AMCA. Recipients need not be AMCA members. After 1982 the Board of Directors set a suggested maximum of no more than 2 awards per year.

1980	John M. Poché (LA)
	Leslie E. Fronk (UT)
	Jesse B. Leslie (NJ)
1981	Linda G. Raiche (CA)
	Margaret S. Slater (NY)
1982	K. G. Nolan (NY)
	Charles F. Scheel (IL)
1983	Coyle E. Knowles (NY)
1984	Ray Treichler (DC)
1985	Lawrence T. Cowper (USAID)
	Janice B. Wells (NY)
1986	T. Oscar Fultz (GA)
1987	Sharon A. Colvin (IL)
1988	Daniel D. Sprenger (TX)
1989	Fred C. Roberts (CA)
1990	Leonard E. Munsterman (IN)
1991	James D. Long (TX)
1992	Charlie D. Morris (FL)
1993	Robert J. Novak (IL)
1994	James W. Robinson (FL)
	Dan L. Ariaz (NV)
1995	Sally Kuzenski (LA)
1996	Carl R. Tanner (IL)
	Sammie L. Dickson (UT)
1997	Charles T. Palmisano (LA)
	George J. Wichterman (FL)
1998	Douglas B. Carlson (FL)
1999	Charles Beesley (CA)
	Donald R. Johnson (GA)
2000	Peter B. Ghormley (CA)
	David A. Brown (CA)
2001	Donald Menard (LA)
	Joel Margalit (Israel)
2002	Dennis Moore (FL)
	Henry R. Rupp (NJ)
2003	James R. McNelly (NJ)
	Robert Bonnett (MN)
2004	James R. Brown (FL)
2005	Mark Newberg (IL)
	Susan Maggy (CA)
2006	Teung Chin
2007	Karl Malamud-Roam (CA)
2008	Wiliam H. Meredeth (DE)
2009	Rep. Dennis Cardoza (CA)
2010	Gordon Patterson (FL)
	Gary Clark (FL)
	Yasmin Rubio-Palis (Venezuela)
2011	Angela Beehler (WA)
	Roxanne Connelly (FL)

JOHN N. BELKIN AWARD

The John N. Belkin Award is given for meritorious contributions to the field of mosquito systematics and/or biology and may be given to anyone judged by his peers to be worthy. Usually, a maximum of one award per year is given.

1981	Botha de Meillon (PA)	1996	A. Ralph Barr (CA)
1982	Lloyd E. Rozeboom (IL)		Michael W. Service (UK)
1983	Kenneth L. Knight (NC)	1997	Christine J. Dahl (Sweden)
1984	Thomas J. Zavortink (CA)	1998	Ralph E. Harbach (UK)
1985	Stanley J. Carpenter (CA)	1999	Yiau-Min Huang (DC)
1986	Elizabeth P. Marks & John Reid (Australia)	2000	Lewis T. Nielsen (UT)
1987	James B. Kitzmiller (FL)	2001	John F. Reinert (FL)
1988	Allan R Stone (MD)	2002	Richard F. Darsie (FL)
1989	Pedro Galindo (Panama)	2003	Richard C. Wilkerson (MD)
1990	Peter F. Mattingly (UK)	2004	Kazua Tanaka (Japan)
1991	Jose P. Duret (Argentina)	2005	Ronald A. Ward (MD)
1992	Bruce A. Harrison (NC)	2006	William K. Reisen (CA)
1993	Edward L. Peyton (DC)	2008	Maria-Anice Sallum (Brazil)
1994	Theodore H. G. Aitken (CT)	2010	Daniel Strickman (MD)
1995	Oswaldo P. Forattini (Brazil)	2011	Rampa Rattanarithikul, Ph.D. (Thailand)

MEMORIAL LECTURE HONOREE & MEMORIAL LECTURER AWARD

The Memorial Lecture Honoree must be one who has made exceptional contributions to the broad field of mosquito control during his lifetime. If there is more than one honoree in a given year, then the group must have made significant contributions as a team or equal stature in the same time frame and to the same aspect of mosquito control. The Memorial Lecturer Award is given to an outstanding speaker (one per year) to present the annual Memorial Lecture in honor of the Memorial Lecture Honoree. The Memorial Lecture Award is not limited to a member of AMCA, but the recipient should be a recognized authority in the broad field of vector control.

	HONOREE	LECTURER	TOPIC
1979	Don M. Rees	J. David Gillett	Out for blood: Flight orientation upwind & in the absence of visual clues
1980	Maurice W. Provost	Anthony W. A. Brown	What have insecticides done for us?
1981	Leland O. Howard	Leonard J. Bruce-Chwatt	Leland Ossian Howard (1857-1950) and malaria control then and now
1982	Carlos Finlay Walter Reed William Gorgas Fred Soper	William C. Reeves	A memorial to Finlay, Reed, Gorgas and Soper as major contributors to present-day concepts essential for control of mosquito-borne viruses
1983	Harry H. Stage	Michael W. Service	Biological control of mosquitoes—Has it a future?
1984	Louis L. Williams	George B. Craig, Jr.	Man-made human disease problems: Tires & LaCrosse virus
1985	Thomas J. Headlee	William R. Horsfall	Mosquito abatement in a changing world
1986	Marston Bates	A. Ralph Barr	The basis of mosquito systematics
1987	William B. Herms Harold F. Gray	Robert K. Washino	
1988	John A. Mulrennan, Sr.	Susan B. McIver	Mosquitoes, medicine & memories
1989	Brian Hocking	John D. Edman	Are biting flies gourmet or gourmand?
1990	John N. Belkin	Thomas J. Zavortink	Classical taxonomy of mosquitoes—A memorial to John N. Belkin
1991	Edward S. Hathaway Anderson B. Ritter	C. Lamar Meek	Les maringouins du mech: The legacy of two men
1992	Sir Patrick Manson	Bruce F. Eldridge	The man we honor
1993	Willard V. King	Ronald A. Ward	Renaissance man of medical entomology
1994	Stanley B. Freeman	Mir S. Mulla	Now & in the future
1995	Maurice T. James	Wayne A. Rowley	Maurice T. James
1996	Telford H. Work	Charles A. Calisher	Telford H. Work—A tribute
1997	Stanley J. Carpenter	Lewis T. Nielsen	In honor of Stanley Carpenter
1998	George B. Craig, Jr.	Robert J. Novak	George Brownlee Craig
1999	A. Ralph Barr	Andrew J. Spielman	
2000	John B. Smith	Wayne J. Crans	
2001	William R. Horsfall	Jimmy K. Olson	
2002	Edward F. Knipling	Waldemar Klassen	Titan and Driving Force in Ecologically Selective Area-Wide Pest Management

Continued on next page

MEMORIAL LECTURE HONOREE & MEMORIAL LECTURER AWARD (continued)

	HONOREE	LECTURER	TOPIC
2003	Kenneth L. Knight	Ralph E. Harbach	Mosquito systematics: From organism to molecules—A tribute to Kenneth L. Knight
2004	Donald J. Pletsch	David A. Dame	Six Decades of International Commitment
2005	William E. Hazeltine	Bruce F. Eldridge	William E. Hazeltine: Rebel with a cause
2006	William C. Reeves	Grant R. Campbell	
2007	Norman G. Gratz	Graham B. White	Remembering Norman Gratz (1925-2005) – Doyen of Vector Control
2008	Andrew Spielman	John D. Edman	
2009	Lamar Meek	Roxanne Connelly	
2010	Harold C. Chapman	Tokuo Fukuda	
2011	H.G. Dyar	Terry Klein	

INDUSTRY AWARD

Established in 1997, the Industry Award is presented to a representative of a mosquito/vector-related industry who has through his/her efforts advanced the work of mosquito and/or vector control or research.

1997	Charles T. Galley (FL)	2004	John L. Clarke, Jr. (IL)
1998	William German (FL)	2005	Ernest Danka (IL)
1999	Gary A. Mount (FL)	2006	Willie N. Cox (IL)
	Daniel F. Boyd (GA)	2007	Bob Bonnett (MN)
	David W. Waldron (GA)	2009	Clarke Hudson (IL)
	J. David Waldron (GA)		Bill Strange (ID)
2002	Robert E. Richard (TX)	2010	Peter Connelly (FL)
2003	Allen W. Wooldridge (FL)	2011	David Sullivan (MT)

GRASSROOTS AWARD

This award is given to recognize excellent performance and dedication by mosquito control field staff.

2005	Omar S. Akbari	Reno Washoe Country, Nevada
	Christopher Trapp	Multnomah County Vector Control,
2006	John Phelps	Mercer County, New Jersey
2008	Chris Frame	Cape May County, New Jersey
2009	Jason Craig Hardman	Salt Lake City MAD, Utah
2010	Jessica Fales	Midland County MC, Michigan
	Gary Hillsdale	Metropolitan MCD, Minnesota
	Elizabeth Vice	Buttle County MVCD, California
2011	David Bruget	Kings MAD, California
	Russell Eck	Washoe County Health District, Nevada
	Phillip Henry	Butte County MVCD, California
	Levi Zahn	Williston VCD, North Dakota

STUDENT PAPER COMPETITION AWARDS

The AMCA Student Competition was established in 1988 to recognize the outstanding student research paper presented at the annual meeting. Judging of oral presentations is based upon organization, delivery, clarity and effective use of visual aids. In 1991, a $500 cash award was presented to the winner, and in 1998 the Hollandsworth Prize was established by the family of Gerald Hollandsworth to encourage student participation in the AMCA national meeting. There is a $250 prize for honorable mention.

1989	Scott Willis	McNeese State U.	1998	C. Roxanne Rutledge	Louisiana State U.
1990	Andrea Brown	Peru State Coll.		Emmalee Kennedy*	U. Illinois
1991	John Paul Mutebi	Notre Dame U.		Timothy Schaub*	U. Illinois
1992	Rosmarie Kelly	U. Massachusetts	1999	Laura Harrington	U. Massachusetts
1993	Merry L. Holliday-Hanson	U. California, Davis		Adam S. Jones*	U. Massachusetts
1994	John E. Gimnig	U. California, Davis		Hillary Reno*	U. Illinois
	Alice Shaeffer*	U. Mainz, Germany	2000	Jason L. Rasgon	U. California, Davis
1995	Glen Scoles	Notre Dame U.		Hope Q. Liu*	Virginia Polytechnic Inst.
	Jittawadee Rochaeroen*	U. California, Riverside	2001	No competition	
1996	Esther Chow Schaeffer	U. Maryland	2002	Laura B. Goddard	U. California, Davis
1997	Lynn Cooper	U. Maryland		Sharon L. Minnick*	U. California, Davis
	Continued on next page			Margaret Sherriffs*	Yale U.

STUDENT PAPER COMPETITION AWARDS (continued)

2003	Sarah Yaremych	U. Illinois	2007	Jennifer Armistead	University of Florida
	Laura Goddard*	U. California		Robert D. Anderson*	University of Delaware
	Jason L. Rasgon*	U. California, Davis		Thomas M. Mascari*	Louisiana State U.
2004	Gregory M. Williams	U. Delaware	2008	Jerome Schleier	Montana State University
	Stephen Aspen*	Colorado State U.		Christopher Barker*	U. California, Davis
	Christian Kaufmann*	U. Zurich		Lisa Reimer*	U. California, Davis
2005	Wesley Rubio	San Diego State U.	2009	Alexandra Chaskopoulou	University of Florida
	Whitney Qualls*	Auburn University		Stephanie Larick*	University of Florida
	Rebecca Trout*	University of Kentucky	2010	Sarah Wheeler	University of California, Davis
2006	Robert D. Anderson	University of Winnipeg		Kimmy Mains*	University of Kentucky
	Linda O'Connor**	University of Delaware		Holly Tuten*	Clemson University
	Joshua R. Ogawa*	Oregon State University	2011	Logan Minter	University of Kentucky
	Matthew Eaton*	Concordia College		Kristen Meckel-Parker*	San Diego County Vector Control Program
	Linda M. Styer*	U. California, Davis			

* - Honorable Mention ** - First Runner Up

AMCA OFFICERS, EXECUTIVE DIRECTORS AND EDITORS

AMCA PRESIDENTS

1935-1939	Thomas J. Headlee*	1965-1966	Anthony W. A. Brown	1989-1990	Judy A. Hansen
1939-1940	Christian T. Williams*	1966-1967	Jay E. Graham	1990-1991	Robert C. Sjogren
1940-1942	Louis A. Stearns*	1967-1968	Harry D. Pratt	1991-1992	Matthew Yates
1942-1944	Robert C. Botsford*	1968-1969	Thomas D. Mulhern	1992-1993	Cyrus R. Lesser
1944-1945	Robert L. Vannote	1969-1970	George T. Carmichael	1993-1994	John A. Mulrennan, Jr.
1945-1946	Perry W. Ruth	1970-1971	Albert W. Buzicky	1994-1995	Chester G. Moore
1946-1947	Harry H. Stage	1971-1972	Andrew J. Rogers	1995-1996	John D. Edman
1947-1949	H. Duke Peters	1972-1973	Glen C. Collett	1996-1997	Robert J. Novak
1949-1950	Harold F. Gray	1973-1974	Kenneth L. Knight	1997-1998	Gary G. Clark
1950-1951	Lester W. Smith	1974-1975	Robert M. Altman	1998-1999	Dan L. Ariaz
1951-1952	Don M. Rees	1975-1976	Harold C. Chapman	1999-2000	William J. Zawicki
1952-1953	Cecil R. Twinn	1976-1977	D. Bruce Francy	2000-2001	David A. Dame
1953-1954	Fred C. Bishopp	1977-1978	Lewis T. Nielsen	2001-2002	Sammie L. Dickson
1954-1955	Roland E. Dorer	1978-1979	Paul J. Hunt	2002-2003	David A. Brown
1955-1956	Richard F. Peters	1979-1980	Glen M. Stokes	2003-2004	Fred W. Knapp
1956-1957	Fred L. Stutz	1980-1981	Robert K. Washino	2004-2005	Roger S. Nasci
1957-1958	Arthur W. Lindquist	1981-1982	Claude H. Schmidt	2005-2006	William R. Opp
1958-1959	John M. Hirst	1982-1983	Richard C. Axtell	2006-2007	Joseph F. Sanzone
1959-1960	Archie D. Hess	1983-1984	Jimmy K. Olson	2007-2008	Gene R. Payne
1960-1961	Daniel M. Jobbins	1984-1985	Gilbert L. Challet	2008-2009	Major S. Dhillon
1961-1962	William E. Bickley	1985-1986	T. Oscar Fultz	2009-2010	Doug Carlson
1962-1963	Arthur W. Geib	1986-1987	Donald J. Sutherland	2010-2011	Janet McAllister
1963-1964	Don W. Micks	1987-1988	George B. Craig, Jr.	2011-2012	William H. Meredith
1964-1965	John A. Mulrennan, Sr.	1988-1989	Bruce F. Eldridge		

* - Eastern Association of Mosquito Control Workers

AMCA TREASURERS

1935-1943*, 1944-1950	Thomas D. Mulhern
1950-1953	Roland E. Dorer
1954-1964	Lester W. Smith
1965-1979	William D. Murray
1980-1985	James R. Caton
1985-1986	Douglas C. White
1986-1988	C. Lamar Meek
1989-1994	John S. Billodeaux
1994-2000	Charles T. Palmisano
2000-2011	Allan D. Inman
2011-present	Gary Hatch

* - Eastern Association of Mosquito Control Workers

SECRETARY, EXECUTIVE SECRETARY, EXECUTIVE DIRECTOR

1935-1943	Thomas D. Mulhern*	Secretary	1986-1991	Harold C. Chapman	Executive Director
1944-1950	Thomas D. Mulhern	Secretary	1991	Lucas G. Terracina	Acting Executive Dir.
1950-1952	Thomas D. Mulhern	Executive Secretary	1992	Mark Vinsand	Executive Director
1953-1973	Theodore G. Raley	Executive Secretary	1992-1993	Harold C. Chapman	Executive Director
1973	Theodore G. Raley	Executive Director	1993-1994	Lucas G. Terracina	Acting Executive Dir.
1974-1978	Thomas D. Mulhern	Executive Director	1994-1995	Robert T. Graham	Executive Director
1979-1980	William D. Murray	Executive Director	2006-present	Sarah B. Gazi	Executive Director
1980-1985	Thomas D. Mulhern	Executive Director			
1985-1986	James R Caton	Interim Executive Director			

* - Eastern Association of Mosquito Control Workers

BUSINESS MANAGER

1995-1999	Pamela D. Toups
1999-2000	Marlene Comeaux
2000-2001	Robertamarie Kiley
2001-2004	Martin. S. Chomsky
2004-2006	Sarah B. Gazi

TECHNICAL ADVISOR

2000-present	Joseph M. Conlon

EDITORS OF *JOURNAL OF AMCA***

1941	Edited by the Publications Committee, Lester W. Smith, Chair†
1942-1943	Edited by the Publications Committee, Ralph W. Vanderwerker, Chair‡
1944	Edited by the Publications Committee, J. T. Hart, Chair
1944-1948	Robert D. Glascow
1949-1973	Donald L. Collins
1973-1981	William E. Bickley
1981-1996	Ronald A. Ward
1996-1998	Robert K. Washino
1999-2003	Bruce F. Eldridge
2004-2006	Kenneth J. Linthicum
2007-present	Lal S. Mian

* - *Mosquito News* became the *Journal* of AMCA in 1985

† - Publication of the Eastern Association of Mosquito Control Workers

‡ - Volume 4, Number 1, was edited by the Publications Committee; subsequent volumes had a single editor

EDITORS OF *MOSQUITO SYSTEMATICS***

1969-1979	Kenneth L. Knight
1979-1992	Lewis T. Nielsen
1992-1993	Lewis T. Nielsen & Ralph E. Harbach, co-editors
1993-1995†	Thomas J. Zavortink, editor, & Lewis T. Nielsen, editor emeritus

* - Prior to 1973 *Mosquito Systematics* was named *Mosquito Systematics Newsletter*

† - In 1995 this publication was discontinued