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Abstracts

Submitted Papers, Posters, and Symposium Presentations

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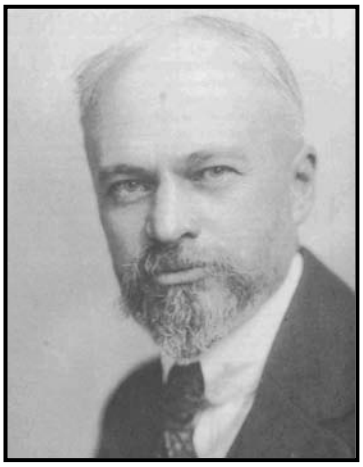
The 2011 AMCA Memorial Lecture Honoree: Dr. Harrison Gray Dyar, Jr. 1866-1929



Dr. Harrison Gray Dyar, Jr. (1866-1929) was a world-renowned expert in the biology and taxonomy of Lepidoptera, the moths and butterflies, Symphyta, the sawflies, and nematocerous Diptera, including the mosquitoes. His ground-breaking research in the early decades of the Twentieth Century logarithmically increased knowledge about mosquitoes and shaped our understanding of their importance to man and the environment, establishing a firm foundation for mosquito control professionals in the 21st century.

Dyar was born February 14, 1866 in the Borough of Manhattan, New York City, the elder of two children born to Harrison Gray and Eleanora (Hannum) Dyar, both descendants of old New England families. He educated at the Roxbury Latin School in Boston, Massachusetts. He graduated from Roxbury at the age of 19 in 1885 with advanced standings in mathematics, physics, and French.

After completing secondary school, Dyar entered the Massachusetts Institute of Technology and studied chemistry, graduating in 1889 with a Bachelor of Science degree. He published his first entomological paper in 1888, a short but detailed study of the immature stages of the moth *Dryopteris rosea* (Walker 1855**)**.

In 1892 Dyar entered graduate school at Columbia College (now Columbia University) and earned a master's degree in biology in 1894, with a thesis on the classification of lepidopterous larvae. He stayed on at Columbia to earn a Ph.D. in 1895, majoring in bacteriology and writing a thesis on airborne bacteria, but minoring in entomology. After graduation, he took a position as Assistant Bacteriologist at the Columbia University College of Physicians and Surgeons.

While teaching at Columbia from 1895-1897, Dyar continued his entomological pursuits, further developing his expertise in the biology and taxonomy of Lepidoptera and Symphyta. In 1897, Dr. Leland O. Howard, chief of the USDA Bureau of Entomology and honorary curator of the United States National Museum, invited Dyar to take the position of honorary custodian of Lepidoptera at the U.S. National Museum. The position didn't offer direct compensation, but Dyar accepted, resigned his faculty appointment at Columbia, and moved to Washington, DC, supporting himself with his inherited personal fortune.

Several years after moving to Washington, Dyar developed a new fascination—mosquitoes. He first became interested in mosquitoes in the summer of 1902, when he read L. O. Howard's recently published book on mosquitoes. Dyar began studying the markings and structure of mosquito larvae, and "thus began his work with this group which lasted until the time of his death." Mosquitoes soon became his primary interest. Working from Monday through Saturday each week, he identified a steady stream of specimens coming into the USDA and USNM as mosquitoes became an increasingly important public health concern in the early 1900s. In addition to fulfilling his identification duties, he was instrumental in acquiring several large collections important to the growth of the museum and its ability to address the needs of the scientific community at large. His personal wealth made it possible for him to travel and collect extensively in North and Central America, to the enormous benefit of the U.S. National Museum and entomology community. He also added to the collection through specimens he reared in the house adjoining his family home in Washington.

Dyar was an employee of the U.S. Department of Agriculture Bureau of Entomology for some of the years he worked at the National Museum, with the title of "expert" and an annual salary of $1,800. To supplement his government funding, he engaged in commercial consulting on mosquito control efforts, espousing views on surveillance and control in national parks that were decades ahead of their time. In 1924, Dyar's background in the study of mosquitoes was the basis for his selection to be commissioned a Captain in the Sanitary Department of the U.S. Army Officers Reserve Corps, attached to the Army Corps of Engineers. He was one of a very small group—records indicate that only 14 Army entomologists were commissioned in the reserves in the period between WWI and WWII. His primary workplace remained the U.S. National Museum, where he was among his peers.

Dyar's interest in the immature stages of insects continued throughout his career. He wrote numerous papers that included detailed descriptions of mosquito larvae, and three that dealt exclusively with them: two as sole author, "A synoptic table of North American mosquito larvae", and "Key to the Known Larvae of the Mosquitoes of the United States", and one as senior author, "The larvae of Culicidae classified as independent organisms". While observing the immature stages of Lepidoptera in life cycle studies, he noted that the head capsule widths of larvae followed a geometric progression in growth through successive instars. In a paper published in 1890, he described this phenomenon's principles, which became known as Dyar’s Law. Although initially based on observations of

Lepidoptera larvae, Dyar's Law applied to immature insects in general and is widely used in entomological studies to discern instars of immature insects, to predict the size of instars missing from samples, and other applications.

His work on adult insects was equally significant, culminating in his landmark revision of mosquito classification, *Mosquitoes of the Americas*, published in 1928. Dyar pioneered the use of adult and immature morphological characters, a new approach which became the standard, and is still the classical method. Dyar and Frederick Knab are primarily responsible for the taxonomic portions of the four-volume work, *Mosquitoes of North and Central America and the West Indies*. Dyar maintained a constant publication stream, authoring a total of 208 papers, reports, books, and other contributions concerning mosquitoes during the period 1901-1929.

In addition to his museum work, Dyar was editor of one of the great entomological journals of his day, the *Journal of the New York Entomological Society*, from 1904 to 1907, and he served on the editorial board of the *Proceedings of the Entomological Society of Washington* from 1908 to 1912. In 1913, he started up his own journal, *Insecutor Inscitiae Menstruus*, which was devoted primarily to Lepidoptera at the outset, but developed considerable involvement with mosquito taxonomy in its prime years. As publisher and editor, he produced 14 volumes, ceasing publication in 1926.

On January 19, 1929, Dyar suffered a stroke at his desk at the National Museum, and died two days later on January 21, 1929. He had become so well known for his mosquito work that *The New York Times* and *The Washington Post* both produced formal obituaries, headlining his expertise in mosquitoes. His lifelong friend Leland Ossian Howard eulogized him at the annual meeting of the New Jersey Associated Executives in Mosquito Control Association in February 1929 with these words: "It will be years, I fear many years, before he can be replaced by an American worker of even approximate knowledge and qualifications."

Dyar married first on October 15, 1889 to Zella Peabody, and second on April 26, 1921 to Wellesca (Pollock) Allen. By his first marriage, Dr. Dyar had a daughter and a son, and by his second he had three sons.

Dyar's biographers often fail to capture the truths behind the legends surrounding him, with the one prominent exception—an exquisitely researched biography produced by Dr. Marc Epstein and Dr. Pamela Henson of the Smithsonian Institution.* Their work accurately covers the many facets of Dyar's public and personal life, sets his life in the context of the time and the people with whom he worked and lived, and provides the truest portrayal of him as a person as well as a professional, and should be consulted by anyone with an interest in Dyar's personal side.

Harrison Gray Dyar, Jr. has been honored many times over the years by his colleagues, through their patronyms, praise, and poignant recollections. The AMCA honors him for his seminal contributions to culicidology, and for his contributions that extend beyond mosquitoes and mosquito bionomics to the broader field of public health entomology.

Terry L. Carpenter and Terry A. Klein

*Epstein ME, Henson PM. 1992. Digging for Dyar, the man behind the myth. *American Entomologist* 38:148-169.

Photo courtesy of the Smithsonian Institution Archives, Image No. SIA2009-0002

The 2011 AMCA Memorial Lecturer: COL (Ret) Terry Allen Klien

Terry Allen Klein was born on June 1, 1946 and grew up on a dairy farm near Salem, OR. Terry attended Oregon College of Education (now Western Oregon College) from 1964-1968, after which he returned to the high school from where he had graduated, Cascade Union High in Turner, OR, to teach earth and biological sciences until 1972. While teaching biological sciences, he became interested in insects; collecting larvae of butterflies and moths, rearing them, and curating the adult specimens.

In 1972 Terry received a grant to attend Oregon State University where he had his first experience in taxonomy, working on the taxonomy of a group of leafhoppers (*Aphrodes* spp.) under Dr. Paul Oman, a renowned taxonomist. After graduation, and with little work experience in entomology, he joined the US military to receive further training in entomology. His original intent was to stay just three years and then get a job as a civilian. However, after his first assignment in 1976-1978 at Fitzsimmons Army Medical Center in Denver, CO, he was assigned to the Armed Forces Research Institute of Medical Sciences in Bangkok, Thailand. There, he had the opportunity to work under Dr. Bruce Harrison, who mentored him in mosquito taxonomy and infectious diseases. It was Dr. Harrison who provided the basis for his continued interest and support in the identification and taxonomy of anopheline mosquitoes, and his cross mating studies with *Anopheles philippinensis* and *Anopheles nivipes* to resolve taxonomic issues.

In 1982-1985, following his assignment in Thailand, Terry attended the University of Florida where he identified the vector (*Culex erraticus*) of malaria (*Plasmodium floridense*) in the green anole (*Anolis carolinensis*) and confirmed the vector (*Lutzomyia vexator*, a sand fly) of malaria (*Plasmodium mexicanum*) in the Eastern Fence lizard (*Sceloporus occidentalis*) through transmission studies. During this period, Terry developed a close working relationship with Dr. Richard Wilkerson, with whom he has continued to work at the Walter Reed Biosystematics Unit on malaria vector distributions and taxonomy in Korea.

After graduating from the University of Florida in 1995 with a PhD degree in medical entomology, he was assigned to the US Army Medical Research Unit-Brazil, where he conducted malaria studies in the Amazon Basin. As a result of mentoring from Dr. Harrison, Dr. Wilkerson, and EL Peyton (deceased) he collected, curated, and reared numerous anopheline and culicine mosquitoes that provided material to study species complexes of anophelines in South America, this being in addition to his malaria work.

In 1990, he left Brazil and was assigned to the Walter Reed Army Institute of Research, Washington, DC, where he managed the malaria and mosquito repellent programs. Then in 1994 he was assigned as Commander, 5th Medical Detachment, Korea, where vivax malaria had re-emerged in 1993 in a Korean soldier after having been eradicated in the 1970s. The disease rapidly spread to US army personnel and Korean civilian populations. He conducted surveys and provided reports to the 18th Medical Command and Eighth US Army, Republic of Korea over the summer of 1995 which identified important measures to reduce malaria risks to U.S. military personnel. In November 1995 Terry was assigned to the US Army Medical Research Institute of Medical Sciences, Fort Detrick, MD, where he conducted field studies in the Amazon Basin of Peru. While there, he continued to work closely with Dr. Wilkerson and his staff and set up a program to collect, rear, and curate specimens for taxonomic studies.

In 1999, Terry returned to Korea as the Entomology Consultant, 18th Medical Command, and later became the Deputy Chief of Staff, Force Health Protection. He worked closely with Dr. Heung-Chul Kim, 5th Medical Detachment, and began rearing anophelines for taxonomic studies. At that time, based on published reports, *An. sinensis* was considered the primary vector of malaria in Korea. After rearing several generations of *An. sinensis*, he determined that two species, *An. sinensis* and *An. lesteri*, were from the same progeny brood, based on current morphological keys. He discussed his findings with Dr. Wilkerson and Dr. Leopoldo Rueda, then reared more progeny broods. These were sent to the Walter Reed Biosystematics Unit where PCR techniques identified two new species, illustrating that members of the *An. sinensis* Group could not be identified by morphological characteristics. Combining this and other information with the distribution of malaria, he concluded that the primary vector of malaria was *An. kleini*, named in 2005, while *An. sinensis*, which was the most common anopheline south of Seoul, was a secondary vector.

Terry retired in June 2006 and was awarded the Legion of Merit for his more than 30 years of outstanding military service. He lives in Korea but now has a second career working as the Regional Emerging Infectious Disease Consultant, 65th Medical Brigade, funded by the Armed Forces Health Surveillance Center, Global Emerging Infections Surveillance and Response System, Silver Spring, MD. While in Korea, his entomological role expanded and with his many Korean and US collaborators, he has worked on malaria, Japanese encephalitis, hantaviruses, scrub typhus, rickettsial, and other rodent- and tick-borne diseases. He has published over 125 scientific papers. He is Clinical Professor 2009-2011 at the University of Korea and on April 7, 2006, he received the Republic of Korea's Presidential Award for his "significant contribution to entomology in Korea".

Oral Presentation Abstracts

Plenary Session

PL1 Memorial Lecture Abstract

Terry A. Klein, terry.klein@us.army.mil and Terry A. Carpenter, terry.carpenter@osd.mil

Dr. Harrison Gray Dyar, Jr. (1866-1929) was an early Twentieth Century expert in taxonomy and biology of culicid Diptera. At an early age, Dyar became interested in the biology, life history, and taxonomy of Lepidoptera, which he continued throughout his entire career. Dyar pursued his passion for entomology, and during his formative years, professionals sent Lepidoptera specimens to him for identification. As his prominence was well known to Leland Howard, then the honorary curator of the US National Museum of Natural History, he was asked and accepted the position as honorary custodian of Lepidoptera in 1897, which later included periods of service with the US Department of Agriculture Bureau of Entomology and the US Army Officers' Reserve Corps. This position went without stipend and it was Dyar's personal wealth that allowed him to continue his love of entomology. However, the museum did provide limited staff and funds for illustrators, supplies, and travel. In the early 1900's, as a result of his role in the Reserve Corps, his interests expanded to include mosquitoes where he concentrated on their life histories and taxonomy. Throughout his career, Dyar often criticized colleagues, both personally and in publications, often with interludes of peace to co-author articles and books. His legacy of original scientific work is of lasting significance to public health and entomology communities, in recognition of which he was selected as the 2010 AMCA memorial lecture honoree.

PL2 The President's Malaria Initiative: An update on progress and challenges

Robert A. Wirtz, rwirtz@cdc.gov

The President's Malaria Initiative (PMI) was inaugurated in June 2005, as a 5-year, $1.2 billion initiative to rapidly scale up malaria control interventions in 15 high burden countries in Africa. The goal of PMI was to reduce malaria-related mortality by 50% in 15 selected countries in sub-Saharan Africa through achieving 85% coverage of vulnerable groups with 4 key interventions: 1) insecticide-treated bed nets, 2) indoor residual spraying, 3) artemisinin-based combination therapy, and 4) intermittent preventive treatment in pregnancy. The keynote address will summarize PMI progress to date, with a focus on the vector-based interventions, and discuss some of the current challenges facing the malaria control community.

PL3 Counteracting bioterrorist introduction of pathogen-infected vector mosquitoes

Walter J. Tabachnick, wjt@ufl.edu

The release of infected mosquitoes or other arthropods by bioterrorists, i.e., arboterrorism, to cause disease and terror is a threat to the United States. Florida has an extensive mosquito control network with training and experience in controlling mosquitoes that could serve as a model for a national response to meet this threat. However, Florida's capabilities are currently inadequate. Florida mosquito control agencies need plans and funds to mount rapid and effective responses that will eliminate infected mosquitoes. A Council on Emergency Mosquito Control should be created to coordinate resources and actions throughout Florida. Florida's response to arboterrorism could serve as a model for the entire United States.

PL4 Dengue fever in Key West, Florida: Adjusting operations and local mindset

Andrea Leal, aleal@keysmosquito.org

In 2009 and 2010, there were over 80 cases of locally acquired dengue fever in Key West, FL, USA. The Florida Keys Mosquito Control District has undergone a number of changes to its operations to transition from primarily nuisance control to disease vector control. The principal vector is *Aedes aegypti*, which can be found in a variety of artificial and natural containers in the domestic setting. There has been a concentrated effort in Key West to reduce the biting population of *Ae. aegypti*, including, but not limited to, an increase in source reduction and larval control, increase in adult surveillance, new product trials, and an increase in public education efforts.

Student Competition

1 Introduction

Roxanne Connelly, crr@ufl.edu

The AMCA Student Paper Competition is open to undergraduate and graduate students who are student members of the AMCA. Papers are judged on quality of oral presentation, use of visual aids, and scientific merit. The student with the best presentation receives the Hollandsworth Prize. Judges have the option of awarding 1 or 2 Honorable Mention prizes. The 2011 contest will be the 22nd time the competition has occurred.

2 Modeling aquatic habitat colonization in the Artibonite valley, Haiti

Mark A. Rider, mrider@tulane.edu

Anopheles albimanus is the primary vector of malaria in Haiti. In spite of having the highest rate of human infection in the hemisphere, few investigations have endeavored to describe the impact of vector ecology on malaria here. The current study models factors associated with the likelihood of vector colonization of aquatic habitats in the central Artibonite region. Results of this modeling strategy in predicting vector presence and abundance, and implications for control are discussed.

Abstracts

3 Budgeting for energy. How *Anopheles gambiae* mosquitoes behave when confronted with an unobtainable host
Simon Zappia, spz@sfu.ca

Anopheles gambiae (Diptera: Culicidae), the main vector of malaria, emerges as a small and energy deficient adult mosquito. Little is known about how its energy state influences its movements in the environment and its response to hosts. In this study we analyze the movement of mosquitoes under different energetic states when confronted with an unobtainable host and an alternative sugar food source. Our results are presented and discussed.

4 A Novel cage olfactometer for *Anopheles gambiae*
Philip E. Otienoburu, otienoburu.1@buckeyemail.osu.edu

Anopheles gambiae is the most efficient vector of Malaria in Africa, accounting for most of the morbidity and mortality in Sub Saharan Africa. The use of plant derived and synthetic attractants is becoming an important tool for surveillance and local control of this deadly mosquito. In this study, we report on a novel cage olfactometer for measuring the orientation of this mosquito to plant derived volatiles in a semi-field setting.

5 Breaking Cultural Boundaries: West Nile Virus Education for Spanish-Speakers in San Diego County
Kristen G. Meckel-Parker, krissy.meckel-parker@sdcounty.ca.gov

The San Diego County Vector Control Program (SDCVCP) is actively involved in educating Spanish-speaking residents about West Nile virus and mosquito abatement. According to the U.S. Census Bureau, approximately 30% of San Diego County inhabitants identify themselves as Hispanic. By working with the Mexican Consulate, participating in binational health events, and training *promotoras de salud* or health promoters, the SDCVCP has successfully connected with a previously underserved population.

6 In search of sand flies: a spatial and temporal journey
Logan M. Minter, log_mint@yahoo.com

Lutzomyia shannoni (Dyar), a sand fly, is considered both zoophillic and anthropophillic and may be a potential vector of human and livestock pathogens. Many aspects of natural history, which are fundamental components of risk assessment and development of integrated pest management programs, remained unclear. Studies examining the spatial and temporal nature of this insect were carried out to gain a better picture of its habits in the Ohio valley region.

7 Impacts of eucalyptus leaves on development of three mosquito species
Jennifer Henke, jennifer.henke@email.ucr.edu

Research has shown that leaves of different tree species vary in their ability to support mosquito development. This study examined the ability of three mosquito species (*Aedes aegypti*, *Culex quinquefasciatus*, and *Cx. tarsalis*) to develop in water containing eucalyptus leaves. *Culex tarsalis* was strongly affected by the presence of eucalyptus while *Cx. quinquefasciatus* was negatively impacted by both a toxin from the leaves and a lack of proper microbe development. *Aedes aegypti* was unaffected.

Legislative and Regulatory Symposium I

8 USEPA NPDES pesticide general permit: an overview
Allison Wiedeman, Wiedeman.Allison@epa.gov

This presentation will review the development and implementation of the USEPA's Pesticide General Permit (PGP) For Point Source Discharges To Waters Of The United States From The Application Of Pesticides

9 California NPDES permit for residual pesticide discharges to waters of the US from vector control applications
Gary Goodman, gwgooodman@fightthebite.net

The Mosquito and Vector Control Association of California created a committee to negotiate with the California State Water Resources Control Board (SWRCB) on the development of the NPDES permit in California. This presentation will focus on the intricacies of the California permit including cost, the type and quantity of sampling, the limitation of products and the creation and implementation of a statewide coalition for permit compliance. The California statewide coalition allows all members of the coalition to pool resources so that an individual mosquito control district does not have to bear the sole cost of compliance. The coalition approach provides the SWRCB with the data that they require to determine the impacts of mosquito control products on the waters of the state and eliminates the redundancy within sampling and monitoring by the permit holders.

10 Public health pesticides and the IR-4 program
Karl Malamud-Roam, kmr@aesop.rutgers.edu

This presentation will review the Inter-Regional Research Project Number 4 (IR-4 Project) and the development and evaluation of public health pesticides.

Disease/Vector Studies I

11 A tale of two epidemics: Dengue in Florida 1922 and 1934
Gordon Patterson, patterso@fit.edu

Dengue fever epidemics played a critical role in the creation of organized mosquito control in Florida. In 1922, a dengue pandemic swept across the Gulf Coast catalyzing the formation of the Florida Anti-Mosquito Association. Twelve years later a dengue epidemic in Miami was suppressed through mosquito control. In both instances, advocates of mosquito control succeeded because of their campaign to enlist the public's support for the anti-mosquito measures.

12 Dengue surveillance in Key West, FL, 2010
Catherine A. Pruszynski, cpruz@keysmosquito.org

Dengue fever infects as many as 100 million people yearly, and is a significant cause of illness in the tropics. Dengue is endemic to South and Central America as well as the Caribbean islands but rarely occurs in the United States. However, between November 2009 and October 2010, the Florida Department of Health confirmed 82 cases of locally-acquired dengue in Key West. The prevention and control of dengue relies on the surveillance of virus in the human population and its vector *Aedes aegypti*. Because of the asymptomatic nature of the disease and the high number of tourists traveling through Key West, human serological data are difficult to obtain. A more consistent method for surveillance is the detection of virus in field-caught *Ae. aegypti* mosquitoes. From June through October 2010, mosquitoes were collected using BG Sentinel traps on a weekly basis at 45 locations throughout Key West. *Aedes aegypti* were vialed and sent to Florida Gulf Coast University for assay by reverse transcriptase polymerase chain reaction for dengue viral RNA. Test results show that positive pools were most prevalent in Old Town, Key West and were identified to be serotype 1 (DENV-1). Vector surveillance through RT-PCR remains a reliable method for dengue detection and is necessary in order to implement effective control strategies.

13 Migratory birds and the dispersal of arboviruses into California
William Reisen, wkreisen@ucdavis.edu, Sarah Wheeler and Ying Fang

Each spring neotropical migrants pass through the Coachella Valley, CA, enroute to northern destinations, providing an opportunity to test the hypothesis that mosquito-borne encephalitis viruses are introduced annually by migratory birds. A total of 5,632 sera were collected from 43 species of migrants during the spring (April-June), of which 34 (0.61%) comprised of 14 species tested positive by enzyme immunoassay; only 10 were confirmed by plaque reduction neutralization tests (PRNT). In contrast, 126 (11%) of 1,109 migrants in 76 species that were found dead by the public during the summer and necropsied in California were positive for West Nile virus (WNV) RNA; however, only 3 (0.7%) of 428 birds tested during the spring were positive. Limited experimental infection studies with WNV showed that Orange-crowned Warblers were highly susceptible and frequently died, whereas most Yellow Warblers survived. Our results indicated that birds entering California rarely exhibited a history of infection and that many birds probably became infected after entering California.

14 Timing of nest initiation determines mosquito burden on nesting birds
Anna Riggan, rigganae@mymail.vcu.edu and Kevin A. Caillouet

During the course of incubation and maturation, nesting adult birds and their offspring experience significant exposure to mosquitoes. In an effort to understand the transmission dynamics of avian malaria during the nesting season (April-July), we designed a novel mosquito collection device that monitors the mosquito landing rate of various cavity-nesting birds. In the laboratory, the Nest Mosquito Trap (NMT) collected approximately 38% of mosquitoes introduced to the nest box. During the 2010 nesting season, we collected 158 mosquitoes over 74 trap nights using the NMT. *Culex salinarius* (72%), *Cx. pipiens/restuans* (22%), and *Cx. erraticus* (6%) comprised most of collected mosquitoes but were proportional to the abundances of mosquitoes collected in CO_2-baited light and gravid traps. Though not a significant difference, more mosquitoes were collected later (0.387 mean/trap night ± 0.136 SE) in the nesting season than earlier (3.74 ± 1.797) ($p = 0.07$). The avian malaria infection rate in the mosquitoes collected by species and date will be discussed. Higher mosquito landing rates and high infection rates in birds that nest later in the season may also affect other avian disease systems that are transmitted by mosquitoes such as West Nile virus.

15 West Nile virus epidemic: Greece, 2010
Alexandra Chaskopoulou, andahask@ufl.edu, Mark D. Latham, Athanasios Tsakris, Georgia Vrioni and Philip Koehler

A West Nile virus (WNV) epidemic occurred for the first time in northern Greece in 2010 in the region of central Macedonia that includes Thessaloniki, the second largest city of Greece (population of ~ 2 million). From the beginning of the outbreak (7/6/2010) until the present (10/22/2010), 261 confirmed cases have been reported with 32 deaths (predominantly in persons over 70 yr of age). Even though the cases were widespread, the epicenter of the outbreak could be identified as the larger area surrounding the Axios and Aliakmonas rivers. This area is comprised mainly of rice-fields (the primary mosquito habitat) and other natural wetlands. The main WNV vector species in the area are presumed to be *Culex pipiens* L. and *Culex modestus* Ficalbi. Prior to the WNV outbreak the main available mosquito control technique in Greece was larviciding, and there were no products available for outdoor ULV adulticiding. After the onset of the disease, 2 vector control products received registrations for adulticiding,

and emergency spraying was conducted both by ground and air in an attempt to interrupt the disease transmission cycle. When mosquito-borne disease epidemics are increasing, vector-control tools that can provide immediate, effective, and environmentally acceptable control practices should be available both as a proactive measure and an emergency response tool for mosquito control.

16 West Nile virus activity in Orange County, CA: 2003-2010

Robert Cummings, rcummings@ocvcd.org, Tim Morgan, Robert K. Velten, Martine Jozan, Laura Krueger and Kiet Nguyen

Since the introduction of West Nile virus (WNV) in Orange County, CA, in 2003, levels of WNV activity have oscillated through years of amplification (2004), modest subsidence (2005-07), recrudescence (2008), and further declines (2009-10) to barely-detectable rates in dead birds, free-ranging passerine bird and sentinel chicken serosurveillance, mosquitoes, and humans. Although evidence of WNV infection has been found in 52 species of dead birds, 10 species of free-ranging birds, 5 species of mosquitoes, and 3 species of mammals in the county, tracking of enzootic transmission infection incidence in dead American Crows (*Corvus brachyrhynchos*) and the southern house mosquito (*Culex quinquefasciatus* Say), along with monitoring antibody seroprevalence levels in free-ranging House Finches (*Carpodacus mexicanus*), has been demonstrated to be the most sensitive indicators of WNV activity and impending amplification. Blood meal analyses of engorged *Cx. quinquefasciatus* females by nucleotide sequencing of PCR products of the *cytochrome b* gene have shown the important role of House Finches and several other passeriform birds in the maintenance and amplification of WNV in Orange County, with *Cx. quinquefasciatus* acting as both the principal enzootic and "bridge vector" responsible for transmission to humans.

17 A comprehensive surveillance program for the detection of West Nile virus throughout the season

Paula Macedo, pmacedo@sac-yolomvcd.com, Marcia Reed, Kara Kelley and David Brown

There has always been discussion among scientists and statisticians about how to best implement a surveillance program. Should the program emphasize trapping as many sites as resources allow, or should it try to increase trapping at sites of interest? At the Sacramento-Yolo Mosquito and Vector Control District (SYMVCD), although we do utilize random sampling to obtain representative samples for inferring quantities of interest in a certain mosquito population, we balance that with the use of auxiliary information based on previous knowledge and information on suitable mosquito habitat to choose trap location and make the collection more efficient. Our program tries to incorporate targeted surveillance within the random surveillance. In addition to that, we increase sampling effort at "hot spots", which may become important early in the season, when transmission foci are sporadic and mosquito infection rates are low. The initiation of arbovirus transmission in our District is traditionally associated with low vector densities and low levels of transmission, and it can be difficult to collect enough samples with sensible detection power. Therefore, dead bird surveillance is a critical component of our program, especially to initially guide additional trapping efforts. This presentation will focus on the surveillance program employed by our District in 2010 and how we made changes throughout the season in response to virus activity, abundance, and other parameters.

18 Investigating the interplay of evolutionary and ecological factors underlying spread of Rift Valley fever virus

Rebecca Gray, rgray@ufl.edu, Andrew J. Tatem, Massimo Ciccozzi, Jodi Ritz, Mauro Delogu and Marco Salemi

Understanding the reciprocal roles of transmission and environment is critical for developing effective intervention strategies for vector-borne diseases. Local epidemics of Rift Valley fever virus (RVFV) are associated with transovarial transmission via *Aedes macintoshi* and with seasonal rainfall patterns. Less clear, however, is the mechanism for long-distance migration of the virus across the African continent. One hypothesis is that insectivorous bats, *Hipposideros commersoni* and *H. ruber*, could act as distinct viral vector/reservoir for RVFV. We investigated global dissemination of RVFV by incorporating both viral genetics and GIS data using a Bayesian framework that allows testing of positional associations between ecological/landscape variables and disease incidence. Viral migration routes were calculated using Bayesian statistics, and potential correlates of migration (e.g., geographic distance, bat migration, mosquito distribution) were tested as *a priori* hypotheses. Climatological data (e.g., precipitation and temperature) were mapped for the African continent during the 20th century and compared to the genetic patterns. We found statistically significant associations that supported a model in which local variations in precipitation affect the population dynamics of *Ae. macintoshi*, which in turn results in bat migrations during periods of drought. Infected bats could thus transport RVFV to new locations, where local mosquito populations initiate a new epidemic.

19 Vector competence of selected species of mosquitoes from Canada to transmit Rift Valley fever virus

Mahmood Iranpour, mahmood.iranpour@phac-aspc.gc.ca, Michael J. Turell and Robbin Lindsay

The competence of mosquitoes to acquire and transmit Rift Valley fever virus (RVFV) was determined by tracking the patterns of viral infection and dissemination in mosquitoes that were allowed to feed upon hamsters syringe-inoculated with RVFV. We tested field-collected *Aedes sticticus, Aedes vexans, Culex tarsalis, Culiseta inornata,* and *Coquillettidia perturbans* 2 wk after they had fed on RVFV-infected hamsters. Based on the detection of virus in saliva collected in capillary tubes, individual *Cx. tarsalis, Ae. sticticus,* and *Cq. perturbans* transmitted RVFV. These preliminary results suggest that these 3 species may have a significant role in RVFV transmission, should this virus be introduced into Canada.

Education and PR

20 Public health education through geocaching

Arleen Lim, arleen.lim@sdcounty.ca.gov, Kristen G. Meckel-Parker and Rebecca Lafreniere

West Nile virus (WNV) first emerged in San Diego County in 2003. Since its appearance, the San Diego County Vector Control Program (SDCVCP) has educated residents on the potential health risks associated with WNV infection. However, this message is often muted by a common syndrome known as "Information Fatigue". With large amounts of information available at people's fingertips and the media bombarding the public with the "Disease du Jour", it is difficult to maintain the public's attention. The SDCVCP is committed to finding novel ways to engage the public and keep mosquito abatement and disease awareness in the public's mind. An example is the innovative SDCVCP Geocaching Project. This project combines modern technology with public health information in a fun, interactive way. "Geocaching is a high-tech treasure hunting game played throughout the world by adventure seekers equipped with GPS devices." The SDCVCP has taken geocaching to the next level by also incorporating Quick Response (QR) codes. QR codes allow geocachers to enter their log directly to the website while in the field. These new tools have helped facilitate the high tech evolution of public health education in San Diego County. The current SDCVCP caches are located in City of San Diego (COSD) parks. As such, this project is mutually beneficial for COSD Parks and Recreation Department, the SDCVCP and the general public. Geocaching is enjoyed by all age groups with a strong sense of community and support for the environment.

21 Design and implementation of a mobile laboratory for vector education

Andrew H. Pak, apak@glacvcd.org and LeShawn Simplis

In 2001, the Greater Los Angeles Mosquito and Vector Control Public Health and Educational Foundation, a 501(c)(3) non-profit organization, was founded to advance the Greater Los Angeles County Vector Control District's (GLACVCD) elementary education program. The following year, the VecMobile, a 35-foot recreational vehicle retrofitted into a mobile science laboratory, was created and began providing youth throughout Greater Los Angeles County with a cost-free, hands-on science curriculum focusing on mosquitoes and their dangers while meeting California educational standards. Today, the VecMobile has reached more than 51,000 students and services more than 700 public and private schools within the GLACVCD area. Students learn how they can better serve their communities by eliminating mosquito sources around their neighborhoods and develop vector awareness while capturing an appreciation for the sciences through the VecMobile's creative and dynamic curriculum. The VecMobile serves as a model for creative science education programs and the Educational Foundation, in partnership with GLACVCD, seeks to expand its reach and curriculum in response to the needs of its constituents. This presentation will share highlights from the VecMobile over the past decade and discuss free vector education in a time of significant state and federal budget cuts.

22 Beach Mosquito Control District swarms local education system and general public

Cynthia J. Mulla, cindymulla@comcast.net

Objective: To organize, build, maintain and nurture a positive climate in which we can enhance a solid working relationship with local school systems and citizens about the importance of mosquito control. In addition, researching proactive methods that will work to improve communication, reduce negativity, and instill a sense of acceptance for mosquito control programs.

23 EcoSMART: A new concept in vector education

Carol Anne Hagele, cahagele@sgvmosquito.org and Kelly Middleton

The San Gabriel Valley Mosquito & Vector Control District is located in West Covina, CA. As a vector control district in densely populated east Los Angeles County, we constantly ponder how to deliver our message effectively enough to change our residents' habits permanently. We have focused on educating the youth in our area schools and have adapted our programs to meet California's Science Standards and the new Education and the Environment Initiative guidelines to help teachers whose tight schedules limit outside programs. But we feel we could reach more kids, and through them, their teachers and families with more innovative ways to get their attention. A plan to build a laboratory-classroom facility on District property has been set in motion. The intent of the EcoSMART (Ecologically Sustainable Methods and Research Training) laboratory is to engage students of all ages and diverse socio-economic backgrounds in activities which involve studying ecological concepts that are critical to current and future public health conditions. Our vision includes partnering with other agencies and businesses, providing tools and space for student-driven research, and engaging students in a mentally and sensory-stimulating experience that will personalize the concepts of vector ecology and environmental health. We see this new facility as a vital investment in young people that will pay dividends in the future many times over.

24 Using service learning to enhance your program

Brian Murphy, Brianrmu@leeschools.net, Neil Wilkinson and Eric Jackson

The Lee County Mosquito Control District has a public school outreach program that collaborates with Florida Gulf Coast University in Fort Myers. As part of that collaboration, an internship program was established for university students. Student interns work for service learning hours, senior internship credit, senior projects, as graduate assistants, for the fun of it, and sometimes even for pay. Interns collect aquatic animals for use in a grade 5 lab, clean and autoclave glassware for high school labs, print handouts and prepare materials for classes, deliver and pick up materials to and from schools, present a kindergarten unit, coteach labs, and (if they are exceptional) teach at

higher levels as well. University students become aware of our mosquito control program by actively becoming a part of it. This program provides great learning opportunities for students and much needed help for the outreach program.

25 Creating a mosquito education calendar with local students' art: Part 1
Barbara J. Struthers, bjstruthers@bjsltd.net, Susan R. Levy, Larry Feder, Roger K. Simonson and Richard Faro

In 2008, South Lake Mosquito Abatement District in northeastern Illinois used the Fight the Bite calendar put out by Fairfax County, VA, as a template; it was well received. In 2009, we decided to have a contest to put local 4th and 5th grade students' pictures in a similar calendar. We offered financial incentives for students whose pictures were used for the calendar and for any teacher who helped a student with a poster. The information that went out to all public and some private schools resulted in only 2 entrants. One of our board members then went to a local private school, explained what we wanted to do and asked for help. We agreed that if one teacher helped all the students whose posters were chosen, he/she could receive all of the teachers' contest money. The result was that the private school art teacher had all her 4th and 5th grade students create mosquito posters that they entered into the contest, and learn about mosquitoes and repellents in the process. We ended up with 56 good posters, these were judged by our board and some local professionals. Because most of the posters came from one school, we held a short ceremony there where we presented checks to the winning students and teacher. Calendars were distributed to all grade school students in one school district as well as at various locations in the community. Total cost including the financial incentives, printing and distribution was just over $20,000.

26 Creating a mosquito education calendar with local students' art: Part 2
Barbara J. Struthers, bjstruthers@bjsltd.net, Susan Levy, Lawrence Feder, Roger Simonson and Richard Faro

See preceding abstract.

27 Evaluation of communication strategies
Luz Maria Rodriguez, lrodriguez@FIGHTtheBITE.net

The Sacramento-Yolo Mosquito & Vector Control District recently conducted a market research study consisting of 400 telephone interviews with residents of both Sacramento and Yolo counties with the objective of assessing the effectiveness of communication between the District and citizens it serves. This research served as follow up to a study conducted in 2007 which concluded that citizens were largely "comfortable" with the mission, communication and overall performance of the District. While the 2007 survey focused more on public behaviors and reactions to the first aerial spraying over residential areas in the region since the arrival of West Nile virus, the 2010 survey devoted more questions to district communication with residents. Highlights of the market research findings include: Most respondents (65%) claimed to have changed mosquito-defense behaviors as a result of the information received from the district. An impressive 2 out of 5 respondents recalled reading, seeing or hearing the campaign slogan, "Fight the Bite." Almost 1 out of 2 respondents (45%) recalled having read, heard or seen information from or about the district in the last 6 months. Additional details and finding of the market research will be discussed during the presentation.

28 *Wing Beats:* Cover to cover
Stephen L. Sickerman, director@swcmcd.org and Jack Petersen

The editors of Wing Beats magazine, the official quarterly trade journal of the American Mosquito Control Association and the Florida Mosquito Control Association, encourage members to submit manuscripts for publication. Suitable subjects for articles–current operations, arbovirus surveillance, legislative issues, historical perspectives, and new equipment, chemistries and technologies –will be discussed. Appropriate writing styles, manuscript formats and digital images will be reviewed for prospective authors.

Legislative and Regulatory Symposium II

29 Mosquito control: Threatened or endangered - A West Coast perspective
Angela Beehler, angela@mosquitocontrol.org

Biological opinions are being completed by NMFS on 37 active ingredients to determine the effects on 28 species of endangered salmon and steelhead. Malathion and naled were 2 of the pesticides studied, and it was determined that continued use of these products as labeled will jeopardize the listed species. Models used to calculate the amount of pesticide exposure to salmonid habitat are unrealistic and must be reviewed. The use of sound science and mosquito control education are necessary to ensure that public health operations can continue to function without prohibitive treatment buffers.

30 Endangered species and mosquito control: Update Florida/East Coast
Michael Hudon, m.hudon@irmosquito2.org

Mosquito control operations continue to be affected directly and indirectly by the Endangered Species Act (ESA). Any new federal permits such as NPDES require evaluation of endangered species. New trends in the ESA petitioning process may affect and are likely to adversely affect the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Services (NMFS) ability to set their own priorities. A recent change in Florida's listing policy and the ESA's similarity of appearance provision will also be presented.

31 ESA: An industry perspective
Peter Connelly, peterc@amvac.net

Recently the National Marine Fisheries Service (NMFS) provided a series of suggestions to the US Environmental Protection Agency (EPA) on how 12 registered organophosphate (OPs) insecticides should be further regulated to protect salmon habitat in the Pacific Northwest (PCW) in the form of a Biological Opinion (BIOP) to EPA. In the BIOP, some assumptions made by NMFS on how one of these products, naled (AMVAC Chemical Corp), was used in public health applications were incorrect. As the registrant for this important public health product in the U.S., AMVAC asked for and received an audience with both NMFS and the EPA in Washington, DC, to try to illuminate the critical differences in public health applications from the more frequent agricultural applications in the hopes that the Service would amend the BIOP. A review of a meeting between the registrant, the NMFS and US EPA and the discussion took place relative to the assumptions used by the Service in preparing the opinion points to the need for stakeholders to proactively and regularly work with regulatory agencies to correct misinformation about product use. Stakeholders need to continue to help the regulators regulate public health products using a realistic understanding of their scarcity, their use and the importance of their existence.

32 The AMCA's new 5-year EPA Pesticide Environmental Stewardship Program activity plan
Douglas Wassmer, dwassmer@pascomosquito.org

The objective of this presentation is to detail the "new" parameters we will be working under and how all of the AMCA partners will need to meet them. The discussion will include the origins of the activity plan and what the AMCA and its PESP Partners may hope to achieve individually and collectively through participation.

33 Status of USFWS's draft National Mosquito Management Policy for National Wildlife Refuges
William H. Meredith, william.meredith@state.de.us

Current status of the USFWS draft National Mosquito Management Policy for National Wildlife Refuges will be reviewed, with emphasis on when possible publication of this proposed policy's second draft might appear in the Federal Register for public review-and-comment, along with what actions will then ensue on part of the AMCA and others in the mosquito control profession. There is good possibility that the second draft of this National Policy will be published by the time of the AMCA's annual meeting. Anticipated or actual problems with some of the contents of the second draft will be enumerated and discussed. Some recent changes in USFWS personnel charged with the developing or implementing this policy will be examined, including implications for such. Some associated problems of a still draft National Policy that are now affecting proposed or final Comprehensive Conservation Plans (CCPs) for individual NWRs across the country will also be reviewed.

Disease/Vector Studies II

34 Eastern equine encephalitis in Michigan
Thomas R. Wilmot, twilmot@co.midland.mi.us and Charles E. Dinsmore

Equine and human EEE cases were identified in Michigan during the summer of 2010. This report describes these cases and gives a historical review of EEE in Michigan.

35 *Aedes albopictus* population size estimation and epidemic risk assessment in northern Italy
Romeo Bellini, rbellini@caa.it, Marco Carrieri, Alessandro Albieri, Rodolfo Veronesi, Paola Angelini and Claudio Venturelli

The recent evidences of sanitary risks related to *Aedes albopictus* in Italy require a control strategy to achieve the suppression of the vector to below the critical density threshold for preventing new epidemic events. We evaluate the reliability of some larval population estimation indices (House Index, Container Index, Breteau Index, Pupal Demographic Survey) and their correlation with the ovitrap and with the human landing collection (HCL) produced data. Three sampling sessions [I) June, II) July, and III) August] were completed in 4 Emilia-Romagna towns during the season. In each town-session, 230-260 premises were inspected: all mosquito sites were recorded and described, and immatures were counted. Drains in public roads were also sampled. Georeferenced standard ovitraps were set up. Within each town, HLC were performed during the peak of female biting activity. Drains (private and public) accounted for 94.2% of total pupae collected, followed by drums (2.6% of pupae), buckets (0.9% of pupae), and medium containers (0.8% of pupae). Good correlation level was obtained between the number of pupae/ha and the mean egg number collected by ovitraps the week after inspection and between HLC and the mean egg number collected the week before. It therefore is possible to calculate the threshold values in terms of the mean number of eggs/ovitrap necessary for the chikungunya (mutated and nonmutated strain) and dengue viruses diffusion (R>1).

36 Maggots have a mouth full to say about West Nile virus
Kara Kelley, kkelley@sac-yolomvcd.com, Paula Macedo, Marcia Reed and David Brown

The ability to detect and timely respond to arbovirus activity is a major task of an arbovirus surveillance program. At Sacramento-Yolo Mosquito and Vector Control (SYMVCD), we try to utilize multiple tools for detection of arbovirus activity. The collection of dead birds reported by the public and subsequent testing for arbovirus is a crucial component of our program, and we use that to guide additional surveillance in any given area. Dead birds reported by the public as having maggots are usually deemed unsuitable for testing in California and many other states. These birds are discarded and potentially useful information regarding arbovirus transmission is lost. We

evaluated the potential of testing the maggots present in these dead birds by RT-PCR to detect West Nile virus. This procedure is faster than harvesting internal organs, no necropsy is necessary, it requires less training and equipment, and it does not require the use of a biological containment facility. In addition, it has the major advantage of using dead birds that would otherwise be rejected for testing, and avoiding the loss of potentially good data that can be used in surveillance programs.

37 Efficacy of host-seeking traps for collecting sand flies (Diptera: Psychodidae) to test for *Leishmania* in Libya

Peter J. Obenauer, obenauerp001@yahoo.com, Badereddin B. Annajar, Hanafi Hanafi, Mahmoud Abdeldayem and Jefferey Villinski

Sand flies are important vectors of cutaneous leishmaniasis, especially along coastal towns of the northwestern region of Libya where an estimated 20,000 human cases have occurred from 2004-2009. Host-seeking traps are an important tool for sampling sand fly populations and surveying the incidence of *Leishmania major* and *L. tropica* within a given population. We evaluated the capture efficiency of the BG-Sentinel + CO_2, CDC light, CDC light + CO_2 and CDC UV light + CO_2 traps in 3 coastal townships from June to October 2010. Over 3,500 sand flies, representing 8 species from 2 genera were collected; the majority were identified as *Phlebotomus papatasi* and *P. longicaspis*. Preliminary results indicate that the CDC-UV light + CO_2 configuration had the highest sand fly capture rates compared to the BG-Sentinel + CO_2 which had the lowest capture rates. *Leishmania* was detected in 4 out of 152 sand fly pools (n=348); 3% of the positive pools were detected from *P. papatasi*.

38 The occurrence of flea-borne typhus in Orange County, CA

Robert K. Velten, rvelten@ocvcd.org, Laura Krueger, Art Tilzer, Kiet Nguyen, Steve Bennett, Carrie Fogarty and Robert Cummings

Orange County, CA, experienced 36 human cases of flea-borne typhus from 2006-2010. These were the first reported cases in the county since the 1970s. Domestic cats (*Felis catus*), opossums (*Didelphis virginiana*), and black rats (*Rattus rattus*) were trapped in the vicinity of the cases during epidemiologic investigations; blood, organ tissue, and flea samples were taken for testing by the CDC for rickettsial DNA. Opossums carried the most fleas of all animals examined, with flea burdens varying from 0 to more than 200. *Ctenocephalides felis* was the most common flea species collected, followed by specimens of *Pulex irritans*, *Diamanus montanus*, and *Echidnophaga gallinacea*. Only 1 roof rat was flea-positive, with a single *Leptopsylla segnis* specimen. Relatively few fleas were found on domestic cats. All single host *C. felis* collections from opossums showed the presence of *Rickettsia felis* DNA. Approximately 3% of *Pulex irritans* and 2 *D. montanus* fleas tested positive for *R. felis* DNA. The single *Leptopsylla segnis* specimen tested negative for *R. felis*. All blood samples tested were negative via PCR of buffy coat cells. These data indicate that *C. felis* collected off opossums in Orange County are capable of vectoring this disease agent to people and that flea control measures are warranted on domestic animals.

39 Vector problems associated with hoarding in Orange County, CA

Laura Krueger, lkrueger@ocvcd.org and John Drews

Homes with hoarding present a challenge to vector control districts servicing urban environments because they provide breeding sources and harborage for a variety of vectors in highly populated areas. Hoarding is defined as the excessive acquisition of items and failure to use or discard them. This presentation will highlight the Orange County Vector Control District's (District) Hoarding Homes Program and the District's participation with the Orange County Hoarding Task Force. Since 2007, 26 homes have been addressed by the Hoarding Homes Program. Program goals are to reduce the population of vectors at the home by means other than a formal abatement process and to provide safety training to workers who enter homes. Results from a vector breeding assessment of hoarding homes reported to the District from 2007 to 2010 shows that if source reduction is not possible, the hoarding homes require multiple visits and pesticide applications over many years or until the problem is corrected. Vectors most often associated with the homes include: mosquitoes, rats, flies, fleas, opossums, feral cats, and wood rats. These cases are complex and require support from numerous public agencies.

40 Competitivity of sterile males *Glossina palpalis gambiensis* (Diptera: Glossinidae) in preparation of an elimination campaign in Burkina Faso

Adama Sow, wosamada@yahoo.fr, Issa Sidibé, Peter Van den Bossche, Germain Sawadogo, Zakaria Bengaly and Jérémy Bouyer

Experimental irradiated *Glossina palpalis gambiensis* males were released over a distance of 3 km along a riverside. Over the total released flies, 93.80% flight off. Periodic entomological surveys allowed determining ratios between released males and wild ones, the apparent density of irradiated and wild tsetse. The abortion rate amongst the wild females and their spermathecal fill were assessed. There was significant difference between abortion rates of females before and those during the release period ($p<0.000$). From the 2^{nd} to the 10^{th} wk of release, abortion rates increased. The spermathecal fill did not show significant difference between females before and during the release. However, the spermathecal fill was higher for the wild females than for the virgin females mated with irradiated males in the insectary ($p=0.015$). Irradiated males showed good dispersal along the riverside. Indeed monitoring traps caught almost the same proportion of irradiated tsetse ($p> 0.05$). The average half-life of the irradiated males was low (4.58±1.26 d). The ratio of irradiated males/wild males remained lower than 2. However, the release did have measurable impact on the wild females' reproduction. Hence, the irradiated males of *G. P. Gambiensis* could be

used in Sterile Insect Technique for the elimination of tsetse in Burkina Faso within the framework of the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC).

41 The sterile insect technique as part of area-wide integrated pest management for the control of vector-borne diseases

Hanano Yamada, h.yamada@iaea.org, Gilles Jeremie, Balestrino Fabrizio, Oliva Clelia and Vreysen Marc

The sterile insect technique (SIT) has celebrated successes worldwide in suppressing, containing, and eradicating several dipteran and lepidopteran pests of agricultural importance. In view of increased risks of introducing exotic insect pests into new areas due to globalisation and climate change, strict government legislation, the current surge in emerging or re-emerging vector-borne diseases, and the increasing appearance of insecticide-resistance, novel and environmentally friendly solutions to these pest problems are in urgent demand. This has created renewed interest to develop the SIT for use in area-wide integrated pest management programs to sustainably manage vectors of such diseases. The SIT is an "autocidal" biological control tactic that agrees with present-day concerns regarding human health and the environment. It requires the production of large numbers of the target insect that, after sterilization, are released in adequate overflooding ratios to reduce the reproductive potential of the wild population. The development of the "SIT package" to manage disease-transmitting mosquitoes is, however, still in its infancy, and many fundamental components still need to be developed, validated, and 12ptimized. The FAO/IAEA Insect Pest Control Laboratories in Austria are driving essential research on various aspects of mass-rearing, sex separation, irradiation, handling, transportation, and release, and the biological quality of the produced sterile mosquitoes.

254 Prediction of West Nile virus vector mosquitoes in Multnomah County, Oregon: A time series analysis

Josiah Roldan, roldanj@onid.orst.edu

West Nile virus (WNV), a mosquito-borne disease, continues to be a serious threat to public health. The Autoregressive Moving Average (ARIMA) model is an effective statistical modeling technique for forecasting mosquito-borne diseases. Analyses of data from recent studies revealed how variations in meteorological conditions can affect WNV transmission. This study endeavored to develop ARIMA models to forecast larval mosquito density and explore the impact of local meteorological conditions on the abundance of 3 mosquito species known to vector WNV in Multnomah County, OR. Time series analysis was performed on larval mosquito data collected by Multnomah County Vector Control from January 2003 to December 2008. Seasonal ARIMA models were formulated for *Culex pipiens*, *Cx. tarsalis*, and *Aedes vexans* to evaluate the relationship between local climatic conditions and mosquito larvae density. Seasonal ARIMA model (0,1,1)(0, 1, 1)12 was the best model for both *Cx. pipiens*, while model (0,1,0)(0,1,1)12 was the best model for *Cx. tarsalis* based on Root Mean Square Error and Akaike's Information Criteria. We were not successful in developing a model for *Ae. vexans*. Cross-correlation analysis revealed correlations between larval density and precipitation and temperature at key lags. Seasonal ARIMA models for *Cx. pipiens* and *Cx. tarsalis* were effective in forecasting larval density in Multnomah County, OR. Although heavy precipitation is observed during spring, the cold temperature appears to be a limiting factor for *Cx. pipiens*, but not for *Cx. tarsalis*. These findings should be considered when performing research in regions with similar meteorological conditions.

New Product Trials

42 Activity and efficacy evaluation of a new biopesticide Natular™ T-30

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

Natular™ T-30, a new formulation of spinosad, was developed by Clarke as a mosquito larvicide. To determine its lavicidal activity and efficacy, laboratory bioassay and field tests were conducted in 2009-2010. The LC_{50} and LC_{90} against laboratory colony of *Culex quinquefasciatus* are 0.08 and 0.228 ppm (whole product) with 24 h of exposure at 25-27°C. In microcosm tests, control level reached to 79.6-96.9% for early instars, 78.0-90.6% for late instars, and 40-100% for pupae during the first 3 d post-treatment. Since day 7 post-treatment, control levels remained 100% until day 112 post-treatment. Subsequent bioassays indicated that larvicidal activity remained > 98% until day 380 post-treatment, and then declined to 67% on day 444 post-treatment. In mesocosm test, no significant control was noticed until day 7 post-treatment. During days 7-49, control levels were 47.5-90.2% for early instars, 61.2-97.4% for late instars and 74.4-98.3% for pupae. In catch basins, no control was noticed when this formulation was applied by dropping it into the water. Greater than 98% control was achieved for at least 44 d when a tablet was floated on top of water in the same catch basins. From this study, Natular™ T-30 showed great potential for its future introduction to operational mosquito control.

43 Evaluation on activity and efficacy of a sand granular formulation coated with *Bti* and *B. sphaericus*

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

Bacillus thuringiensis israelensis (*Bti*) and *Bacillus sphaericus* are widely used in the U.S. as mosquito larvicides. Studies have shown that when *Bti* and *B. sphaericus* are used in duplex, it not only extends the species spectrum, but also minimizes resistance development. Given the challenges of certain habitats such as dairy wastewater lagoons with high organic content, extensive weed growth and high larval densities, it is preferable to have a formulation that takes advantage of the *Bti*/*B. sphaericus* duplex and has good penetration through vegetation. Using washed, dry sand as a carrier, VectoLex WDG (650 ITU/mg) and VectoBac® TP (5,000 ITU/mg) as active ingredients, and a bonding agent, we developed a sand granular formulation with final potency of 50 *B. sphaericus* ITU/mg and 200 *Bti* ITU/mg. In laboratory bioassay, expected larvicidal activity was demonstrated. This formulation is dry and

flowable, non-dusty and has great penetration because of high specific gravity and small granular size. It can be readily applied by granule spreaders to achieve preferred coverage and vegetation penetration. When this formulation was applied at 10 lb/acre to dairy wastewater lagoons, 85- 100% control against immature *Culex* spp. was achieved for 3-4 wk.

44 Characteristics of and laboratory efficacy evaluations for a new formulation of the microbial larvicide, *Bacillus thuringiensis* subsp. *israelensis*
Byron L. Reid, byron.reid@bayer.com, Britt Baker, Deborah Koufas and Nonggang Bao

A new aqueous formulation of the microbial larvicide *Bacillus thuringiensis* subsp. *israelensis* was developed to optimize applications by ULV or space spray equipment. The nature of the formulation is presented, its ability to form evaporation retarding droplets assessed, and basic laboratory efficacy screening results are reviewed.

45 Field evaluations of microbial larvicide applied using modified ULV sprayer against mosquito larvae
Jing Zhai, jing.zhai@eurofinsagro.com, "Paleta" Volnei Rekowsky and David Mathews

A new aqueous-based microbial larvicide was evaluated against *Aedes aegypti* and *Culex quinquefasciatus* larvae in Florida and North Carolina. A London Fogger's 18-20 model was modified to accommodate high flow rates and larger droplet sizes required for the formulation. Larva containers were placed at distances from 25 ft to 400 ft from truck path. Three application rates of 4, 8 and 16 fl oz/acre were evaluated. The paper discussed optimal droplet size range and effective spray distances at each application rate.

46 K&D *in vitro* assays of commercially available repellents against *Aedes aegypti*
John P. Smith, docmx8@gmail.com, Jimmy Walsh and Eric Cope

Side-by-side product comparisons will be presented showing percent repellency at 0, 1, 2, 4 & 6 h post-treatment. Each product tested 9 times in a randomized complete block using Klun and Debboun 6-chambered plexiglass module to expose mosquitoes to treated cloth positioned over wells containing artificial blood and covered with collagen membranes.

47 Operational aerial applications of etofenprox (Zenivex®) in a large treatment area
Marin Brouillard, marin@cmcd.org, Jeff Stivers and Bill Reynolds

Three ULV aerial applications of Zenivex® E20 (etofenprox) were conducted during 2010 at an application rate of 0.0039, pounds AI/acre, delivered by a Shorts Skyvan aircraft using 2 Micronair AU4000 rotary atomizer nozzles, calibrated to deliver a DV0.5 of 33.85 microns. Weather conditions were monitored at aircraft release height. Seven sample sites, each with 2 bioassay cages containing 20-25 mosquitoes per cage, combined with 3cm spinning impingers (1 trial) to monitor droplet flux values were deployed in the application area. Treatment bioassay results of caged mosquitoes were variable with acceptable results among sample sites and trials.

48 Effect of ULV etofenprox (Zenivex® E20) ground application on *Aedes vexans* in Teton County, WY
Dean Gaiser, dgaiser@central.com, John Holick, Marta Iwaseckzo, Brad Lovett and Janice Stroud

Zenivex® E20 (20% etofenprox) was introduced to the North American market in 2009. Studies were conducted in 2010 to gather additional information on the performance of Zenivex® in the field. This study was set up south of Jackson Hole, WY, in late July of 2010 as a single-pass caged mosquito ground-fogger trial. Etofenprox was applied at 0.0035 lb AI/acre. Local mosquitoes were collected (primarily *Aedes vexans*), but with some *Aedes cinereus* and *Ochlerotatus spencerii* mixed in. Hot, windy conditions prevailed throughout the trial. The products were applied from a 1000-ft drive line positioned upwind 100 ft from a 3 x 3 grid of stations with 100-ft spacing. Deposition data was gathered with spinning impingers using 3 mm slides at each station. There were 15 to 20 mosquitoes per cage with 2 cages per station. Two replications were completed. Zenivex® E20 controlled 99% of the caged mosquitoes under adverse conditions. Non-treated control mosquito mortality ranged from 5 to 7%.

49 Comparison of ground-applied ULV etofenprox (Zenivex® E4) to permethrin (Biomist 4+4) on *Culex quinquefasciatus*
Dean Gaiser, dgaiser@central.com, Keith Haas and John Lehman

Central Life Sciences introduced a new ULV mosquito adulticide formulation in the summer of 2010. Zenivex® E4 (4% etofenprox) is a less concentrated alternative to Zenivex® E20, which was introduced 2009. In early September 2010, a study was conducted in Casper, WY in cooperation with the Natrona County Public Health Department. This study was designed to compare the efficacy of Zenivex® E4 and Biomist® 4+4 using a single-pass caged mosquito ULV ground-fogger trial. Zenivex® E4 and Biomist® 4+4 were both applied at 0.00258 lb AI/acre in separate foggers. The products were applied from a 1000-ft drive line positioned upwind 100 ft from a 3 x 3 grid of stations with 100-ft spacing. Deposition data was gathered with spinning impingers using 3 mm slides at each station. There were 24 to 40 mosquitoes (*Culex quinquefasciatus*) per cage with 1 cage per station. Two replications were completed. Mortality at 24 h in rep 1 for Zenivex® E4 was 97%, and 100% for Biomist® 4 + 4. Mortality at 24 h in rep 2 for Zenivex® E4 was 99%, and 98% for Biomist® 4+4. Non-treated control mosquito mortality ranged from 4 to 10%.

50 Field observed effects on non-target species and factors critical to commercialization of a soybean oil based larvicide

Andrew Malec, amalec@step*An*.com, David Vincent, Alvin Young and Robert Clegern

The need for "greener", environmentally friendly mosquito control as well as the need to control the spread of West Nile virus by *Culex tarsalis* in ponds and in shallow and stagnant waters in the western United States prompted the United Soybean Board to fund the development of a soybean oil based larvicide. This funding was supplemented by the efforts of 2 industrial partners, Stepan Company and BVA Oils. Five years of field trials were undertaken in Campbell County, WY, to assess the feasibility of such a product. Negligible toxicities to non-target species, which included copepods, *Daphnia*, damselflies, and midges, were observed over the course of these trials. The applicability of such a larvicide over a range of difficult-to-treat areas as well as areas of sensitivity such as schools, playgrounds, and water catch basins not only in the United States but also globally was explored. Potential barriers to commercialization of a soybean oil-based product were determined and the known toxicological data pertaining to methyl soyate was reviewed.

Biorational Pesticides: Then, Now, and the Future I

51 *Bti* and *B. sphaericus* for mosquito control: History and development

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Bacillus thuringiensis subspecies *israelensis* (*Bti*) and efficacious isolates of *Bacillus sphaericus* have become the predominant non-chemical means employed for control of mosquito larvae in the USA and several other countries. The efficacy of *Bti* formulations has been demonstrated in a variety of habitats against a multitude of species of mosquitoes and black flies. *Bacillus sphaericus* formulations have been utilized predominantly in organically enriched habitats against *Culex* species, but they are also active in a variety of habitats having low organic enrichment. *Bacillus sphaericus* has been shown to persist longer than *Bti* in polluted habitats and, under certain circumstances, can recycle in larval cadavers. Two disadvantages of *B. sphaericus* are a narrower host range than *Bti* and the development of resistance in certain populations of *Culex quinquefasciatus*. Biotic and abiotic factors that influence the larvicidal activity of *Bti* and *B. sphaericus* include species of mosquito and their respective feeding strategies, rate of ingestion, age and density of larvae, habitat factors, type of formulation, storage conditions, production factors, and means of application and frequency of treatments. Because of their efficacy and relative specificity, both *Bti* and *B. sphaericus* can be ideal components of integrated mosquito control programs.

52 Toxin interactions, activity enhancement, and resistance management of *Bti* and *B. sphaericus*

Margaret C. Wirth, mcwirth@ucr.edu, William Walton and Brian Federici

Toxin interactions play a pivotal role in the activity and host range of the microbial pesticide *Bacillus thuringiensis* subsp. *israelensis* (*Bti*). The 3 major Cry toxins (Cry4Aa, Cry4Ba, Cry11Aa) and the cytolytic toxin (Cyt1Aa) in *Bti* interact synergistically and are the primary source of *Bti*'s high activity. Synergy is also important in *Bti*'s host range, which targets the primary vectors of many important human diseases. More importantly, synergy is responsible for *Bti*'s capacity to avoid the evolution of insecticide resistance. In contrast, *Bacillus sphaericus*, an unrelated microbial insecticide, lacks *Bti*'s toxin complexity, in particular the cytolytic component, and high levels of resistance have already evolved under operational field conditions in China and Thailand where this bacterial species was used alone. To overcome known limitations in microbial pesticides, researchers have characterized the activity, and interactions of wild type and recombinant bacterial strains to understand their effect on larval mortality and resistance evolution. Specific approaches that slow the evolution of resistance and novel, recombinant bacterial strains; some of which show enhanced activity, improved host range, and delay resistance, were identified. This knowledge may provide a new range of larvicidal products and resistance management strategies to manage mosquito populations.

53 Microbial larvicides, powerful tools for public health made possible by continuous development

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Bacillus thuringiensis subspecies *israelensis* (*Bti*) and *Bacillus sphaericus* strain 2362 (Bs-2362) are 2 amazing discoveries which have been developed into useful tools for control of pestiferous dipterans. They are used globally for control of both disease vectors and nuisance insects in the order Diptera, sub-order Nematocera. Due to their efficacy and target specificity, these microbial larvicides offer solutions to public health professionals working to control mosquitoes and black flies, while leaving the lightest ecological footprint of any available insecticide. However, these discoveries were initially considered of limited value as a result of the complexity of industrial fermentation, lack of stable and effective formulations, manufacturing considerations, and the need for appropriate application technologies and assessment methods. It has only been through ongoing research, advanced fermentation methods, innovative formulation development, high standards in manufacturing, reliable delivery systems, and development of application methodologies, that our profession has realized the potential of these agents. With ongoing attention to these areas, the future of *Bti* and Bs-2362 in public health is expected to remain bright for many years to come. The investments and ongoing inputs of industry to development of these tools will be reviewed in this paper. Specific examples will be discussed.

54 FourStar sustained release microbial formulations: design and development
Robert Sjogren, rdsjogren@gmail.com

FourStar Microbial Products LLC presents the development of sustained release microbial formulations containing *Bacillus sphaericus* and *Bacillus thuringiensis israelensis*. Product design objectives, features and efficacy of briquet and granular formulations will be discussed. The presentation offers a look at new formulations that will be coming to the market in the next 2 years.

55 Microbial biopesticides: Research and application in Brazil
Maria Helena N. Silva-Filha, mhneves@cpqam.fiocruz.br, T. Romão, K. Chalegre, L. Ferreira, M. Melo-Santos, C. Oliveira and L. Regis

Bacillus thuringiensis svar. *israelensis* (*Bti*) and *B. sphaericus*-based biolarvicides were introduced in Brazil for Diptera control in the 1980s and 1990s, respectively. *Bti* was first adopted for controlling *Simulium*, while its utilization for *Aedes* has expanded after the detection of organophosphate resistance among populations. Utilization of *Bti* has expanded as a larvicide for conventional breeding site treatments as well as being associated with other tools such as oviposition traps, to prevent larval development in such sites. Recent studies have provided advancements in terms of *Bti* persistence, and evidence of recycling and molecular data on the synergism among *Bti* toxins had clarified the low potential of resistance observed to this biolarvicide. *Bacillus sphaericus* has been effective to control *Culex* and *Anopheles* larvae in Brazil, particularly because of its performance under field conditions. However, *B. sphaericus* utilization has been challenged by the risk of resistance since its mode of action relies on the interaction of a single toxin with 1 target site from mosquito larvae. Studies have been performed to elucidate the molecular basis of *B. sphaericus* resistance to develop suitable methods of monitoring and management. Introduction of biolarvicides with multiple mosquitocidal toxins could be strategic for integrated control programs in view of the potential ability to overcome resistance and to be used for controlling both *Culex* and *Aedes* species in urban areas.

56 Biopesticides for mosquito control: What is different in Europe?
Norbert W. Becker, norbertfbecker@web.de and Klaus Hoffmann

In Europe, mass oviposition sites of floodwater mosquitoes, *Aedes vexans*, are frequently located in ecologically sensitive areas usually under strict regulations. These sites in river plains or along lakes are often close to human settlements and/or popular tourist areas. Along the coasts, salt marshes serve as mass oviposition sites of *Ochlerotatus caspius;* these sites are frequently used for oyster and fish production where contamination with chemicals is prohibited. Widespread rice fields in the Mediterranean Region and irrigation fields also provide mass sites for this species. In many European countries, water storage in barrels used for watering gardens - usually serve as mass larval habitat for *Culex pipiens* and even *Aedes albopictus*. The application of microbial larvicides provides effective mosquito control, preserves the non-targets, ensures the safe production of food and encourages community participation. In many areas, the use of microbial larvicides is the only safe and effective tool to prevent the mass emergence of mosquitoes and to assure the quality of life and health of the residents. The treatment of huge areas in a very short-time window of larval breeding is successfully achieved by sophisticated application techniques, cost-effective formulations and the application of modern tailor-made information techniques.

Global Perspective on the *Culex pipiens* Complex in the 21st Century I

57 Introduction
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The *Culex pipiens* complex, including *Culex pipiens*, *Cx. quinquefasciatus*, and *Cx. molestus* are important pest species and vectors of human and animal diseases throughout the world's tropical, temperate, and Holarctic regions. Diseases transmitted by member of the complex include: St. Louis encephalitis and West Nile virus (WNV) in North America, WNV and Rift Valley fever in sub-Saharan Africa, and *Dirofilaria immitis* globally. This symposium has gathered many of the world' experts on this species complex to explore the current state of the knowledge on the systematic status, speciation, ecology, biology, vector competence, population genetics, endosymbionts and role in disease transmission of these species in various parts of the world. Information presented at the symposium will improve our knowledge of important members of the complex and enhance our ability to conduct efficient surveillance and efficacious control strategies. A summary of findings and overall conclusions will be discussed in relation to mosquito control and interrupting disease transmission caused by these species.

58 *Culex pipiens* Linnaeus: Species versus species complex-taxonomic history and perspective
Ralph E. Harbach, r.harbach@nhm.ac.uk

The taxonomic history of *Culex pipiens* Linnaeus (1758-present) is reviewed. The central question is whether *Cx. pipiens* is a single polytypic species or a complex of sibling species? Name-bearing type specimens have been designated to fix the morphological identities of *pipiens*, *molestus* Forskål, and *quinquefasciatus* Say, but whether these nominal forms represent one or more biological species remains controversial. Despite extensive morphological variation, there is no indication of subspecific or racial differences in geographically separated populations of *pipiens*. Introgression occurs where populations of *pipiens* and *quinquefasciatus* overlap, but the retention of parental epiphenotypes outside the zone of introgression provides evidence of independent species cohesion. The main conclusion reached is that *pipiens* and *quinquefasciatus* are separate species which sometimes

hybridize and *molestus* is nothing more than a phenotypic and physiological variant of *pipiens*. Based on morphological similarity, the *pipiens* complex includes *pipiens*, *quinquefasciatus*, and *australicus* Dobrotworsky & Drummond. There is no morphological or taxonomic evidence to suggest that the *pipiens* complex includes any other species.

59 The *Culex pipiens* complex in Europe

Norbert W. Becker, norbertfbecker@web.de, Artur Jöst and Thomas Weitzel

In the course of the evolutionary process, mosquitoes have successfully adapted to a great variety of aquatic habitats and thus have evolved into more than 3,500 mosquito species since the mesozoic period until the present time. *Culex pipiens* belongs to one of the most successful group of species. In Europe, the complex consists of several species, subspecies and biotypes namely *Culex pipiens* Linnaeus, *Cx. pipiens* biotype *molestus* Forskal and *Cx. quinquefasciatus* Say. *Culex torrentium* Martini is also frequently considered to be a member of the complex. The females of the complex are very difficult to distinguish. However, there are great differences in their bionomies and importance for humans. For efficient control of the human nuisance and disease vector populations of *Culex* spp., it is imperative that we understand the biology, phenology and abundance of the various *Culex* populations. Therefore, many attempts have been undertaken to distinguish between non-relevant and relevant *Culex* populations. In our enzyme electrophoretic studies, we used several genetic enzyme markers to identify and to differentiate between the members of the *Culex pipiens* complex. Thus, we are able to target the *Cx. p. pipens* biotype *molestus* populations in our routine mosquito control programme based on the use of *Bacillus thuringiensis israelensis* and *B. sphaericus* or products containing toxins of both bacilli.

60 The *Culex pipiens* complex in East Asia with ecological thoughts on the origin and interrelationship of *molestus, pallens* and *quinquefasciatus*

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The *Culex pipiens* complex in East Asia includes *pipiens* (s. s.), *molestus*, *pallens* and *quinquefasciatus*. *Pipiens* (s. s.), not extending to the east of Xinjian and Baikal, is disjunct from the others. Temperate *pallens* and southern *quinquefasciatus* are conjunct without gaps. Distribution of *molestus* overlaps with the latter two. Origins and interrelationships of these three are discussed based on ecological traits, particularly climatic adaptation. For *molestus*, my hypothesis is that it adapted to the Mediterranean climate and secondarily colonized urban environments. For *pallens* and *quinquefasciatus*, the point is whether they established themselves before their contact or one of them was derived from the other (parapatric differentiation or a split followed by secondary contact). As a result, an idea of distributions of *Culex pipiens* complex members before large changes by human activities is presented as an initial trial toward better ones.

61 A current view of the status and significance of the *Culex pipiens* group in Australia and New Zealand

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The mosquito known in the northern hemisphere as *Culex pipiens* Linnaeus (a.k.a. *Cx. pipiens pipiens* or *Cx. pipiens* form *pipiens*) is not known in Australia and New Zealand. However, in Australia, there are 4 species of the *Culex pipiens* group: 2 indigenous, *Culex australicus* Dobrotworsky & Drummond and *Culex globocoxitus* Dobrotworsky, and 2 introduced, *Culex quinquefasciatus* Say and what is known locally as *Culex molestus* Forskal (? = *Culex pipiens molestus* or *Culex pipiens* form *molestus*), all 4 being members of the *pipiens* subgroup (= '*pipiens* complex'). In New Zealand, there is the introduced *Cx. quinquefasciatus* and 1 indigenous species, *Culex pervigilans* Bergroth, which is a member of the *pipiens* group but the *trifilatus* subgroup rather than the *pipiens* subgroup and thus not part of the so-called '*pipiens* complex'. The species status of the indigenous *Cx. australicus* and *Cx. globocoxitus* in Australia, and *Cx. pervigilans* in New Zealand, appears to be accepted as legitimate; however, the true identity of the mosquito called '*Cx. molestus*' in Australia remains contentious, even as its local profile has been increasing over the past 40 yr. The taxonomic and biologic knowledge of all these species, their public health significance in Australia and New Zealand, and an update on investigations into the biology of the local '*Cx. molestus*' and its relationships with the other local species of the *Cx. pipiens* group will be presented.

62 A critical assessment of molecular tools for the identification of Palearctic members of the *Culex pipiens* group

Yvonne-Marie Linton Linton, yvol@nhm.ac.uk, Renita Danabalan and David J. Ponsonby

This presentation focuses on testing available 'gold standard' molecular techniques for the differentiation of *Culex pipiens pipiens* and *Culex pipiens molestus* from the Palaearctic Region. Specimens, collected as immatures in overground habitats and as resting and host-seeking adults across southern England and Wales in 2006, were morphologically identified as *Cx. pipiens* s.l. Molecular identification using the CQ11 assay of Bahnck & Fonseca (2004) revealed high levels of hybridisation and *Cx. pipiens molestus* from ground pools across the southern UK. These surprising results caused us to verify these data using DNA barcodes and the purported species diagnostic PCR-RFLP assay of Shaikevich (2007). Sequence data revealed that inadvertent inclusion of *Culex torrentium*, a common and often sympatric species in Europe, results in non-specific banding patterns with CQ11, which could lead the inexperienced user to identify specimens as *Cx. p. pipiens*, *Cx. p. molestus* and/or hybrids.

Operations and Management I

63 Evaluation of three strategies for control of *Aedes aegypti* and *Aedes albopictus* populations
Chris Lesser, Christopher.Lesser@manateemosquito.com and Mark Latham

Control of *Aedes aegypti* and *Aedes albopictus* populations below nuisance threshold levels through traditional Integrated Pest Management (IPM) techniques has generally proven to be ineffective. This research project examines the efficacy of 3 ULV chemical intervention approaches to abate population levels of *Ae. aegypti* and *Ae. albopictus* within large geographical areas. Three study sites and 1 control were established within residential and historically high domestic mosquito problem-areas of southwest Florida. Study sites ranging in size from 145 to 413 acres. Chemical applications were made weekly to larvicide only-, adulticide only- and larvicide/adulticide-study sites from July 2010 to October 2010. Ovi-trap egg and larval counts were used to assess *Ae. aegypti* and *Ae. albopictus* population size and change from June 2010 through October 2010.

64 Area-wide management of *Aedes albopictus*: Gauging the efficacy of multiple control measures during 2010
Isik Unlu, iunlu@mercercounty.org, Taryn Crepeau, Ary Farajollahi, Sean Healy, Kristen Bartlett-Healy, Daniel Strickman, Gary Clark, Randy Gaugler and Dina Fonseca

Aedes albopictus is a major human biting pest and is considered second only to *Aedes aegypti* in its importance as a disease vector of dengue. *Aedes albopictus* is responsible for the majority of service requests from urban and suburban residents in New Jersey during recent years; however, standard approaches to mosquito abatement have failed to control this back-yard mosquito species. We used BG Sentinel traps and ovitraps to monitor mosquito populations within 6 sites (2 full intervention, 2 minor intervention, 2 control sites) in Mercer and Monmouth counties. We tested multiple control methods including, door-to-door source reduction and larvicide applications, ULV adulticide applications, and public education. This presentation will summarize our results for the 2010 mosquito season.

65 Area-wide management of *Aedes albopictus*: lessons learned
Dina M. Fonseca, dinafons@rci.rutgers.edu, Sean P. Healy, Taryn Crepeau, Isik Unlu, Ary Farajollahi, Kristen Bartlett-Healy, Randy Gaugler, Don Shepard, Yara Halasa, Daniel Strickman, George Hamilton, Daniel L. Kline and Gary G. Clark

Aedes albopictus, the Asian tiger mosquito, is the principal vector of chikungunya fever and a critical vector of dengue. This daytime biting pest often causes the majority of service requests from urban and suburban residents in New Jersey and many other states and nations where it has spread. Our objective is to develop an effective strategy for the area-wide control of *Ae. albopictus* while demonstrating the public health importance and socio-economic benefits of the area-wide control approach. The project was initiated in the spring of 2008, and we have now tested multiple control and education approaches, as well as gauged public interest, public participation, and overall costs. This presentation will summarize the project's progress, highlight our major findings, and try to elicit members of the audience into considering participating in the near future.

66 Budget issues: A review of your program can lead to cost savings and efficient operations
Mark E. Smith, mmcd_mes@mmcd.org

In the face of these economic times, the Metropolitan Mosquito Control District is working to lower costs and optimize its effectiveness without reducing customer service. An in-depth review of your program can lead to more efficient operations, improved strategic planning and reducing your overall budget expenditures.

67 An overview of mosquito control and habitat easements
Marty Scholl, schollfamily@wildblue.net

Mosquito control can be made more challenging when an easement holder has written objectives for a specific habitat type on a piece of property. Many times these objectives and management practices can be in direct conflict with mosquito and vector control. Easement holders often fund the habitat restoration, and to ensure the success of their investment, often will be recorded on the deed. Mosquito and vector control agencies can work with the easement holders to ensure mosquito control activities are not hindered and, in many cases, can be reduced substantially. There are many types of easement holders such as the National Resource Conservation Service, US Fish and Wildlife Service, California Department of Fish and Game along with many other large-scale state and privately funded organizations. It is important that the mosquito and vector control agency be involved with the planning of the habitat restoration prior to construction to minimize potential impacts. It is important that the long-term management plan have mosquito and vector control integrated language to ensure a good working relationship, and to reduce mosquitohabitat. This talk will look briefly at successful management plans and how the implemented best management practices have reduced mosquito production while maintaining the easement objectives.

68 Where source reduction is not an option: Management on public lands
Francis Bosch, franb@co.williams.nd.us

Williston, ND, is located downstream from the confluence of the Missouri and Yellowstone rivers. It is one of the few remaining major waterways in the U.S. which remains unaltered by dams or canals. Historically, this area has been plagued by mosquitoes, being first recorded in the Lewis & Clark journals in 1806. *Aedes vexans* is the principle floodwater mosquito with *Culex tarsalis* being another predominant species. Collaboration with other

government agencies, including neighboring McKenzie County and the Trenton Indian Service Area, as well as the Army Corps of Engineers and U.S. Air Force Reserve, has leveraged this District's ability to manage a far greater area. Extensive aerial application of bio-rational pesticides maintains the fragile structure of the floodplain and surrounding wetlands while new methods such as controlled burning during the winter are currently being explored. This has resulted in significant reduction of nuisance and vector species, particularly over the past 2 yr.

69 Revamping a resistance monitoring program to follow statewide guidelines: Challenges and triumphs
Marcia Reed, mreed@sac-yolomvcd.com, Paula Macedo and David Brown

Active monitoring and management of resistance levels in field populations of mosquitoes by periodic evaluating pesticide susceptibility of various populations should be an integral component of mosquito control programs. The Mosquito Pesticide Resistance Monitoring Working Group - Mosquito and Vector Control Association of California recommends the implementation of a statewide pesticide resistance monitoring program. They recommend that monitoring methods should be standardized to ensure comparability of data obtained from different sources. Following recommendations of the working group, the Sacramento-Yolo Mosquito and Vector Control District made modifications to its existing resistance monitoring program to implement the standardized methodology as well as the use of the same susceptible control populations, which are crucial in analyzing resistance over large geographical areas encompassing multiple mosquito control agencies. We report on the challenges faced when balancing the demands of surveillance trapping and resistance testing during an active mosquito season.

70 Are gravid traps better in sampling for *Culex pipiens* than CO_2 baited traps?
Banugopan Kesavaraju, banu@slcmad.org, Dennis Kiyoguchi and Sammie Dickson

Culex pipiens is one of the principal vectors for West Nile virus. *Culex pipiens* larvae are often associated with habitats with high microbial productivity and gravid females prefer to oviposit in highly productive waters, which are referred to as stinky water. Since stinky water is an important component of gravid traps, they might be more efficient than any other trap in attracting *Cx. pipiens*. We compared the gravid traps manufactured by Clarke, J. W. Hock and Bioquip for their efficiency in trapping *Cx. pipiens*. We placed 3 traps of each type in 3 different sites for multiple days and compared the total number of *Cx. pipiens* caught in each trap. Gravid trap manufactured by J. W. Hock trapped significantly more *Cx. pipiens* than any other trap. We compared J. W. Hock trap with Clarke ABC CO_2 baited traps in 3 different habitats. There was no significant difference between the J. W. Hock and the CO_2 traps. Since gravid traps attract more potentially infected mosquitoes than newly eclosed non blood-fed mosquitoes and are logistically easy to set up, we conclude that J. W. Hock gravid traps are more efficient in sampling for *Cx. pipiens* in the Salt Lake City area.

71 Using historical light trap data to predict future operational activities: Phase I
Teyler M. Hurst, thurst_moscasa@bresn*An*.net and Sarah Cantu

Like many mosquito abatement/control districts in the country, the Alamosa Mosquito Control District has collected light-trap data for many years and used the data immediately for direction of the adulticide program. And, after that immediate use, the data was stored in our database, simply gathering dust. During the past off-season, we analyzed 7 yr worth of seemingly endless amounts of light trap data, not knowing to what use if any, it might serve. The data is composed of total mosquitoes collected as well as the species identified for each sampling date. It soon became clear that the data might have a multitude of uses in the operation of mosquito control, ranging from surveillance and larvicide operations to adulticide operations. This presentation will be centered on how we plan to use our historical data to help focus larvicide efforts according to historical numbers and species trends. We anticipate that we will be able to predict larvae location at any given date, therefore increase the effectiveness and efficiency of our larvicide operations and ultimately, reduce the number of adults which will reduce the frequency and intensity of our adulticide program.

72 Barriers and spatial repellents for personal protection
David A. Dame, dadame@ufl.edu, Max Meisch, Daniel L. Kline and Todd W. Walker

Insecticides were assessed in the field for protectant suitability on perimeter vegetation and fabric enclosures. CO_2-generating traps were used as surrogate hosts for dense populations of *Anopheles quadrimaculatus, Psorophora columbiae* and *Culex* spp. The most effective insecticide was combined with spatial repellents to enhance the level of protection. The study was funded by DWFP.

73 Ultra-low-volume deposition of public health insecticides in a hot desert environment
David Hoel, davidfhoel@yahoo.com, Michael L. Fisher, Muhammad Farooq, Todd W. Walker and Manolito C. Batayola

Three public health insecticides and 1 dilution oil were applied from 30 min to 3 h after sunset during June and July 2010, at Camp Buehring, Kuwait, to determine the relative quantity, height and distance traveled in a hot Middle Eastern desert. Oil-based mosquito adulticides were sprayed using a truck-mounted Curtis DynaFog Maxi-Pro 4 ULV sprayer at both 5 and 10 mph on evenings when wind speed was less than 10 mph. Fyfanon® ULV (96.5% malathion), Scourge® 4 + 12 (4% resmethrin), ULD BP-300 (3% pyrethrins) and BVA Spray 13 (100% refined petroleum distillate) were mixed with Caracid Brilliant Flavine FFS fluorescent dye, then sprayed, and collection targets (1-m long, 2.5 cm wide biodegradable cotton ribbons) were later read with a fluorometer to quantify the amount of insecticide deposited on targets set at 6", 30" and 60" at distances of 5', 20', 50', 100', 200' and 300'.

Mean insecticide deposition across all distances was 31% on 30" targets and 49% on 60" targets while 6" targets typically collected ≤ 20% of test spray. Mean ground temperatures were typically within 1 °C of air temperatures at 60" and 1 to 2°C higher than air at 6" or 30". These insecticide deposition results may explain in part why control of low-flying phlebotomine sand flies with ULV insecticides has met with less than optimal success by U.S. military forces deployed in the Middle East.

74 AmeriCorps volunteers: A new tool in the fight against mosquitoes

Kristen Bartlett-Healy, krisb@rci.rutgers.edu and George Hamilton

AmeriCorps NCCC (National Civilian Community Corps) is a volunteer based program, whose goal is to address the needs of local communities in the United States. Teams of 8 to 12 volunteers assist in projects lasting from 6 to 8 wk, and are generally geared towards community service and outreach. In 2010, we utilized AmeriCorps NCCC volunteers (Badger 7) as part of the area-wide management of the Asian tiger mosquito. Volunteers went door to door in 2 communities with high populations of *Aedes albopictus*. At each residence, they walked around the property with homeowners, pointed out mosquito habitats, and taught them how to reduce standing water in their back yards. Volunteers also provided information on a tire recycling week, community workshops, and trash can drilling days. Although AmeriCorps volunteers were used in our program for education, they can also be a useful resource for other mosquito related projects, such as water management, community cleanups, and other community outreach projects.

255 Aquatain AMF: Summary of trials and their implications for West Nile virus and other mosquito-borne diseases

Graham Strachan, **graham@aquatain.com**

Aquatain AMF is a new technology liquid monolayer for mosquito control. The product has recently been registered in Australia, with the active component in the product – silicone – being the first new active to be approved for mosquito control in that country for many years. Trials by universities and health ministries around the world have confirmed its effectiveness on *Culex, Anopheles* and *Aedes* mosquito species. The product has a very rapid impact on *Culex* larvae and pupae, with implications as a weapon against West Nile virus. This paper gives a brief overview of the product, in addition to a more detailed description of the field and lab trials.

Latin American Symposium I

75 Why is vector control not controlling dengue?

Roberto Barrera, rbarrera@cdc.gov

Because the incidence of dengue and dengue hemorrhagic fever continues increasing in the Americas, it is necessary to evaluate why vector control is not controlling dengue. The fact that *Aedes aegypti* was eliminated from most of the Americas several decades ago makes it difficult to understand why current vector control programs cannot keep *Ae. aegypti* below vector densities to prevent dengue virus transmission. The main tools used to eliminate *Ae. aegypti* were "focal application" of residual insecticides in and around water containers (e.g., DDT), source reduction, and a disciplined, vertically structured control program. Most common current approaches to control *Ae. aegypti* and dengue consist of house inspections for source reduction and larviciding, space spraying of insecticides from vehicle-mounted equipment, and peri-focal control around dengue cases. These approaches fail at delivering the controlling agent to a significant portion of the local *Ae. aegypti* population, so that it can rapidly re-colonize the area. The limitations of each of these methods are illustrated in detail. It is recommended that vector control programs adopt an integrated vector management approach to conduct area-wide control of *Ae. aegypti*. Among needed developments are: ovicides, longer-lasting larvicides, and effective, inexpensive vector surveillance tools.

76 Acceptability and sustainability of intervention methods for *Aedes aegypti* control in urban and semi-rural areas

Claudia M. Romero-Vivas, clromero@uninorte.edu.co and Andrew K. Falconar

Presently, Colombia has the second highest incidence of dengue fever cases in the Americas with control activities focused on the immature stages of *Aedes aegypti* in large water storage containers. Biological (local fish, copepods) and chemical (temephos) control were used in 2 semi-rural and 2 urban areas respectively within the Department of Atlántico. A questionnaire related to water storage containers and the acceptability/sustainability of the selected intervention methods was applied to 202 households. For rural and urban areas, the percentage of houses with a regular piped water supply was 51.6% and 93%, respectively, and the most frequent container types were tanks (71%) and plastic drums (42 %), respectively. Although fish showed 100% efficacy and the copepods did not control *Ae. aegypti* larvae in the field, both methods were highly accepted by the rural community (100% and 86%, respectively); around 85% showed interest in long term use of both bio-control methods and would produce the local fish and copepods for their containers and for the community. In urban areas, only 35% and 33% of the community will welcome and may accept the long-term use of fish and copepods; 84% welcomed the use of temephos. Overall, the community accepted education as an intervention method (93%) and 75% of those interviewed were willing to be part of a team that educated the community. In this study, biological control was accepted and may be sustainable in rural areas while in urban areas, temephos was appropriate; however, if insecticide resistance occurs methods other than local fish and copepods need to be further evaluated because of their low acceptability.

77 Entomological risk for dengue fever by *Aedes aegypti* (Linnaeus, 1762) larval infestation in Cartagena (Colombia): 2009 - 2010

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Dengue fever is endemic in Cartagena. Between 2003 and 2009, there were 1,841 cases of this disease. We did an analysis of the results of 3 *Aedes* indices in December 2009, February 2010 and March 2010, to estimate entomological risk for vector infestation and to define strategies for prevention and control. We did a descriptive study by entomological inspection for *Aedes aegypti* larvae following the WHO methodology. We estimated the *Aedes* Infestation Index (AII), Container Index (CI) and Breteau Index (BI), as well as frequency of positive containers. During the time studied, we inspected 6,595 houses and 25,226 containers. In December 2009, the AII was 23.9%; CI: 18.7% and BI: 27.9. In February 2010, the AII was 21.9%, CI: 6.3% and the BI: 28.3 while in March 2010 the AII was 16.9%, CI 4.0% and BI 20.9. These indices were different in each locality studied in Cartagena. The larvae were more abundant in metal/plastic tanks (52.8%) followed by plants growing in vases filled with water (18.1%) and cement tanks (13.7%). There is an entomological risk for dengue fever in Cartagena because of high larval infestations. Prevention and control plans should be focused for each zone in Cartagena.

78 Entomological surveillance of *Aedes aegypti* in crowded human populations

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In recent years, a concern among health officials is about possible dengue transmission in areas with crowded human populations. To learn more about this, an entomological survey was carried out in elementary schools. Five egg traps were placed in several schools, weekly each one was registered with the school's name, a strip number, and number of eggs and finally traps were refilled with water. High densities of eggs were detected in some schools and a high transmission risk was projected in those places and insecticides were applied in the area.

79 Co-occurrence of *Aedes aegypti* and *Aedes mediovittatus* in aquatic habitats in southeastern Puerto Rico

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Aedes mediovittatus, the Caribbean treehole mosquito, is a competent vector of dengue viruses, although it has not been incriminated as a vector in nature. It is not clear whether vector control programs should target this species or not. Previous studies using ovijars in the City of San Juan, Puerto Rico revealed that *Ae. mediovittatus* was present in urban forests and areas of low density housing. Here, we investigated the distribution and co-occurrence of *Ae. mediovittatus* and *Aedes aegypti* pupae in water-filled containers in a rural municipality of Puerto Rico. Pupal surveys were conducted in 9 localities of the Municipality of Patillas (1,956 houses, 5,917 water containers). *Aedes aegypti* was more prevalent (House Index 21.1%) and abundant (6,207 pupae) than *Ae. mediovittatus* (10.1%, 2,603 pupae). Both species overlapped in 6% of the houses and 1.8% of the containers. Yet, there were 2 localities where *Ae. mediovittatus* was more prevalent than *Ae. aegypti*. Both species occupied essentially the same type of artificial containers although *Ae. mediovittatus* was not found in water tanks or in animal drinking pans with *Ae. aegypti*. Most *Ae. aegypti* were found in buckets, discarded containers, miscellaneous containers, plant pots, and barrels. Most *Ae. mediovittatus* were found in discarded containers, tires, buckets, barrels, and miscellaneous containers. These results indicate that *Ae. mediovittatus* extensively overlaps with humans and *Ae. aegypti*.

80 Selection of oviposition sites by female *Aedes aegypti* (Diptera: Culicidae)

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Selection of oviposition sites by female *Aedes aegypti* and the consequences of this decision on the survival of offspring was examined. Traps with untreated water and water treated with spinosad and temephos were exposed to oviposition of *Ae. aegypti* females for 3 days. After that, the number of eggs laid was registered and later all strips with eggs were returned to the container in order to produce mosquitos larvae. Mosquitoes oviposited in all treatments; traps with temephos had the highest risk of having mosquito larvae, because that less eggs were laying, oviposition was done mainly in traps with water untreated and spinosad, not a single larvae survived where spinosad was applied.

81 Electrophysiological and behavioral response of n-heneicosane, the oviposition pheromone of *Aedes aegypti*, on *Aedes albopictus*

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Aedes aegypti and *Aedes albopictus* are highly anthropophilic mosquito species and potential vectors of dengue and yellow fever viruses. The location of suitable sites for oviposition requires a set of visual, tactile and olfactory cues that interact with the female before laying their eggs. In this study, we evaluated the effect of n-heneicosane, a recognized oviposition pheromone of *Ae. aegypti*, on the olfactory receptors of the antennae of *Ae. aegypti* and *Ae. albopictus* using electroantennographic detection coupled with gas chromatography (GC-EAD). We also analyzed the effect of the compound on the oviposition response of *Ae. albopictus* in order to determine whether the n-heneicosane also influences the behavior of this species. We observed a significant electroantennographic response to n-heneicosane in adult females in both species of mosquitoes. As this pheromone elicited electrophisiologic response on *Ae. albopictus*, we also evaluated the oviposition behaviour responses of this species, determining

whether n-heneicosane could be used in baited traps to improve monitoring and control strategies against both species of mosquitoes.

82 Use of ovitraps to incriminate vertical transmission of *Aedes albopictus* as a vector of dengue viruses in two suburban localities of Santiago, northeastern Mexico

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In Nuevo Leon state in northeastern Mexico, dengue virus (DENV) istransmitted by *Aedes aegypti*. However, it is documented that *Aedes albopictus* is also capable of transmitting DENV infections. In addition, vectorial competence of this species is well known and the virus infects female ovaries. Thus, vertical DENV transmission represents a risk to trigger dengue outbreaks under low mosquito population densities. This mosquito is a vector that has been found in some areas of Nuevo Leon as Santiago city, near of Monterrey, Mexico. Santiago reports important dengue case numbers week to week during the dengue season. Strong suspicions of *Aedes albopictus* as an active DENV vector have been considered in this region. The aim was to detect natural field infections of vertically-transmitted DENV in *Ae. albopictus* in Santiago city. Ovitraps were placed to determine the presence of *Ae. albopictus* and to incriminate as responsible for cases of DENV in Santiago town. Two hundred ovitraps were placed in backyards and vacant lots: 100 in Mahuacates study site and 100 in Panteon San Marco. A group of 177 were recovered and checked for *Aedes* eggs (89%) after 7 d. Of 177 ovitraps, 147 (83%) were positive for *Ae. albopictus* eggs. In Mahuacates, 6,199 eggs were collected and 2,370 were collected in Panteon San Marco. Mahuacates had 81% positivity and Panteon San Marco 84% for *Ae. albopictus* eggs. Other mosquito species were also collected in Panteon San Marco such as *Culex* spp. and *Aedes aegypti* while in Mahuacates *Toxorhynchites rutilus* was found. Adult *Ae. albopictus* reared from eggs collected from ovitraps will be tested for DENV using RT-PCR to determine serotype, genotype, and phylogenetic relationships.

83 Evaluation of anti-adhesive materials for preventing the oviposition of *Aedes aegypti* (L.)

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Aedes aegypti is an important vector of dengue fever (DF). Every year more than 10 million DF cases are reported in the world. The egg has a chemically resistant chorion. It is invisible to conventional inspection. Egg chorionic pad keeps it wet and fixed in the breeding site. This stage is the most numerous of the cycle life. To date, *Ae. aegypti* eggs have generally been ignored as an object for control programs. This research was aimed to evaluate potential anti-adhesive plastic materials acting over sticky exochorionic compound. The rationale was to induce egg sinking and, therefore, prevent egg embryos from hatching. Gravid females were used for the insectary trials. Three repetitions for each material were conducted and results recorded every 24 h. Preliminary data showed that only 3 materials had greater blocking activity: cellophane paper, polynvinyl chloride (PVC), and high density polyethylene, 26.7%, 12.8% and 5.2%, respectively. Field trials are underway for 2011 mosquito season.

84 Lethal ovitraps as a strategy for vector control of *Aedes aegypti* in Medellin, Colombia

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In Colombia, dengue is the main vector-borne disease due to the large number of cases and also it is distributed in major urban centers of the country. The absence of a vaccine for disease prevention has meant that control measures are mainly focused on the reduction of the vector (adulticides, larvicides and elimination of breeding sites). However, these methods have high costs. A less expensive alternative for vector control are lethal ovitraps (LO). In this study we evaluated, under laboratory conditions, different types of LO through a factorial design 33. The following insecticides were used: permethrin, temephos and deltamethrin. Attractive sources of hay infusion assessed were 10% and 20% and dechlorinated water. The oviposition substrates that were compared included dacron, towel and flannel. It was determined the number of eggs per LO and mortality of larvae, pupae and adults. A statistically significant difference was observed between the types of insecticides tested, the attractive sources and substrates for oviposition. In the second stage of this study, assessed under field conditions, the LO that showed better results than in the laboratory.

85 A lethal ovitrap for *Aedes aegypti* control

Emilia Seccacini, Laura Juan, Patricia Eisenberg, María Cecilia Lorenzo, Héctor M. Masuh, hmasuh@gmail.com, Eduardo Zerba and Susana Licastro

Aedes aegypti is the main vector of dengue and yellow fever in Latin America. It generally inhabits urban areas (indoors) and deposits its eggs in man-made containers. Ovitraps were developed as a surveillance tool and they have been used for detecting and monitoring vector populations. Only in a few cases has it been used for vector control, incorporating an insecticide-impregnated strip. The present study evaluates the performance of newly designed ovitraps incorporating in the plastic matrix pyriproxyfen as a slow release insecticide that prevent larvae from developing into adults. Polyethylene films impregnated with 0.1, 0.5 and 1% pyriproxyfen were added to vessels containing water and 3rd and 4th instar *Ae. aegypti*. A 100% adult emergence inhibition (EI) was obtained for all the concentrations studied. Films kept in water were active for at least 60 d. The same films used as ovitraps for gravid females produced 100% adult EI of the eggs laid on the water. An adult EI of 100% was obtained with ovitraps made of paraffin, estearine or polyethylene containing 0.5% pyriproxyfen. This new ovitrap that

continuously releases an insecticide into the water could be an additional tool for mosquito control, especially when ovitraps remain in the environment as new breeding sites in endemic areas.

86 Evaluation of chlorine bleach formulations as ovicides for the control of *Aedes aegypti*
Andrew J. MacKay, hcj8@cdc.gov, Belkis Caban, Veronica Acevedo, Manuel Amador, Roberto Barrera and Gilberto Felix

We evaluated the potential of chlorine bleach formulations to eliminate eggs of *Aedes aegypti* in natural habitats. *Aedes aegypti* mosquitoes deposit their eggs in a variety of natural and artificial container habitats, typically in a band above the surface of the water. The eggs become resistant to desiccation after completing embryogenesis and can remain viable for many months. It was reported that a small proportion of eggs of a Puerto Rican strain of *Ae. aegypti* remained viable for more than 21 months. Dormant eggs may frustrate vector control efforts by providing a reservoir of mosquitoes that enables the vector population to quickly recover from short-term perturbations due to control measures targeting the larval or adult stages. The purpose of this study was to identify minimal effective concentrations of different formulations of NaOCl that can be used as spray applications on representative substrates to prevent any *Ae. aegypti* eggs already present from hatching. We tested three formulations (Clorox® regular bleach, Clorox® regular bleach formulated with 3% (w/w) washed smectite clay, and Clorox® ProResults Outdoor bleach cleaner) on three types of substrates: polypropylene plastic, rubber, and concrete. The results indicated significant variation in the effectiveness of the formulations depending on the type of substrate.

Trustees' and Commissioners' Symposium

87 The saga concludes: Gem County Mosquito Abatement District's conclusion to its Clean Water Act citizen suit
Jason R. Kinley, director@gcmad.org

Since 2002, the Gem County Mosquito Abatement District (GCMAD) has dealt with a Clean Water Act citizen lawsuit brought by an organic dairy and the Western Environmental Law Center. Jason Kinley, director of GCMAD, will discuss the events leading up to the law suit, the mediations and legal processes resulting from the law suit, and final outcomes and recommendations to other districts who may face Clean Water Act/NPDES law suits in the future.

88 The journey between goodwill intentions and social impact: A behind-the-scenes look at malaria prevention
Aryc Mosher, aryc_moussa@yahoo.com

A simple donation starts a bed net on a complex journey. However, there are numerous components that need to be aligned to create a concrete working intervention. Using an example of malaria and lymphatic filariasis control in Nigeria, Aryc W. Mosher, Assistant Director with The Carter Center, will provide a behind the scenes look at the strategies and implementation of a net distribution. Included in his presentation will be a photographic essay of a program in action.

89 Private property and Fourth Amendment limitations on vector control and inspections
Richard Shanahan, rps@bkslawfirm.com

The Fourth Amendment of the U.S. Constitution limits government searches of private property without a court-issued warrant. This limitation encompasses actions by vector control agencies to inspect and treat vectors on private property that is within the protection of the Fourth Amendment. This presentation will discuss those limitations, the scope of Fourth Amendment protected property, exceptions, and warrant procedures.

90 The next West Nile virus-type disease: How will we know? When will we know?
Laverne A. Snow, laverne.snow@gmail.com and Dave Brown

Surveillance is a critical step in identifying and controlling any emerging disease. Since the 1999 West Nile virus (WNV) outbreak in New York City, mosquito abatement districts, in partnership with public health agencies, have done a great job of surveillance and control for mosquitoes carrying WNV. The number of human WNV cases is declining in many states, largely as a result of mosquito abatement efforts, combined with public health, medical and citizen interventions. Travel, weather, urbanization and other factors, however, influence emergence of new viruses. And the prediction is when, not if. What will be the next deadly mosquito-borne disease to spread across the U.S.? Chikungunya? Rift Valley fever? Dengue? Malaria? How will we know? What will we do? As Trustees, what is our responsibility to ensure appropriate policies, plans and budgets are in place to identify and control for emerging diseases? Can we act before many people suffer and die? These 2 presentations will discuss the need for surveillance, present information on what is currently being done to identify emerging and re-emerging diseases and offer approaches for trustee/board discussion.

91 Are we ready for, and can we respond to, an introduced pathogen or mosquito with the current regulations and resources mosquito control agencies face?
David Brown, dabrown@fightthebite.net and Laverne A. Snow

This paper will discuss the readiness to respond to an introduced virus/mosquito. It will focus on requirements for financial resources, current known strategies to address the new emergence and political fortitude to implement them. It will also provide information for consideration by trustees to help determine if resources are currently

allocated appropriately and direction for establishing new plans as will be required for mosquito control activities under the new NPDES requirements.

92 Striking the balance between public health and environmental resource protection through education, partnerships, and compliance
Amber Semrow, asemrow@ocvcd.org

In this era of increasingly stringent environmental resource restrictions and tight public sector budgets, vector control programs are called to do more with less. One strategy for addressing these challenges head on is by engaging, educating, and coordinating with resource agencies, municipalities, and other stakeholders. The Southern California Vector Control Environmental Taskforce is one such effort that models a regional approach to inform and partner with local resource regulators, city departments, storm water programs, water districts, and other interests to effectively address minimizing vectors while ensuring good environmental stewardship.

93 An overview of best management practices and successful implementation
Marty Scholl, schollfamily@wildblue.net

This discussion will provide an overview of Mosquito Reducing/Minimizing Best Management Practices (BMPs), principles and methodologies. Included will be a focus on key elements of a BMP implementation plan such as mosquito source history, written site management plans, easement conditions, long-term maintenance and management, and financial assurances. Ending the discussion will be a brief overview of the role of BMPs as a method of gaining long-term compliance with local and state vector regulations.

Biorational Pesticides: Then, Now, and the Future II

94 Spinosad: A novel biopesticide for mosquito control
Jim McNelly, jimmcnelly@clarke.com and Mark Hertlein

Spinosad, first introduced into agricultural markets in 1997, has been formulated and registered for public health use under the brand name Natular™. Spinosad is considered a reduced-risk active ingredient by the United States Environmental Protection Agency (USEPA) and Natular™ recently received that organization's Presidential Green Chemistry Challenge Award. Development of the 6 formulations utilized for larval mosquito control, 2 single-brood and 4 multiple-brood residual formulations, will be discussed. Global stewardship initiatives and efficacy evaluations designed to complement vital industry issues such as insecticide rotation and disease mitigation will be addressed, including the control of West Nile virus associated vectors in the U.S. and dengue vectors in Saudi Arabia.

95 Methoprene: The original biorational
Doug VanGundy, Dvangundy@central.com

The discovery of methoprene in the late 1960s and subsequent commercialization in 1975 ushered in new innovations in insect control. The term biorational was coined by the group of Zoecon researchers responsible for the discovery of methoprene. The term biorational has now become synonymous with alternative pest control products. Methoprene's roots go back to the early 20th century with the discovery of insect neuroendocrine factors. From those early years on, many major discoveries occurred that provided a better understanding of the mechanisms of insect development. The discovery and identity of juvenile hormone and its fit within the insect molting process was a major breakthrough, allowing for subsequent chemical synthesis of juvenile hormone analogues, which paved the way for the ultimate commercialization of methoprene and its 2 sister compounds, hydroprene and kinoprene. The first commercial product containing methoprene was for use in mosquito control. Many use patterns and markets have developed over the years from flea control to protectants for stored foods. Methoprene has a 35-yr history of success in controlling important pests and is expected to continue that tradition in the future.

96 Other IGRs for mosquito control
Christina Liew, christina_liew@ymail.com and Tianyun Steven Su

Other IGRs for mosquito control include another JHA pyriproxyfen, chitin synthesis inhibitor diflubenzuron, novaluron, and ecdyson agonists RH2485 and others. Pyriproxyfen is a pyridine-based pesticide invented and formulated for controlling various pestiferous arthropods. SumiLarv® 0.5G was formulated to control mosquitoes and flies. Pyriproxyfen was introduced to the U.S. in 1996 and marketed under the trade name Nylar for agricultural pests. It is also occasionally used to control pest on pets and livestock in the US and Europe. Promising larvicidal activity and efficacy against mosquitoes were demonstrated in early studies. So far no EPA registered products are available for operational mosquito control. Diflubenzuron was synthesized a long time ago and used for mosquito and midge control under SLN. Novaluron is a relatively new chitin synthesis inhibitor; great lavicidal activity and efficacy have been demonstrated in laboratory and field against a variety of mosquito species. Ecdysone agonist RH-2485, RH 5992 and RH-5849 were recently tested for their potential to control immature mosquitoes. Promising larvicidal activity against all stages was achieved at very low concentrations against major vector species of medical importance. Potential for future development for use of these IGRs in operational mosquito control will be discussed.

97 More biorational pesticides with various modes of action
Raj Saran, raj.k.saran@usa.dupont.com

DuPont Professional Products brings the company's 200-yr tradition of science and innovation to the global pest management, turf/ornamentals and golf industries. New actives, such as Indoxacarb, have already proved its superior efficacy in a number of formulations against key urban pests because of its novel mode of action. Similarly, chlorantraniliprole, a new compound with novel mode of action, has been launched against key crop and urban pests. Mode of actions of these chemistries, superior environmental profile, and their potential in mosquito control are discussed.

Global Perspective on the *Culex pipiens* Complex in the 21st Century II

98 Population structure of the *Culex pipiens* complex in Portugal and Macaronesian islands
Joao Pinto, jpinto@ihmt.unl.pt, Bruno Gomes, Carla A. Sousa, Maria T. Novo, Ricardo Alves, Ferdinando B. Freitas, Antonio P G. Almeida, Martin J. Donnelly and Marta Gouveia

Culex pipiens s.s. is the most widespread mosquito in Portugal. In a recent study, we have detected the presence of the 2 biological forms, *pipiens* and *molestus*, described for this species, occurring in sympatry in above-ground habitats. Under these conditions, genetic analyses based on microsatellites revealed considerable levels of hybridization between forms. Introgession, however, appears to be asymmetrical, with more *molestus* genes being introgressed into the *pipiens* form. Following these findings, we have extended our genetic analyses to additional populations collected in the archipelagos of Madeira and Cape Verde. In the latter, *Culex pipiens* s.s. co-exists with its sister species *Culex quinquefasciatus*. Furthermore, we have undertaken additional bio-ecological surveys in the region of sympatry in order to genetically characterize mosquito samples collected at the ground level vs. tree canopy or that have blood fed in mammal or avian hosts. This presentation will provide an overview of the most recent results obtained by these analyses.

99 The Spielman legacy: his influence on the *Culex pipiens* complex in the USA
William Reisen, wkreisen@ucdavis.edu

Any modern discussion of the biology of the *Culex pipiens* complex bears the unshakable influence of the late Andrew Spielman. His accomplishments, with those of his former students, post docs and collaborators, were as diverse as they were significant. His contributions began with his doctoral work focused on the genetics of autogeny of *Cx. pipiens*. He embraced cutting edge technology of that era to uncover previously unrealized complexities in the physiology and population structure of this taxon. From the late 1950s through the late 1970s, Andy published most of his dozen seminal papers that focused on aspects of *Cx. pipiens* biology. These covered aspects of physiology, autogeny, population structure, anatomy and ecology. His attention returned to this group with the emergence of West Nile virus (WNV). He then led a team of colleagues distributed throughout this mosquito's geographic range to probe latitudinal and diel influences on the distribution of the vector as well as on the force of transmission of WNV. He sought sound physiological bases to reveal all aspects of vector competence and vectorial capacity and insisted that these findings be central to the design of any intervention. A review of Andy's contributions and perspectives are pertinent when considering new findings as well as the challenges and opportunities that lie ahead.

100 Local adaptation and hybridization across the *Culex pipiens* complex in the USA
Dina M. Fonseca, dinafons@rci.rutgers.edu

We used 8 highly polymorphic molecular markers (microsatellites) to characterize the extent of the hybridization between *Culex pipiens* (both forms) and *Cx. quinquefasciatus* in the U.S. We examined populations from 3 longitudinal transects, 2 on the East Coast and 1 on the West Coast. The markers used were chosen based on 1) sufficient number of markers needed to insure statistical accuracy during the analyses; 2) markers had to be amplifiable in all taxa; and 3) markers had to include alleles unique to each taxa, allowing a clear separation between the genomes of pure populations and those of potential hybrids. We found much deeper introgression of alleles from each species than expected from previous classical analysis of male genitalia. A Bayesian multilocus cluster analysis without *a priori* identification of the specimen's geographical origin identified 3 distinct microsatellite signatures. We found virtually no individuals with a "pure" signature in the mid-latitudinal states, and found that the frequency of hybrid types shifts across elevation, at each latitude, likely associated with temperature. We examined how temperature may affect hybrid distribution by performing laboratory studies and developed a predictive model of the impact of hybridization on the population dynamics of *Culex pipiens* complex across the US latitudinal gradient.

101 Distribution and bloodmeal hosts of members of the *Culex pipiens* complex in the USA
Harry M. Savage, hms1@cdc.gov and Linda Kothera

In the USA, the *Culex pipiens* complex is represented by 2 subspecies, *Cx. p. pipiens* L. and *Cx. p. quinquefasciatus* Say. The subspecies differ with respect to overwintering strategies, with *Cx. p.pipiens* entering diapause in response to winter conditions and *Cx. p. quinquefasciatus* lacking this ability. Specimens were collected along a transect from New Orleans, LA to Chicago, IL. Microsatellite markers were used to: genetically characterize subspecies and hybrids, and determine the degree and extent of hybridization in order to define the hybrid zone. The results support the presence of 2 distinct genetic entities, with a broad, stable hybrid zone in between. Admixture analyses classified more than 40% of individuals as hybrids. Allelic richness was markedly different at the northern and southern ends

of the transect, and there was a significant isolation by distance effect. The hybrid zone appears to be wider and extends further to the south than previous work indicated. We suggest that the parental subspecies and the hybrid zone are maintained by heterosis combined with selection for diapauses at northern latitudes. At 3 sites along the transect comprehensive bloodmeal-host utilization studies have been conducted: *Cx. p. quinquefasciatus* from LA; hybrids from Memphis, TN; and *Cx. p. pipiens* from Chicago, IL. Utilization of humans as hosts varied greatly among sites, 1-18% of bloodmeals.

Operations and Management II

102 Mass deployment of lethal ovitraps against *Aedes aegypti* in Key West, FL
Sam Hapke, shapke@springstar.net, Andrea Leal, Brian Zeichner, Beth Schaafsma and Michael Banfield

SpringStar Inc is commercializing the military-patented lethal ovitrap technology, which is designed to control populations of container-ovipositing mosquitoes. The product, trademarked as "Trap-N-Kill," was field tested against *Aedes aegypti* in Key West, FL, in the summer of 2010. With ~5,300 traps placed into the field, this was the largest recorded deployment of the lethal ovitrap technology. The logistics of the large-scale deployment, including public acceptance, integration with the local mosquito district, field durability, efficacy, and novel improvements, will be reviewed.

103 Conducting regulatory field studies for mosquito control products following Good Laboratory Practice Standards
Fran Krenick, fkrenick@clarke.com

Efficacy studies that produce data for submission to the Environmental Protection Agency (EPA) for registration and support of registration of public health pesticides must be conducted using Good Laboratory Practice Standards (GLP) as mandated by EPA; 40 CFR Part 160 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This paper will discuss the challenges and successes of conducting field and laboratory studies following the EPA GLP standards.

104 A one-stop-shop for vector mapping
Guy Hendrickx, Els Ducheyne, David Rogers, Willy Wint, Stephanie Bastier, Lieven Bydekerk, Herman Eerens, Andries Rosema, Steven Foppes and Marieta Braks

In the absence of detailed knowledge needed for decision making and control, modeling techniques can be used to provide maps of the presence of vector species or the risk of establishment of foreign species. The techniques required are complex and involve a number of stages. Sample field distribution data for the target organism are first needed to calibrate the models, which provide the final risk map outputs. A large quantity of Earth Observation (EO) satellite imagery must then be acquired and processed to feed the models, which themselves must then be developed and run to produce the final product. Though well established, such techniques are the preserve of a few specialist technicians and are not generally accessible to the wide range of vector control agencies or public health, research or commercial organizations, which could use the risk maps produced. VECMAP addresses this problem head on by providing a seamless system that integrates the entire process of producing risk maps into a single package that can be used by a wide range of practitioners, either on their own or supported by a consortium of acknowledged leaders in the field. VECMAP consists of both software and supporting services designed so that clients can use the system on their own, or with the support of the consortium.

105 Real time mobile weather observations for BMPs
Derek Radel, sales@newmountain.com

The ability to monitor true wind speed while conducting vehicle pesticide spraying has numerous operational effects on an integrated pest management program. Until now the ability to monitor and record real time weather conditions including true wind speed and direction was impossible or difficult at best without stopping the operations and manually taking an observation. The NM150 ultrasonic weather station is a 7-sensor, multi-function weather station which uniquely integrates GPS. This system provides true wind monitoring from moving vehicles, specifically introduced by New Mountain Innovations for use in mosquito spray trucks. This system improves application efficacy while reducing the impact pesticides can have on environmental situations needing mitigation. With this capability, the operator can in real-time determine if the weather conditions are meeting the label requirements. In addition, having a true record for post-operations assessment can help determine the effectiveness of that particular spray operation and management can make adjustments for future applications.

106 Attractive toxic sugar baits (ATSB): Bait formulations and applications for the control of sand flies
Gunter Muller, guntercmuller@hotmail.com, Edita E. Revay, Vasiliy D. Kravchenko and Yosef Schlein

Two years of research on attractive toxic sugar baits (ATSB) for sand fly control in the frame of a Deployed War-Fighter Protection Program project is summarized and discussed from a product point of view.

107 The principal and performance of a novel contact trap for the control of *Anopheles gambiae* and nuisance mosquitoes in Africa

Gunter Muller, guntercmuller@hotmail.com, Sekou F. Traore, Mohamed M. Traore, Seydou Doumbia, Vasiliy D. Kravchenko, Zoya A. Yefremova, Edita E. Revay, John C. Beier and Yosef Schlein

A novel contact trap system, BITEBACK, developed by MidMos Solutions Ltd., Birmingham, GB, combining the attracting features of CO_2, moisture, heat, shape, color and contrast was evaluated in 900 m^3 release chambers in Israel and field tests in Mali, West Africa. The unit is free standing and powered by combustion of propane, butane or mixtures of the two alone. Night vision observations of traditional combustion traps with capture mechanisms showed that only a fraction of the attracted biting flies were caught. In contrast, the new system killed efficiently all the attracted mosquitoes by contact with a pesticide (lambda-cyhalothrin) impregnated cloth target. In the release chambers, the presence of a Mosquito Magnet Liberty reduced the biting pressure of released *Culex pipiens* within 24 h by 62% (*Aedes albopictus* 29%), while the contact trap reduced it by 91% and 77%, respectively. In Mali, at the end of the rainy season, 10 BITEBACK systems were used to protect a small village partially surrounded by rice paddies and wetlands while a similar control village was unprotected. In the experimental village, CDC trap catches of female mosquitoes dropped after 2 wk by almost 80% (*Anopheles gambiae* s.l. 75%, *Culex* sp. 83%, and *Aedes* sp. 87%) and after 4 wk by 92% (*An. gambiae* s.l. 86%, *Culex* sp. 89%, and *Aedes* sp. 95%). At the same time in the control village the mosquito catches increased by almost 4 times mainly from *Culex quinquefasciatus*.

108 Attractive toxic sugar baits (ATSB): Simple strategies to minimize adverse impacts on non-target organisms

Gunter Muller, guntercmuller@hotmail.com, John C. Beier, Sekou F. Traore, Mohamed M. Traore, Seydou Doumbia, Zoya A. Yefremova, Vasiliy D. Kravchenko and Yosef Schlein

The impact of ATSB was evaluated on mosquitoes and non-target organisms in different habitats in Israel (Mediterranean, oasis) and in Mali (semi-arid, savannah, rice irrigation). As a standard approach ASB solutions, without toxin but containing different colored food dye, were sprayed on both attractive flowering plants and on non-flowering vegetation. The following day mosquitoes and other insects were collected with malaise traps, sweep nets, UV-light traps, and pitfall traps. Depending on the investigated insect orders, individuals were identified to the level of family, genus or species and those that have fed on the baits were determined by gut dissection to detect colored food dye. The data in Israel and Mali show that numerous species of non-target insects fed on ASB (non toxic) solution applied on highly attractive flowering plants. However, if the same ASB solutions were applied as a barrier treatment on non-flowering vegetation on the periphery of mosquito breeding sites or around villages, then the feeding on the baits by non-targets, including bees was little to none. However, bait feeding of local mosquito populations was in a range (44 to 74%) which was in previously published trials sufficient for control. The only groups of non-targets feeding in significant amounts on baits were non-biting midges, house and filth flies. Different types of bait station designs with metal grids allowed mosquitoes to feed while larger insects like honey bees were protected.

Latin American Symposium II

109 Susceptibility to temephos and enzymatic activity in populations of *Aedes aegypti* from Venezuela during 2008 and 2010

Leslie Alvarez, hleslieag@hotmail.com, Milagros Oviedo, Gustavo Ponce and Adriana E. Flores

Two populations of *Aedes aegypti* larvae collected from Lara and Trujillo states in Venezuela were tested using the World Health Organization bioassay technique to determine susceptibility to temephos during 2008 and 2010. The activities of α and β esterases, mixed function oxidases (MFO), glutathione-S-transferase (GST), insensitive acethylcholinesterase (iAChE) were assayed in microplates. The New Orleans (NO) strain of *Ae. aegypti* was used as reference and the threshold criteria for each enzyme were the highest NO absorbance values. The results showed susceptibility in the studied populations to temephos during both years with RR DL50 values lower to 5. Elevated α and β esterases were present in the population for 2008 and for 2010 MFO y iAChe while the population from Pampanito showed elevated α esterases only altered enzymatic mechanism.

110 Temephos resistance in Caldas, Colombia: Current state and detection of biochemical mechanisms implicated in two autochthonous populations of *Aedes aegypti* (Diptera: Culicidae)

Lorena I. Orjuela, loriza83@gmail.com, Manuela Herrera, Idalyd Fonseca and Martha L. Quinones

The use of the organophosphate larvicide temephos is one of the main control activities for dengue control in Colombia. The development of resistance is a threat for control efficacy. In this study, the level of susceptibility of *Aedes aegypti* to temephos was evaluated in 2 autochthonous populations in La Dorada, Caldas (Las Margaritas and Las Ferias neighborhoods), during 2007 and 2008. World Health Organization bioassays were carried out using the diagnostic dose of 0.02 mg/ml and the Resistant Ratio (RR) was calculated for each population. The results showed high levels of resistance to temephos in both populations, with RR higher than 10: 11.48 in Las Margaritas and 13.27 in Las Ferias. Enzymatic biochemical assays were carried out to define the mechanisms involved in this resistance. Four enzymes were studied: non-specific esterases, mixed function oxidases, glutathione-S-transferases, and insensitive acetylcholinesterases. Biochemical assays did not detect alteration profiles. More studies are required to establish if mechanisms like aryl-esterasas could be implicated in temephos resistance in Caldas *Ae. aegypti* populations.

111 Susceptibility to chlorpyrifos in pyrethroid resistant strains of *Aedes aegypti* from the east coast of Mexico
Adriana E. Flores, adrflores@gmail.com, Nallely Banda, Brenda G. Silva, Humberto Quiroz-Martinez and Gustavo Ponce-Garcia

Chlorpyrifos resistance of 6 field strains of *Aedes aegypti* (L.) adult females from Veracruz, Mexico was investigated and compared with a susceptible strain (New Orleans) by using the bottle bioassay. The strains used were resistant to *d*-phenothrin, permethrin, deltamethrin, lambda-cyalothrin, bifenthrin, cypermethrin, alpha-cypermethrin and z-cypermethrin. Results showed that strains from Tantoyuca, Veracruz and Coatzacoalcos were susceptible to chlorpyrifos with RR< 5. The strains from Martinez de la Torre and Poza Rica were tolerant (RR>5<10) and only Cosoleacaque strain was resistant to chlorpyrifos. The practice of utilizing a single insecticide until the appearance of resistance has become standard practice that unfortunately rapidly reduces the number of insecticides available for effective vector control. The use of chlorpyrifos could have a tremendous potential for implementation in the *Ae. aegypti* control program in Mexico.

112 Fitness costs of insecticide resistance in *Aedes aegypti* (L) artificially resistant to lambda-cyhalothrin
Idalyd Fonseca-González, idalyd.fonseca@siu.udea.edu.co, Duverney Chaverra Rodríguez and Nicolás Jaramillo-O

Insecticide resistance has become an obstacle for dengue control strategies worldwide. It has been proposed that there is a fitness cost associated with insecticide resistance. Understanding these potential costs is critical for developing efficient vector control strategies. This work evaluated the fitness costs under laboratory conditions of a strain of *Aedes aegypti* artificially selected for resistance to the pyrethroid lambda-cyhalothrin over 9 generations, in comparison with a control strain established from the same parental population and maintained under the same conditions and number of generations, but not exposed to selection for insecticide resistance, and the susceptible Rockefeller strain. For this purpose, horizontal life tables constructed from five cohorts of 100 mosquitoes were evaluated and compared between the resistant strain, control strain and Rockefeller strain for the following parameters: developmental time to adult, adult daily survival rates, female longevity, adult fecundity, fertility, sex ratio and net reproductive rate. The preliminary results showed that the resistant strain differs significantly from the control strain and the Rockefeller strain in the survival curves, female longevity, fecundity and net reproductive rate ($P < 0.005$). We did not find significant differences in the rate of hatching, developmental time to adulthood or the sex ratios between the three strains. The strain maintained without selection showed daily survival rates, fecundity and net reproductive rates similar to the Rockefeller strain, but statistically different from the selected strain. These results indicate that fitness costs occur in adults and could be associated with reproduction of the insecticide resistance mosquitoes, suggesting a potential use in dengue vector control alternatives.

113 Experimental trials of bed nets impregnated with Fendona® for control of *Aedes aegypti* (Diptera: Culicidae)
Humberto Quiroz-Martinez, hqm_uanl@yahoo.com, Violeta A. Rodriguez-Castro, Juan F. Martinez-Perales and Mara I. Garza-Rodriguez

Bed nets impregnated with insecticide are attracting increasing interest to control *Aedes aegypti*; our study was performed in order to measure the efficacy of bed nets impregnated with Fendona® for *Ae. aegypti* control. Bed nets impregnated with and without insecticide were placed over beds, and cones with 20 female *Ae. aegypti* were placed in a top, middle and bottom section of the bed net, mortality was registered after 24 h of exposure. Impregnated bed nets showed high control efficacy of *Ae. aegypti* females.

114 Effectiveness of space spraying application of Aqua Reslin Super® and Aqua-K-Othrin® in the context of dengue control
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The spatial application of insecticides plays a significant role in vector control programs and in some situations is seen more as political decision than a strategic one. Nonetheless, it is necessary to assess the effectiveness of the insecticides applied at ultra-low volume. In the Regional Centre of Investigation in Public Health, we have evaluated Aqua Reslin Super® and Aqua-K-Othrin®, in lines and with obstacles tests. Insecticides were applied following the recommended instructions using an *Aedes aegypti* strain from Tapachula, Chiapas, Mexico. This strain was resistant to pyrethroids (43% mortality to permethrin and 51% to lambda-cyhalotrin). In line tests, mortalities registered in some replicates reached 100% at 100 m with Aqua Reslin®. With Aqua K-Othrine®, mortalities reached 100% up to 40 m, and 73.3% at 80 m. In tests with obstacles, mortality reached 100% in the front garden and 80% in the living room with both products and in the backyard 86.7% and 93.3% with Aqua Reslin Super® and Aqua K-Othrine®, respectively. It is inferred that resistance in the Tapachula strain is mostly metabolic, and if KDR is present, it is at very low frequency. Results suggest that these products still respond favorably to the dose of 10 and 1-2 g of active ingredient per ha, respectively, in areas where KDR resistance is not present.

115 Field evaluation of a new combined larvicidal-adulticidal ultra-low-volume formulation against *Aedes aegypti* (Diptera: Culicidae) in Colombia
Martha L. Quinones, mlquinonesp@unal.edu.co and Natali Ortiz

Evaluation of alternatives to temephos for dengue control is necessary, due to the increasing presence of resistant *Aedes aegypti* populations in Colombia. A new ultra low volume (ULV) formulation containing permethrin as an adulticidal active ingredient and the insect growth regulator (IGR) pyriproxyfen as a larvicide was evaluated in a field trial in San Joaquin, Cundinamarca. Pre and post-intervention weekly surveys were carried out in treated and control areas, evaluating the number of deposits with larvae, larval density, pupal index using the sweeping method,

and adult density as the number of adult mosquitoes collected for 10 m in each house. Sentinel cages containing adult mosquitoes and jars containing *Ae. aegypti* larvae were placed outside during insecticide treatments. An 80% reduction in adult density was found, and lasted for 2 wk after treatment. Also, a 54% and 27% reduction in larvae and pupae density respectively was observed, lasting for 6 wk after treatment. An inhibition in adult emergence of 95% was found in the sentinel jars. This new adulticide and IGR ULV formulation shows promise to be used as an alternative to temephos.

116 An analysis of the species diversity and geographical distribution of sand fly (Diptera: Psychodidae) fauna from Quintana Roo, Mexico

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A faunistic study was carried out to gain insight into the distribution, species richness and abundance of sand flies in Quintana Roo, Mexico. Even though Quintana Roo is one of the states in Mexico most affected by leishmaniasis, to date, there have been no studies aimed to analyze the distribution of local sand fly species. Therefore, the objectives were to determine the species richness and abundance of sand flies in 3 regions of the state of Quintana Roo. From January to early April 2008, sand fly collections were made in 18 selected sites throughout Quintana Roo. Collection of flies was carried out using baited Disney traps, CDC light traps and Shannon traps. A total of 14,532 specimens were captured and were comprised by 2 genera and 20 species; 2 of which are new species. Overall, the northern region of Quintana Roo appeared to have the highest species richness and abundance, followed by the central and southern regions, which had an equal richness, whereas the central region showed the lowest sand fly abundance. Each region showed a rather distinctive dominant species composition, although *Lutzomyia shannoni* and *Lu. cruciata* were among the most abundant species in all 3 regions. Some of the most abundant species are vectors of leishmaniasis on the Yucatan Peninsula. Results indicated that environmental factors may be the main factors mediating the differences in the sand fly richness and abundance in the various regions of Quintana Roo; however, at this stage, we cannot conclude the spatial scale at which those environmental factors operate.

117 Sand fly species (Diptera: Psychodidae) from diurnal resting sites and within a karstic cave in the Yucatan Peninsula, México

Ana C. Montes-de-Oca-Aguilar, chelita90210@hotmail.com, Alejandro D. Moo-Llanes and Eduardo A. Rebollar-Tellez

Phlebotomine sand flies are the vectors of *Leishmania* spp. parasites. Studies on the biology and ecology of this insect group have mainly been focused on the epidemiological aspects of parasite transmission. Despite the medical importance of sand flies, some basic biological and ecological aspects of these flies are still unknown. “Where do sand flies hide during the daylight hours?” is one of the most recurrent questions. Therefore, in the present study our objectives were to search for and determine adult resting sites for sand flies, as well as to document the daily activity of sand flies inhabiting a karstic cave. The search for resting sand flies was conducted from November 2007 to April 2008 in several locations of the Yucatan Peninsula. Resting flies were captured using a portable backpack aspirator. On the other hand, daily activity of sand flies inhabiting the karstic cave was carried out in November 2008 in a selected site in the state of Yucatan. Flies in the cave were caught using CDC light traps. All flies were preserved in 8 ml plastic vials containing 70% ethanol. In total, we collected 72 sand flies in 18 out of 103 tree-trunks (17.5%) that were aspirated, whereas in the karstic cave we collected a total of 703 flies. Within a karstic cave, 7 species: *Brumptomyia hamata, Lutzomyia beltrani, Lu. cayennensis maciasi, Lu. cratifer, Lu. deleoni, Lu. serrana* and *Lu. trinidadensis*. There were apparent peaks of activity for the most common species from around 1600 to 2000h and from 2000 to 0000 h.

Young Professionals Career Symposium

118 Overview

Roxanne Connelly, crr@ufl.edu, Stanton Cope, Roger Nasci, Dave Brown, Mark Beavers, Dan Strickman, Jason Clark, Graham White and Vicki Kramer

The AMCA Young Professionals group was formed in 2010 to promote interaction among young professionals in the field of mosquito control and research, to highlight research and professional achievements accomplished by young professionals, and to promote interaction between young professionals and well-established and experienced professionals in the field of medical entomology, vector control, and public health. One of the tasks assumed by the group is to promote already existing student activities during the AMCA annual meeting and to create new activities with the scope of increasing student/young professionals’ participation during the AMCA annual meeting, and the AMCA Young Professional’s Career Symposium is designed to complete that task. The symposium includes representatives from agencies involved in the AMCA and vector control. Speakers will deliver presentations on careers within the agency or field they represent and will provide information on current prospects for careers in the agency, details on job responsibilities, educational requirements, tips on preparing for a specific career, rewarding aspects of the job, competitiveness, and advice. Speakers represent the Centers for Disease Control, vector control, military, the United Stated Department of Agriculture, industry, international interests, academia, and public health.

Global Perspective on the *Culex pipiens* Complex in the 21st Century III

119 Genetic differences between *Culex pipiens* f. *molestus* and *Culex pipiens pipiens* (Diptera: Culicidae) in New York

Rebekah J. Kent, fxk7@cdc.gov, Laura Harrington and Douglas Norris

The definition and phylogenetic placement of the autogenous *molestus* form of *Culex pipiens* has puzzled entomologists for decades. We identified genetic differences between *Cx. p. pipiens* (L.) and *Cx. pipiens* f. *molestus* Forskål in the SH60 fragment described previously. Single-strand conformation polymorphism analysis, cloning, and sequencing of this fragment demonstrated high polymorphism within and among individual *Cx. p. pipiens*, with common SH60 variants shared among individuals from distant locations. In contrast, *Cx. pipiens* f. *molestus* from New York City each contained a single SH60 variant, which was not identified in any other *Cx. p. pipiens* specimens analyzed. Supporting microsatellite analysis demonstrated significant but reduced gene flow between *Cx. p. pipiens* and *Cx. pipiens* f. *molestus* in New York relative to *Cx. p. pipiens* populations in New York and California. Results are discussed in the context of 2 contrasting hypotheses regarding the origin of *Cx. pipiens* f. *molestus* populations.

120 Microsatellite characterization of form molestus and form pipiens of *Culex pipiens pipiens* from Chicago and New York City

Linda Kothera, LKothera@cdc.gov and Harry M. Savage

Above- and below-ground populations of the mosquito *Culex pipiens* L. are traditionally classified as form pipiens and form molestus, respectively, and gene flow between forms is thought to be limited. Relatively few f. molestus populations have been found in the US, which has hindered their study in North America. In this study, we used microsatellites to characterize a newly discovered population of f. molestus in Chicago, Illinois, and compared levels of genetic diversity and differentiation in above- and below-ground populations from Chicago and New York City, NY. Levels of genetic diversity, as measured by expected heterozygosity and allelic richness, were markedly lower in both f. molestus populations. Allele frequencies were distinctly different between the 2 f. molestus populations. Pairwise F_{ST} values between populations indicated that f. molestus populations were highly divergent from each other, as well as from their associated above-ground populations. Cluster analysis suggested the most likely number of groups was 3, with the 4 f. pipiens populations in 1 cluster, and each of the f. molestus populations in its own cluster. A neighbor-joining tree calculated from the percent shared alleles was consistent with the results of the cluster analysis. Admixture analysis detected a low number of hybrids between forms, which were mostly confined to the 2 New York City above-ground populations.

121 *Culex pipiens* sensu lato in California: A complex within a complex?

Anthony Cornel, cornel@uckac.edu, Rebecca Trout-Fyxell, Stephanie Siefert, Catelyn Nieman, Yoosook Lee and Gregory Lanzaro

There is still, in the 21st century, no full agreement about the specific identities and genetic relationships of the members of the *Culex pipiens* complex. Preliminary studies using microsatellites and single nucleotide polymorphisms in California populations reveal that the population structuring is not adequately defined by the presence of *Cx. pipiens* in the north, *Culex quinquefasciatus* in the south and their hybrids in central San Joaquin Valley. Populations in San Joaquin Valley region comprise multiple morphologically identical populations that do not have solely mixed representations of *Cx. pipiens* and *Cx. quinquefasciatus* genes. The SNP data suggests there is some genetic differentiation between above and below ground and between urban and rural *Cx. pipiens* sensu lato in Marin and Fresno Counties respectively.

122 *Wolbachia* and the *Culex pipiens* complex

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The endosymbiotic bacterium *Wolbachia* has a long and intriguing scientific history with the mosquito *Culex pipiens*; indeed, the full name of the bacteria (*Wolbachia pipientis*) comes from its discovery in this mosquito in the early 1920s. In this talk, I will review the discovery of *Wolbachia* in *Cx. pipiens*, the discovery of the reproductive manipulation known as cytoplasmic incompatibility (CI) and the ultimate experiments linking *Wolbachia* to this phenotype almost 50 yr after the initial discovery of the bacteria. I will also detail more recent research detailing the interaction between *Wolbachia* and the population biology of this mosquito. Finally, I will discuss the impact of new genomic technologies on the role of *Wolbachia* on *Culex* biology and pathogen transmission.

Adult Control I

123 Adult mortality associated with ingestion of trypsin modulator from transgenic plants

Richard Duhrkopf, rick_duhrkopf@baylor.edu and Christopher M. Kearney

The mortality of adult *Aedes albopictus* fed a 5% sucrose solution containing trypsin modulating oostatic F (TMOF) derived from tobacco leaves in which the TMOF gene was inserted, was compared over a 7-d period with adults fed 5% sucrose in water. Mortality in the 5% sucrose cages was 10 to 15% while mortality in the TMOF cages was 100%.

124 Basic efficacy of oral insecticides in toxic sugar baits to control sand flies and mosquitoes
Laor Orshan, Laor.Orshan@eliav.health.gov.il and Gabriela Zollner

Targeting adult stages of mosquitoes and phlebotomine sand flies is the only option when habitat sites are unknown or inaccessible. Outdoor control measures are an important component of integrated vector management programs. Conventional control methods, including the use of residual insecticides and thermal fogging, are problematic in many areas. The use of oral insecticides added to sugar solution is a new, promising alternative method for outdoor control of adult mosquitoes and sand flies. The choice of insecticides is vital for the successful use of the method in the field. Suitable insecticides should be non-repelling even in high concentrations, remain potent in outdoor conditions and have good basic oral efficacy on target species. The great potential for the use of toxic sugar baits necessitates the alternate use of suitable insecticides to prevent or slow down the development of insecticide resistance. The palatability and basic efficacy of spinosad, thiamethoxam, dinotefuran and boric acid in sugar baits was tested against several mosquito and sand fly species. Feeding rates on insecticide dilutions and mortality rates up to 72 h post-exposure are presented for *Culex pipiens*, *Anopheles stephensi* and *Aedes aegypti* mosquitoes and *Phlebotomus papatasi* and *Phlebotomus sergenti* sand flies. The suitability of these insecticides for use in toxic sugar baits and the framework for further testing their persistence is the field is discussed.

125 Evaluation of ULV applications against Old World sand fly species in equatorial Kenya
Seth C. Britch, seth.britch@ars.usda.gov, Kenneth Linthicum, Todd Walker, Muhammad Farooq and Jeffrey Clark

Reducing populations of phlebotomine sand flies in areas prevalent for leishmaniases is of ongoing importance to U.S. military operations. Collateral reduction of sand flies or human cases of leishmaniases during pesticide campaigns against vectors of malaria indicate that residuals like DDT can be effective. However, not enough is known regarding the efficacy of the current arsenal of Department of Defense-approved pesticides. We need to know more about the potential for ULV pesticides to control Old World sand fly vectors. In this study we examine the performance of the Terminator ULV and the Grizzly ULV with Duet™ and Fyfanon in four combinations against caged *Phlebotomus duboscqi* in a natural environment in western Kenya. All equipment and Fyfanon are approved and listed by the Armed Forces Pest Management Board. Caged sand flies were reared from local *P. duboscqi* and the area has long been studied as a *Leishmania* focus. Patterns of mortality across grids of sentinel sand flies showed greater efficacy from the Grizzly ULV equipment regardless of chemical. However, patterns of deposition from dye-stained ULV droplets showed higher dispersal in 1 trial from the Terminator. Off-site sand fly trapping before and after treatments suggests local population suppression from ULV sprays. We discuss the implications of these findings for future military preventive medicine activities and encourage further investigations into the merits of ULV for force health protection.

126 Efficacy of PermaNet® 2.0 and PermaNet® 3.0 against insecticide resistant *Anopheles gambiae* s.s. in experimental huts in Côte d'Ivoire
Benjamin G. Koudou, gkoudou@liverpool.ac.uk and Alphonsine Koffi

The main goal of this study was to evaluate the efficacy and wash resistance of a new LLIN, PermaNet® 3.0 compared to PermaNet® 2.0 in an area of high pyrethroid resistance. The study was conducted in experimental huts at the Yaokoffikro in Côte d'Ivoire. The efficacy of intact unwashed and washed LLINs was compared with a conventionally treated (dipped) net washed to just before exhaustion over a 12-wk period. Mosquitoes were collected each morning 5 d per wk. Mortality rates of over 80% from cone bioassays with wild-caught pyrethroid resistant *An. gambiae* s.s were recorded only with unwashed PermaNet® 3.0. The proportion of mosquitoes exiting the huts was significantly lower with the control than for the other treatment arms ($P < 0.001$) which were similar ($P > 0.05$). Mortality rates with *An. gambiae* s.s and *Culex* spp. were lower for the control than for other treatments ($P < 0.001$), which were similar ($P > 0.05$) except for the unwashed PermaNet® 3.0 treatment ($P < 0.001$), which showed higher mortality ($P < 0.001$). The results of this study showed that the new long-lasting bed nets PermaNet® 3.0 caused significantly higher mortality against pyrethroid resistant *An. gambiae* s.s, with both kdr and metabolic mechanisms, and resistant *Culex* spp. than PermaNet® 2.0 and the dipped net.

127 Bioassays for monitoring resistance to pyrethroid insecticides in *Aedes aegypti* in Thailand
Waraporn Juntarajumnong, agrwpj@gmail.com, Kanutcharee Thanispong, Sunthorn Pimnon and Theeraphap Chareonviriyaphap

Aedes aegypti is a primary vector for dengue fever/dengue haemorrhagic fever worldwide. Prevention and control of the disease are almost dependent on vector control method using synthetic pyrethroids. These compounds are commonly used in homes and this could be an important cause of insecticide resistance in a house-haunting mosquito like *Ae. aegypti*. Therefore, pyrethroids resistance was detected and monitored by bioassays using diagnostic dose method. The diagnostic doses for synthetic pyrethroids including alpha-cypermethrin, cypermethrin, bifenthrin, permethrin, lambda-cyhalothrin and deltamethrin susceptibility test were established based on *Ae. aegypti*, the susceptible USDA strain, for practical and routine use. The diagnostic doses were subsequently used to evaluate the susceptibility/resistance status in field-collected samples in various parts of Thailand. The preliminary results demonstrated that the mosquitoes from Kanchanaburi province were susceptible to alpha-cypermethrin, cypermethrin and lambda-cyhalothrin. However, incipient resistance to bifenthrin, permethrin and deltamethrin was observed in these mosquitoes. The data from this study will provide important implications for effective control of dengue vector in Thailand.

128 Ground-based operational and caged mosquito applications of AquaAnvil™ in Portsmouth, VA
Grifith S. Lizarraga, glizarraga@clarke.com, George Wojcik and Jim McNelly

AquaAnvil™ has been utilized within the integrated mosquito management regimen of the City of Portsmouth for several years, all from truck-mounted ULV equipment. AquaAnvil™ uses the Droplet Optimization Technology (DOT) which, through evaporation, is designed to create a more potent, efficacious ULV droplet. During the 2010 season, caged mosquito efficacy evaluations were conducted using the highest and lowest labeled rates at 2 dilution ratios - 1:3 and 1:4. Observations from operational use of the adulticide will be discussed along with data from the 2010 caged mosquito trials.

129 Improvement of caged-mosquito field bioassays utilizing a modified wind-sensitive vane
Grifith S. Lizarraga, glizarraga@clarke.com

Caged-mosquito field bioassays are an important tool for corroboration of ULV adulticide efficacy. Such work is vital to the mosquito control and research communities. However, comparable demonstration research is also used, with slight variation, in agriculture and other public health related fields. During the 2009 and 2010 seasons, a review of field equipment and methodologies associated with caged mosquito trials took place, including incorporation of a previously published wind-sensitive vane used to auto-correct cage position. Several simple improvements enhance the vane described by Vessey et al. and facilitate the caged-mosquito field bioassay process. Data from demonstration research performed in both Arizona and Texas using Duet™ will be presented to highlight the value of the improved "Vessey Vane".

130 Evaluation of bite protection performance of permethrin-treated United States military uniforms
Ulrich R. Bernier, uli.bernier@ars.usda.gov, Melynda K. Perry and Amy L. Johnson

Since 1991, the U.S. Military has treated uniforms with permethrin as 1 mechanism to better protect their deployed personnel from arthropod bites. Treatments have been performed primarily in the field using several methods that either sprayed permethrin onto the uniform or by using an Individual Dynamic Absorption (IDA) kit where the uniform is placed in a bag with permethrin, water and an emulsifier. Recent changes in uniform fabric composition, especially the use of fire-resistant materials, have led to uniforms with a looser weave to enhance breathability when personnel wear these fabrics comprised of synthetics. This leads to increased probability that a mosquito can bite through the uniform. Another problem is that these fabrics absorb and retain less permethrin. Factory permethrin-impregnation of uniforms overcomes these issues by use of appropriate binders to retard permethrin loss and thereby provide a high level of protection from insect bites throughout the uniform lifetime. The U.S. Marine Corps completed the transition to all factory-treated Marine Corps Combat Utility Uniforms (MCCUUs) in March 2007. The U.S. Army has completed this transition with their Fire-Resistant Army Combat Uniforms (FRACUs) in October 2010. This talk will cover these successes along with the results of this testing (permethrin content and bite protection) of uniforms (U.S. Marine Corps, U.S. Army, and U.S. Air Force) evaluated over the past 5 years.

131 Biting inhibition efficacy of metofluthrin by new evaluation method
Takao Ishiwatari, ishiwatarit@sc.sumitomo-chem.co.jp, Masayo Sugano and Yoshihiro Takebayashi

Metofluthrin (commercial name: SumiOne®, Eminence®) shows extremely high knockdown and spatial repellent activity against mosquitoes not only in conventional heating emanators like coils and liquid vaporizers, but also in non-heating emanators like paper and resin. High repellent efficacy of metofluthrin with paper and resin emanators was presented in 2004, 2005 and 2008. Meanwhile, a new small-scale repellent evaluation method was presented in 2008, by which we can evaluate the relationship between aerial concentration of AI and repellency (biting inhibition activity) in the same condition. In this report, biting inhibition activity of metofluthrin was evaluated in this new method against 3 strains of *Aedes* mosquitoes and compared to its knockdown activity evaluated in the conventional method using test chambers. SumiOne and Eminence are registered trademarks of Sumitomo Chemical Company Limited.

Latin American Symposium III

132 Susceptibility and enzymes associated with malathion and deltamethrin in four populations of *Aedes aegypti* from Venezuela
Leslie Alvarez, hleslieag@hotmail.com, Milagros Oviedo, Gustavo Ponce and Adriana E. Flores

The LD_{50} was determined for malathion and deltamethrin in populations of *Aedes aegypti* from Tres Esquinas, Pampanito, Ureña and Lara, Venezuela using the bottle bioassay, as well as, resistance ranges (RR) compared to the insecticide susceptible New Orleans strain. The populations were selected with each insecticide and quantified α and β esterases, mixed function oxidases, insensitive acetylcholinesterase (IAChE) and glutathione S-transferase (GST) using the microplate technique. Montella´s criterion was applied and ANOVA and Tukey test of significance (α = 0.05) were evaluated. The LD_{50} to deltamethrin ranged from 0.027 to 0.053 µg/bottle. Mosquitoes from Lara, Tres Esquinas and Pampanito showed loss of susceptibility at this insecticide (RR 9.05X, 8.6X and 6.9X, respectively). The LD_{50} for malathion ranged from 1.2 and 4.3 µg/bottle. The low RR values indicated loss of susceptibility in Tres Esquinas, Ureña and Pampanito, on the other hand, Lara was resistant (RR 13.7X). *Betaesterasas* and a*lfaesterasas* were observed as an altered enzymatic mechanism associated with malathion resistance found in Lara, as well as GST with the loss of susceptibility to deltamethrin.

133 Breeding sites and seasonality of *Anopheles* species in the Puerto Carreño municipality, Vichada, Colombia
Juan S. Durán, sebastianklon_89@hotmail.com, Jan E. Conn and Helena L. Brochero

Puerto Carreño is endemic for malaria transmission because of appropriate geographical/ecological conditions combined with an influx of symptomatic individuals from surrounding rural areas. This study examined breeding sites using species composition, diversity and abundance during a 9-month period. Species identified were 170 *Anopheles marajoara* s.l., 68 *An. darlingi*, 67 *An. braziliensis*, 5 *An. oswaldoi* s.l. and 2 *An. argyritarsis*. During the rainy season, the predominant species was *An. marajoara* s.l.; *An. darlingi* was more common during the dry season. We inspected 21 mostly permanent breeding sites: 12 (57%) excavations, 3 (14.3%) lagoons, 3 small riverbanks, 2 (9.5%) flooded pastures, and 1 (4.8%) morichal palm pond. *Anopheles marajoara* s.l. (111/170) and *An. braziliensis* (60/67) were associated with excavations characterized by direct sunlight and scarce vegetation. *Anopheles darlingi* (52/68) preferred small shaded riverbanks with emergent vegetation, near dense vegetation patches. These excavations result from displaced people using soil for wall construction. During malaria outbreaks local intervention consists of biological control using *Bacillus sphaericus*. To avoid the establishment of urban malaria under such conditions, we recommend 1) control strategies be focused on surveillance for symptomatic people and 2) the creation of a bi-national program with Venezuela to offer diagnosis and adequate, immediate treatment.

134 Biological aspects of *Anopheles* spp. in Puerto Carreño, Vichada, Colombia
Irene P. Jiménez, pilarjimenez_7@hotmail.com, Diana C. Suárez, Jan E. Conn and Helena L. Brochero

Puerto Carreño, Colombia shares a frontier with Venezuela. The forced displacement of residents from rural to urban areas in search of better opportunities due to internal armed conflict, coupled with the recognition of anophelines in the town, has resulted in an increasing number of municipal malaria cases. Mosquitoes were collected using human landing catches indoors and outside dwellings between 18:00-06:00h for 50min/h for 2 consecutive nights/month for 8 months. We inspected urban breeding sites and analyzed malaria cases per month. The abundance of species collected was *Anopheles darlingi* (79.5%, n=949) followed by *An. marajoara* s.l. (15.6%, n=186) and *An. braziliensis* (5%, n=59). *Anopheles darlingi* had 2 peaks of biting activity: indoors (19h/20h; 21h/22h) and outdoors (19h/20h; 21h/22h) while *An. marajoara* s.l. had 1 peak indoors (18h-21h) and 2 outdoors (18h/19h; 20h-21h). There was no correlation between adult and larval abundance for either *An. marajoara* or *An. darlingi*. These results suggest that most transmission occurs early in the evening when people are not protected by nets. We recommend that malaria control strategies be focused on adequate diagnostics, immediate treatment for symptomatic people and control of immature forms in urban breeding sites. Adult mosquito control efforts should be undertaken during epidemic situations to interrupt transmission.

135 Parasitism of nematodes *Romanomermis iyengari* in breeding sites of *Anopheles pseudopunctipennis* in Oaxaca, Mexico
Rafael Perez, rperezp@ipn.mx, Gonzalo Flores, Sabino Martinez and Jaime Ruiz

We evaluated the application of parasitic nematodes *Romanomermis iyengari* in 3 malaria endemic communities in Oaxaca, Mexico. Previously, maps of the communities were made with all the breeding sites and the pre-treatmentdensity of mosquito larvae (density of mosquito larvae before the treatments) were determined. The parasite applications were made in all the breeding sites, which varied in size from 80-8240 m^2. Three days later the data of percentage of parasitism and intensity of infection were collected. Seven days after the application data were taken from density post-treatment of mosquito larvae. The application rate of 2,000 to 3,000 nematodes m^2 was used. Parasitism of mosquito larvae ranged from 71-100%, and the population reduction of the mosquito larvae varied from 79-88%. In 60% of breeding sites, *R. iyengari* was able to recycle and persisted in the breeding sites, so the application of nematodes controlled the populations of larval *Anopheles pseudopunctipennis*.

136 Cryopreservation of the mosquito parasite, *Romanomermis iyengari*
Rafael Perez, rperezp@ipn.mx, Edward Platzer and Bladley Hyman

The mermtihid nematode *Romanomermis iyengari* is a parasite of mosquito larvae and has a high potential for reducing mosquito populations. It is important to develop new technologies for the preservation and distribution of infectious material useful for mosquito control. We developed a cryopreservation procedure for preservation of mermithid nematode eggs. Initially, we evaluated the use of different sucrose concentrations to prevent *R. iyengari* egg hatching during isolation from maintenance culture medium. The efficacy of different dimethyl sulfoxide (DMSO) concentrations to prevent ice crystal formation during the cryopreservation process was also evaluated. The cryopreservation procedure was optimized with 0.34 M sucrose and 2.5% dimethyl sulfoxide. Samples of nematode eggs were stored in liquid nitrogen at -189°C and after 1 to 8 days of storage, egg samples were thawed and DMSO removed by washing. Egg hatching, nematode viability, and the infectivity of J2 stage nematodes to *Culex pipiens* and *Aedes aegypti* mosquito larvae was measured. Hatching occurred in most egg samples. In 4 cryopreserved preparations, preparasites emerging from frozen eggs successfully infected mosquito larvae. These results make available a new process for conservation of mermithid nematode species and provide a more reliable method for transporting infectious material to biocontrol sites.

137 Diversity of aquatic insects associated with larval breeding sites of Culicidae of medical importance in eight states of Mexico

J. G. Bond, gbond@insp.mx, Mauricio Casas-Martínez, Arnoldo Orozco-Bonilla, Humberto Quiroz-Martinez, Rodolfo Novelo-Gutiérrez, Armando Ulloa, Trevor Williams and Carlos F. Marina

This study was conducted to determine the abundance and diversity of aquatic insects associated with mosquito breeding sites in 8 Mexican states. An entomological survey was carried out in Guerrero, Oaxaca, Chiapas, Sinaloa, Nayarit, Michoacan, Jalisco and Colima states. All breeding sites were sampled and characterized. Aquatic insects were sampled with an entomological net and preserved in 96% ethanol, taken to the laboratory, and identified to genus and species using taxonomic keys. The diversity of aquatic insects was estimated using the Shannon index. The accuracy of index values was estimated by the Jackknife method and confidence intervals for the statistic were calculated by Bootstrap with replacement. A total of 321 collecting sites were registered. The total taxonomic richness consisted of 11 orders, 64 families, 173 genera, and 246 species (4,688 individuals) of aquatic insects. The highest diversity index was found in Chiapas State (3.71) and Michoacan (3.61) that did not differ significantly, followed by Sinaloa (3.54) that registered significantly lower aquatic insect diversity. Jackknifing indicated that diversity index values were slightly underestimated in all cases, but the magnitude of the error was small (1.18%). The most abundant culicid predators taken across all sampling sites were *Tropisternus* spp. (Coleoptera: Hydrophilidae), and the predatory bugs *Pelocoris* spp. (Hemiptera: Naucoridae) and *Ranatra* spp. (Hemiptera: Nepidae) that ocurred at frequencies of 47.7, 21.2 and 16.0 %, respectively.

138 Seasonal variation of *Lutzomyia antunesi* in a rural area of Villavicencio, Meta, Colombia

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Lutzomyia antunesi is the most abundant species in anthropic environments and gallery forests, and was the predominant species in the latest outbreak (with 15 cases) of cutaneous leishmaniasis in 2005 and was associated with cases reported in2009. The objective was to identify patterns of seasonal variation of *Lu. antunesi* in 3 habitats and their relationship with climatic factors. The study was conducted in 3 villages, where a house were selected according to pre-sample peridomestic abundance of *Lutzomyia*, a CDC light trap was installed on the inside, around and in the forest near each house for 3 consecutive nights each month from June 2008 to May 2009. Climatic data were obtained from the local Institute of Hydrology, Meteorology and Environmental Studies. ANOVA and Tukey test were used to determine the seasonal variation patterns of *Lutzomyia* populations, and Pearson correlation tests and linear regression were used to establish relationship between the abundance and climatic factors. On the results *Lu. antunesi* were found in the 3 catch areas and was the most abundant species 89.28% (19,587 of 21,937), followed by *Lu. walkeri* (5.09%), *Lu. panamensis* (2.26%), *Lu. flaviscutellata* (1.07%), *Lu. gomezi* (0.86%), and *Lu. fairtigi* (0.52%). Other results show that *Lu. antunesi* presents a seasonal variation and seasonality with significant differences ($P<0.01$) between the months of the dry season (December-April) and rainy season (May-November), Also, a positive correlation with minimum temperature ($P<0.01$), and a negative correlation with rainfall ($P<0.01$) were found and could be indicators of possible transmission times.

Global Perspective on the *Culex pipiens* Complex in the 21st Century IV

139 Members of the *Culex pipiens* complex as vectors of viruses

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Members of the *Culex pipiens* complex have been implicated as vectors of a number of arboviruses including St. Louis encephalitis, West Nile, Okelbo (Sindbis), and Rift Valley fever viruses. For some viruses, such as West Nile virus, laboratory studies have indicated that various members of this complex have a similar ability to become infected with and transmit virus, thus providing evidence for the similarity among the various members of this complex. On the other hand, although strains of *Cx. pipiens pipiens* from various parts of the world have all been relatively efficient vectors of RVFV, *Cx. pipiens quinquefasciatus* from Africa, Australia, and North America have been nearly refractory to this virus, thus indicating that the various members of this complex do not necessarily respond similarly to a particular arbovirus. This presentation will cover the importance of the *Cx. pipiens* complex as vectors of disease and similarities and differences in their responses to different viruses.

140 To bite or not to bite: Blood-feeding patterns of the *Culex pipiens* complex mosquitoes in the USA

Goudarz Molaei, Goudarz.Molaei@ct.gov, Shaoming Huang and Theodore G. Andreadis

Eco-epidemiological studies of vectors-hosts interactions are of importance for understanding of transmission dynamics of mosquito-borne viruses. We investigated host-feeding patterns of *Culex pipiens* complex mosquitoes as important vectors of human pathogens by taking advantage of mitochondrial *cytochrome b* gene. We found that *Cx. pipiens* predominantly feed on avian hosts (93%) and focus their feeding activity on several key bird species in particular, American robins, gray catbirds, and house sparrows in the northeastern U.S. *Culex quinquefasciatus* indiscriminately feed on both birds and mammals in southern U.S. In Texas, *Cx. quinquefasciatus* acquired 39.1% of blood meals from birds, 52.5% from mammals, and 8.3% mixed from avian and mammalian hosts. The most frequent avian hosts were mourning doves, white-winged doves, house sparrows, and house finches. In southern California, *Cx. quinquefasciatus* obtained 88.4% of blood meals from avian and 11.6% from mammalian hosts, including humans. House finches, house sparrows and other mostly Passeriformes birds were among frequent hosts and likely play important roles in maintenance and amplification of arboviruses in this region. Epidemiological

significance of spatio-temporal variations in host feeding patterns of *Cx. pipiens* complex mosquitoes and relative contribution of vertebrate hosts to disease maintenance and amplification will be discussed.

141 The contribution of *Culex pipiens* complex mosquitoes to transmission and persistence of West Nile virus in North America

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Mosquitoes within the *Culex pipiens* complex have been implicated as major vectors of West Nile virus in North America because of their seasonal abundance, vector competence and high field infection rates. However, the role of *Cx. pipiens* complex mosquitoes in enzootic amplification of WNV among avian hosts and epidemic transmission to humans varies throughout its geographical distribution. In the northeastern US, *Cx. p. pipiens* is recognized as the primary enzootic vector responsible for amplification of virus among wild bird populations. However, because it is strongly ornithophilic, its role in transmission to humans appears to be limited. In the northcentral and mid-Atlantic states by contrast, *Cx. p. pipiens* shows an increased affinity for human hosts and has been incriminated as a key bridge vector. The involvement of *Cx. p. pipiens* form "molestus" in WNV transmission is largely unknown, but human-biting *Cx. p. pipiens* are more likely to have a molestus genetic signature. In southern regions of the U.S., *Culex p. quinquefasciatus* and hybrids are more opportunistic feeders, and are thought to be principal enzootic and epidemic vectors. In western regions of the U.S. where *Culex tarsalis* predominates, especially in rural areas, *Cx. p. pipiens* and *Cx. p. quinquefasciatus* play much limited roles and are recognized as secondary vectors. The detection of WNV from overwintering populations of *Cx. p. pipiens* and their role in local overwintering of WNV will also be discussed.

Adult Control II and Aerial Control/Aviation

142 Development and testing of modified bioassay cage

Bradley K. Fritz, brad.fritz@ars.usda.gov and Clint Hoffmann

Bioassay cages are an essential component for evaluating the efficacy of novel adulticides and/or novel application methods or technologies. Previous evaluations of the available bioassay cages have shown that the structure of the cages can significantly reduce the both the air and spray volume that penetrate into cage resulting in the insects within the cage being exposed to different concentrations of spray as compared to outside cage levels. The level of reduction in airspeed and spray volume penetrating the cages is dependent on the ambient airspeed with greater reductions at lower ambient airspeeds. To overcome these reductions, a new bioassay cage modification has been developed and tested. The new cage modification was structured such that the volume of spray laden air approaching the front face of the cage is increased resulting in air velocities and spray volumes inside the cage that are similar to those outside of the cage. The new cage modification will allow researchers to directly correlate caged insect mortality levels to drifting spray concentrations outside of the cage.

143 Dose response of mosquito mortality from wind tunnel evaluation

Bradley K. Fritz, brad.fritz@ars.usda.gov and Clint Hoffmann

Past research has shown that the volume of air and spray material that penetrate into insect bioassay cages is a function of both the cage structure and the ambient wind speed. With differing amounts of spray and air penetrating, when applications are made under multiple wind speeds, correlating efficacy with insect mortality becomes difficult. This study looks at several adult control formulations applied at rates from 1/10 to full rate in a low speed wind tunnel with an air assist nozzle used to generate 2 droplet sized sprays. Bioassays are conducted using the different spray treatments under multiple tunnel airspeeds. Spray flux entering the cage is determined using previously collected data documenting the spray and air penetration through the cage. Mosquito mortality is correlated with applied spray and with the actual spray penetration into the cage. The results will provide field researchers with guidance on correlating the measured spray movement across an area with the biological control determined from the caged bioassays.

144 Genetic control of *Aedes aegypti*: Evaluation of RIDL® technology in open field trials

Angela Harris, Derric Nimmo, Andrew McKemey, Bill Petrie and Luke Alphey

Oxitec has developed strains of *Aedes aegypti* and *Aedes albopictus* which are homozygous for one 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. In 2009 and 2010, field releases of RIDL *Aedes aegypti* were conducted in a small town in the Cayman Islands. An initial range finding trial was conducted in 2009 with approximately 19,000 male RIDL mosquitoes released over a 4-wk period. Monitoring was conducted using ovitraps and BG sentinels. Results showed that RIDL males could compete well with WT males for WT females under field conditions. In 2010, a suppression program was initiated over a 7-month period. Approximately 150,000 RIDL males were released per week over the 55 ha site. We will present data showing the successful suppression of a wild population of *Ae. Aegypti* using the RIDL technique.

145 Laboratory evaluation of prallethrin as an active ingredient of DUET™ against *Aedes aegypti* and *Aedes albopictus*

Gary G. Clark, gary.clark@ars, usda.gov, Frances V. Golden, Sandra A. Allan and James R. McNelly

Prallethrin, one of the two active ingredients in DUET™, has previously been shown to activate *Culex quinquefasciatus* females in the laboratory resulting in greater mortality. In this study, formulations of DUET™ prepared with and without prallethrin were evaluated in a wind tunnel with unfed and bloodfed *Aedes aegypti* and *Aedes albopictus* females. Formulations were delivered in a spray cloud of ULV droplets in a wind tunnel and the responses of individual mosquitoes were videotaped. Videotapes were analyzed using several behavioral analysis programs (e.g., Observer, Ethovision, Motus) and various parameters of flight (e.g., flight speed, duration, turning) were evaluated to determine the impact of the pesticide exposure. Comparisons of mortality at 8 h were made between the different formulations for each species. Results of this evaluation and their implications for field applications will be discussed.

146 Where does the spray go? Penetration and droplet characterization of an adulticide application using DUET™ via truck-mounted ULV equipment in an urban environment

Ary Farajollahi, afarajollahi@mercercounty.org, Sean P. Healy, Isik Unlu, Taryn Crepeau, Dina M. Fonseca, Randy Gaugler and Scott C. Crans

Control of *Aedes albopictus*, the Asian tiger mosquito, is problematic because larval sources are difficult to access and ubiquitous in urban/suburban habitats, and adult control measures are transient at best. Operational adulticide applications are also conducted primarily at night when *Ae. albopictus* may not be active and possibly resting in cryptic habitats such as underneath porches or in vegetation. We conducted truck-mounted ULV field trials using DUET™ (dyed with Uvitex) within an urban setting (75 acres consisting of 1,122 parcels) to evaluate penetration and characterize sprayed droplets. Six randomly assigned parcels were chosen within the site, and 3 locations were chosen within each parcel (front of home, middle foyer between adjacent row homes, and back yard). At each location, a ground level (1 ft) rotary slide impinger (Florida spinner) was used to collect droplets. We present our findings on penetration, density, and size of DUET droplets within these habitats after an operational spray application.

147 Effect of ULV aerial adulticide applications on honey bee mortality in Natrona County, WY

Ashley Fulton, ashleyraefulton@hotmail.com, John Lehman, Dean Gaiser and Keith Haas

An ongoing concern for some beekeepers in Natrona County has been a perceived potential for aerial adulticiding operations to have a negative effect on honey bee (*Apis mellifera*) colonies. Although efforts are made to time adulticide applications late enough in the evening or early enough in the morning to avoid contact with actively foraging bees, local conditions do not always allow this. In addition, some beekeepers believe that even aerial adulticides applied late enough to avoid active foragers are causing an increase in bee mortality. In an effort to better understand this issue, a preliminary field study was conducted in late June 2010. Zenivex® E20 (etofenprox) and Fyfanon® (malathion) were aerially-applied on separate nights and treatment blocks to areas that had commercial honey bee hives present. Caged mosquitoes were placed inside and outside the treated areas along with spinning droplet impingers using 3 mm slides (co-located with bee hives as well) to measure mosquito control, droplet VMD, and drops/sq cm. Todd dead-bee traps were used to evaluate bee mortality. There was no apparent increase in bee mortality from either treatment. Both Zenivex® and Fyfanon were effective in reducing adult mosquitoes (primarily *Culex tarsalis*). Peak adult mosquito activity was determined to be between 9:00 P.M. and 10:00 P.M.

148 Atomization of public health pesticides under aerial application conditions

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

When large areas need to be sprayed to control mosquitoes, aircraft are used since they can cover thousands of acres in a single night. These aircraft use a variety of spray nozzles and pesticides to make effective spray applications. It is important that applicators have a thorough understanding of the spray droplet size they are producing with their sprays; therefore, studies were conducted in a high speed tunnel to measure the droplet size from different spray nozzles and formulations. The airspeed during these tests varied from 120 to 215 mph. The information from these tests will allow users to select the spray nozzle that produces the droplet size spectra required for efficacious spray applications.

149 Integrating AGDISP and CALLLPUFF for aerial applications in mosquito control

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This presentation discusses the integration of an aerial pesticide dispersion model AGDISP with an air quality model CALLPUFF. There is a need for AGDISP to have a more sophisticated extension into the far-field (>500m downwind). AGDISP models the behavior of aerially released material from a wide range of aircraft. Released spray material is modeled as a discrete set of droplets, aggregated into categories. Each drop size category is defined by its average diameter and volume fraction, and is examined sequentially. A single droplet Lagrangian approach is used to model one droplet of each size bin calculating trajectory using a wake driven vorticity equation and subsequently aggregating and accounting for the total mass. The droplets descend toward the ground, with evaporation accounted for during this transit. CALPUFF is a non-steady-state meteorological and air quality modeling system that considers complex terrain and space-time varying meteorology. CALPUFF is being used for a wide variety of air quality modeling studies, and is a comprehensive modeling tool that includes meteorological and geophysical data

processors, a meteorological model, a puff-based dispersion model, and post-processing modules. The integration of the 2 models will allow detailed measurement of near field wake in combination with responsive real time meteorological and terrain dispersion modeling.

150 Aerial application of Anvil® 10 + 10 ULV for the control of eastern equine encephalitis in southeastern Massachusetts

Priscilla Matton, brismosqpc@comcast.net and Wayne Andrews

An aerial application of Anvil® 10 + 10 ULV was made to approximately 284,000 acres in southeastern Massachusetts to control eastern equine encephalitis. The application was conducted over 3 nights from August 5-7, 2010. Pre- and post- trapping resulted in an 80% overall reduction in the mosquito population and a 90% reduction in mammal biting mosquitoes.

Latin American Symposium IV

151 Efficacy of high resolution satellite imagery to detect *Anopheles albimanus* habitat in Haiti

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In the Artibonite Valley of Haiti, the peak in human malaria appears to be closely related to precipitation, lagging behind the peak of the rainy season by 2-3 months. Precipitation-mediated malaria suggests that spatial expansion of larval habitats and high abundances of mosquitoes may be necessary for epidemic human malaria in this region. During the height of the rainy season (from July 21-29), standing water was surveyed across 3 elevation strata (valley floor, foothills, and mountains) in a 16km^2 scene centered on Deschappelles, Haiti. The spatial extent of all standing water within this small test area in the upper Artibonite Valley was then mapped using 40 cm resolution Geoeye imagery, acquired on 18 August 2010. A hybrid supervised classification workflow was developed to delineate potential *Anopheles albimanus* habitats, including: wet agricultural lands, seasonal pools and wetlands, and drainage ditches. Building rooftops were also delineated to quantify host population distribution in Deschappelles. A quantitative accuracy assessment showed varying thematic accuracies among land cover classes ranging from < 50% (drainage ditches) to >80% (rice fields). Efficacy of the high resolution imagery to detect these epidemiologically important surface features is discussed. The ability to accurately depict and quantify the spatial footprint of potential larval habitats is central to determining the relationship between larval habitat expansion and the transmission of malaria in Haiti.

152 Malaria vectors involved in the urban transmission in Miraflores, Guaviare, Colombian Amazonia

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Miraflores, a municipality in of the Department of Guaviare is located at 213 m above sea level and has rainforest characteristics and tropical wet forest. The urban area is located on the left bank of Vaupés River. Drastic changes in the ecosystem have cut and burned the forest for crops and livestock have led to risk factors that favor urban malaria transmission. Miraflores has the highest annual parasite index (103 cases x1,000 inhabitants) for malaria in Guaviare; with transmission of *Plasmodium vivax* (63 cases x 1,000 inhabitants); *P. falciparum* (39 cases x 1,000 inhabitants); and mixed malaria recording an endemic channel that shows a permanent state of outbreak. In the urban area, anophelines were captured using human landing catches indoor/outside dwellings between 1800h and 0600h for 50 min/h for 2 consecutive nights in dry and rainy season. The predominant species was *Anopheles darlingi* (80%) and followed by *An. marajoara* sensu lato (15%) and *An. oswaldoi* (5%). *Anopheles darlingi* were caught throughout the night, with 2 peaks of biting activity: indoors: (1900h/2100h) and (0100h/0200h) and outdoors (2000h-21:00h) and (0400h-0600h), showing an endophilic and endophagic behavior. The main anopheline oviposition sites were inspected and 15 urban breeding sites were characterized: excavations (n= 8), small riverbanks (n=6), and lagoon (n=1). In the rainy season, the water levels of Vaupés River rose, flooding the municipality and forming one great breeding ground for malaria-carrying mosquitoes. Based on epidemiological data, malaria case occurrence was analyzed every month for the last 5 yrs. An inverse relationship between the number of malaria cases and rainfall was found and the highest rate of transmission is recorded in the dry season. With epidemiological data, geographic maps, environmental, socioeconomic and entomological characteristics, there was a focus on the risk of urban transmission discriminated against in high, medium, and low as an important input for decision-making vector control. Actions should be strengthened to ensure proper diagnosis and treatment for malaria, through the training of primary health care personnel.

153 Natural infectivity by *Plasmodium* spp. in *Anopheles nuneztovari* s.l. and *Anopheles darlingi* from Córdoba, Colombia

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In the Department of Córdoba, located in northwestern Colombia, malaria is an important public health problem, reporting approximately 30% of the total confirmed malaria cases/year in Colombia. Because little entomological information is available in this region, the aim of this work was to determine *Anopheles* species composition and natural infectivity of mosquitoes collected in 5 municipalities presenting the highest number of malaria cases of Córdoba. A total of 7,477 *Anopheles* mosquitoes belonging to 9 species were collected using human landing catches in several field trips carried out from 2005 to 2010, which corresponded to *An. nuneztovari* s.l. (59.1%), *An. albimanus* (24.8%), *An. pseudopunctipennis* s.l. (10.5%), *An. triannulatus* s.l. (2.9%), *An. darlingi* (1.8%) and 4 other species at <1%. Two species were found to be naturally infected by *Plasmodium* spp., as determined by ELISA

and confirmed by nested PCR. *Anopheles nuneztovari* s.l. was infected with *P. falciparum* (n= 1), *P. vivax* VK210 (n=3) and *P. vivax* VK247 (n= 1), infection rate of 0.210% (IC 95%: 0.068-0.489), and *An. darlingi* infected with *P. vivax* VK247 (n=1), 1.250% (IC 95%: 0.032-6.769). This study provides basic information about the role of these species in malaria transmission.

154 Malaria entomological inoculation rates in the Lower Caura River Basin, Bolivar State, Venezuela

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Malaria is a public health problem in Bolívar State, southern Venezuela, where 85% of total cases in the country are reported and most municipalities are considered at high risk for malaria transmission. A longitudinal study was conducted in 3 riverine selected villages: Surapire, inhabited by ameriandians of the Ye'kwana ethnic group, El Palmar, inhabited by the Sanema ethnic group and Jabillal inhabited by "criollos". Every 2 months, mosquitoes were collected from sunset to sunrise during 3 consecutive nights in each village using CDC light traps and Mosquito Magnet™, and in Jabillal human landing catches were also conducted between 1800 and 2200 h. The following morning mosquitoes were killed, identified and kept dry over silica gel. A total of 2,573 mosquitoes collected by all 3 methods representing 6 species were assayed by ELISA and 2 pools, equivalent to 2 *Anopheles darlingi*, yielded positive for *Plasmodium vivax* CS protein. The mean biting rate for *An. darlingi* was 44.1 and the sporozoite rate was 0.19%. The estimated entomologic inoculation rate (EIR) for *An. darlingi* was 8.38 infective bites/person/year. Funded by IDRC #103696-006.

155 The length of the gonotrophic cycle of *Anopheles darlingi* Root 1926 (Diptera: Culicidae) under controlled laboratory conditions

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Increases in ambient temperatures have been associated with increases in malaria transmission in Colombia. The purpose of this study was to evaluate the effects of temperature on the gonotrophic cycle length of the main malaria vector in Latin America, *Anopheles darlingi*. Mosquitoes were collected with the human landing capture technique and transported alive to the laboratory. After arrival, blood was provided and fully fed females were selected and kept in climate chambers at 24, 27 and 30°C. Bloodfed females were held in a container with water for oviposition, and assessed at 12 h intervals. The mean duration of the gonotrophic cycle was 5.0 d (CI95% 4.79-5,21), 4.36 d (4.22-4.49), and 3.64 d (3.44-3.83) at 24, 27 and 30°C, respectively. A 3°C rise in temperature produced a reduction of about 1 day in the length of the *An. darling* gonotrophic cycle. These results are being used in Colombia by the Integrated National Adaptation Program Project (INAP) to fine-tune the parameters of dynamic malaria models in order to better estimate the malaria basic reproductive rate. According to these results, increases in temperature related to global changes in climatic conditions are likely to enhance the vectorial capacity of this primary malaria vector and hence, could lead to a further increase in the incidence of this disease in Colombia.

156 Anthropophilic biting activity of *Anopheles* (*Kerteszia*) *neivai* Howard, Dyar & Knab, associated with the activities of fishermen in a malaria endemic area in the Colombian Pacific

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On the southwest Pacific coast of Colombia, a field study was initiated to determine the human-biting activity of *Anopheles* (*Kerteszia*) *neivai* in places frequented by fishermen, including nearby houses. Mosquitoes were collected over 24 h periods and during period of biting activity in mangrove swamps, marshlands, fishing vessels in three locations, and outdoors and indoor houses. A total of 4,745 mosquitos were collected. *An. neivai* represented the 78.4% (3,721) and *An. albimanus* the 21.6% (1,024). *Anopheles neivai* was most abundant in the mangroves and vessels (90.8%), while *An. albimanus* represented the 82% indoors, and 73% outdoors of the houses. In the mangroves and fishing vessels, *An. neivai* showed biting activity throughout the day, with a peak between 1800 - 1900h (52.7 mosquito per man-h), and 2 minor peaks, 1 between 2100 - 2300h (13.1 per man-h), and other between 0500 - 0600h (4.9 per man-h). These peaks coincided with fishing activities in the marshlands and mangroves, a situation that puts the fishermen at risk of acquiring malaria during fishing activities. It is recommended that protective measures be implemented to reduce the risk of the fishermen getting malaria during their activities.

157 Current state of susceptibility of *Anopheles albimanus* Wiedemann (Diptera: Culicidae) to insecticides in Guapi, Cauca, Colombia

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Because of the selection pressure caused by the application of chemical insecticides on insect populations, they have developed resistance. For the control of *Anopheles albimamus* in Guapi different insecticides have been used. It is unknown if the pressure to which have been subjected their populations has generated resistance, therefore, we assessed the susceptibility of this species to public health insecticides to determine which of them can be used in this area of the Department of Cauca and establish alternative measures for the vector control by the Vector Control Program. During 2009, we conducted biological tests using the CDC bottle assay methodology and evaluated the diagnostic dose for deltamethrin (12.5 µg/ml), lambdacyhalothrin (12.5 µg/ml), alphacypermethrin (12.5 µg/ml), malathion (100 µg/ml), fenitrothion (50 µg/ml), permethrin (1 µg/ml), and DDT (50 µg /ml) in *An. albimanus*. This population was susceptible to all insecticides evaluated with the exception of DDT, to which introduced loss of

susceptibility from 77% to time diagnosis of 45 min. The application of chemical insecticides as the main control measure for malaria in Guapi has only generated resistance to DDT in local mosquito populations, so officials can continue using lambdacyhalothrin and residual deltamethrin and use long lasting insecticide-treated nets whose active ingredients are pyrethroids

158 Detection of Kdr (1014) mutation in *Culex quinquefasciatus* Say from Nuevo León, México

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The knockdown resistance (Kdr) target site to 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* Say is an important vector of different encephalitis viruses. We analyzed strains of *Cx. quinquefasciatus* from Nuevo León State, México. In this study, using polymerase chain reaction (PCR), a molecular tool based on test genomic DNA of each mosquito samples, we found the Kdr mutation (leucine to phenylalanine at position 1,014) was present in some samples. Currently, the major emphasis in resistance research is on the early detection of the molecular mechanisms of resistance for rational resistance management, with a view to controlling the development and spread of resistance in vector populations through better planning of insecticide usage.

159 Blood feeding arthropods from National Natural Park Laguna del Otún, Colombia

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The Paramo ecosystem ranges in Latin America from Costa Rica to Chile. In Colombia, there are few studies about the blood feeding fauna inhabiting this ecosystem. This work reports the hematophagous fauna found in Laguna del Otún. CDC light traps baited with CO_2, CDC traps with UV, and an oil trap were used in the field. In some cases, in order to capture a swarm, the CDC inverted trap was used in addition to human landing collections.For immature stages of Simuliidae, streams were checked while standing water was checked for Culicidae. Ectoparasites were collected on some birds. A total of 125 adults were collected: 111 were identified as *Culicoides marinkelli*, 3 were *Simulium rubiginosum*, 4 were *Gigantodax misitu*, 4 were *G. arreartorum*; and 24 *Aedes* spp. larvae of mmature black flies were identified as *G. misistu*, *G. arreartorum*, *S. stelliferum* and *S. mariavulcanoae*. Two *Ixodes* spp. ticks were collected from birds. From this information is important to determine their hosts and their role in the transmission of vector-borne pathogens to wild fauna.

160 Improvement of caged-mosquito field bioassays utilizing a modified wind-sensitive vane

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Caged-mosquito field bioassays are an important tool for corroboration of ULV adulticide efficacy. Such work is vital to the mosquito control and research communities. However, comparable demonstration research is also used, with slight variation, in agriculture and other public health related fields. During 2009 and 2010, a review of field equipment and methodologies associated with caged mosquito trials took place, including incorporation of a previously published wind-sensitive vane used to auto-correct the position of bioassay cages. Several simple improvements enhance the vane described by Vessey and facilitate the caged-mosquito field bioassay process. Data from demonstration research performed in both Arizona and Texas using Duet™ will be presented to highlight the value of the improved "Vessey Vane".

161 Infectivity of nematode *Strelkovimermis spiculatus* in *Culex quinquefasciatus* mosquito larvae

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We evaluated the effect of parasitic nematode *Strelkovimermis spiculatus* against mosquito larvae of *Culex quinquefasciatus*. To evaluate the parasitic capacity of *S. spiculatus*, 5 doses of nematodes were applied (20, 15, 10, 5 and 3:1); the percentage of parasitism (PP) and intensity of infection (IINF= number of nematodes per mosquito larva) was determined. A PP of 100% was recorded for 5 doses and IINF of 11.15, 9.65, 7.05, 4.20, 2.65 at doses 20, 15, 10, 5 and 3:1, respectively. To evaluate the effect of different doses of *S. spiculatus* nematodes in breeding sites of 1 m^2, 500 2nd instar mosquito larvae were applied in 3 different doses (1,000, 3,000 and 5,000 nematodes/m^2). A PP of 100, 97.5 and 80% and IINF of 5.4, 3.5, and 1.2 nematodes were registered with the doses of 5,000, 3,000 and 1,000 nematodes per m^2, respectively. To evaluate nematode recycling in breeding sites of 1 m^2, 500 2nd instar mosquito larvae and 5,000 nematodes were applied (dose 10: 1) for a period of 24 wk. We observed the recycling of the nematode, obtaining PP of 12.5 to 100% and MI from 0.13 to 18.43 nematodes per mosquito larva.

162 Evaluation of a low-cost trap for the surveillance of mosquito vectors in Escobedo, Nuevo Leon, Mexico

Maricela Laguna-Aguilar, laguna_qbpc@hotmail.com, Olga S. Sanchez-Rodriguez, Marcela S. Alvarado-Moreno, Rosa M. Sanchez-Casas, Ildefonso Fernandez-Salas and Eduardo A. Rebollar-Tellez

Vector surveillance of dengue fever has been hampered by the lack of an effective trap that is inexpensive and noninvasive. Carbon dioxide microbial and affordable materials are options analyzed in this study. The aim of this investigation was design a trap using affordable materials, a bait of low cost and local production potential. MAS-Trap (Mosquito Adult Small Trap) is a black plastic box with a funnel top, a collection bag and a motor. The bait is a mixture of water, sugar and bakers yeast. Field trials were conducted in northeastern Mexico. We conducted a randomized block design using 3 treatments (trap with bait, trap without bait, and trap with sugar water) in 5 blocks. Three traps were placed outside the home for 24 h with the different treatments after which the number of mosquitoes that were caught was recorded. Differences were observed in trap collection efficiency between blocks

(F=9.8) and treatments (F=3.5). The addition of microbial bait did not increase the efficiency of the traps. The trap without attractant had the highest collection mean. The analysis was performed in the statistical package SPSS with P = 0.05 effectiveness. Under these conditions, MAS-Trap has the potential to become an effective tool for collecting mosquitoes indoors and outdoors. It can be produced at a low cost by local vector control programs and it can be operated with a minimum expenditure of energy. The MAS-Trap will now be tested in field areas with different indices of infestation.

163 Frequency of the KDR ILE1,016 mutation in *Aedes aegypti* (Diptera: Culicidae) in Mexico
Quetzaly Siller, qksr75@gmail.com, Gustavo Ponce, Adriana E. Flores and Aldo Ortega

The kdr Ile1016 mutation was discovered in strains of *Aedes aegypti* resistant to permethrin on Isla Mujeres, Qunitana Roo Mexico and recent studies have reported the presence of this mutation in mosquitoes from different localities in Mexico, as well as an increase in the frequency of this mutation from 1997 to 2009. To determine the frequency of the Ile1,016 mutation as well as its genetic equilibrium according to the Hardy-Weinberg principle, 790 *Ae. aegypti* mosquitoes from 14 localities of Mexico were sampled from 2007 to 2009. The DNA was extracted from each mosquito using the salt technique and PCR was performed to amplify the wild-type allele (Val1,016) and the mutated allele (Ile1,016), which confers resistance to permethrin. A X^2 test was carried out to determine the genetic equilibrium for the locus studied. We found that the Ile1,016 mutation was present in the 17 strains studied, 3 of which had the hig frequencies: ACA9 (0.97), IGU9 (0.9265) and SAN9 (0.90). The strains PAN7, VER7, COS9, COA9, TAN9 and MTY9 showed genetic disequilibrium. The presence of the high frequencies of the Ile1,016 mutation in *Ae. aegypti* is due mainly to the selection pressure of pyrethroid insecticides, particularly permethrin.

Washington Conference Workshop

164 Overview
Douglas Carlson, doug.carlson@irmosquito2.org

The annual Washington Conference provides AMCA members and supporters the opportunity to convene in Washington, DC, learn about the legislative and regulatory issues confronting mosquito control and personally meet with elected representatives and regulatory officials. This helps ensure that AMCA voices are heard in Washington and that we gain support for mosquito control initiatives that enable us to better protect public health. Several important issues face mosquito control agencies throughout the United States that will immediately affect our operations. At this session, critical legislation and issues will be identified and strategies will be provided for successful personal meetings with legislative representatives to help assure the best outcomes for public health programs. This session will include tips for interacting with elected legislators (House and Senate) and regulatory officials, along effectively communicating the message of our position papers to these representatives.

West Nile Virus 2010: National Summary and Arizona Epidemic

165 National West Nile virus summary
Roger S. Nasci, rsn0@cdc.gov, Nicole Lindsey, Jenn Lehman, J. Erin Staples and Marc Fischer

West Nile virus remains widespread in the United States. The number of human cases increased in 2010 over reports from the previous year. This presentation will summarize available 2010 WNV surveillance data, and discuss human cases, viremic blood donors, estimated number of infections and county-level incidence patterns with reference to previous years. In addition, the national funding situation for arbovirus surveillance and the ArboNET system will be updated.

166 Overview of West Nile virus in Arizona: 2003-2010
Craig Levy, levyc@azdhs.gov, Tasha Stewart, Michael Fink, Christine Wampler, Cindy Yu, Tammy Sylvester, Andi Bunko Patterson and Graham Briggs

The goal of this presentation is to give a brief overview of the history of West Nile virus (WNV) in Arizona from 2003 - 2009, including descriptions of the statewide surveillance program, transmission ecology, and outbreaks and trends observed during this time. Also discussed will be the intense WNV activity and outbreak which occurred in 2010 causing Arizona to lead the nation in number of human cases.

167 Maricopa County Mosquito Surveillance and Control
John Townsend, Jtownsen@mail.maricopa.gov, Kirk Smith and Dan Damian

Maricopa County is 9,224 mi^2 in size making it the 14^{th} largest county and 4^{th} most populous in the United States. Maricopa County's vector surveillance is comprised of over 500 weekly adult mosquito sampling locations and 2,600 monthly larval sampling locations. During our 2010 WNV season, over 6,000 adult mosquito samples were collected and tested for the presence of WNV. Our adulticide operations are based on collecting 30 or more *Culex* females per trap per night and/or RAMP results > 30. For *Cx quinquefasciatus* we had 122 numerical in excess of that level and 231 positive RAMP samples and for *Cx. tarsalis* we had 74 numerical in excess of that level and 82 positive RAMP samples. As a result of this surveillance data, 264,570 acres were adulticided by truck mounted ULV foggers.

168 Assessment of spray efficacy and resistance status during an outbreak in Maricopa County, AZ
Janet McAllister, jvm6@cdc.gov, Mariah Scott, Kirk Smith and John Townsend

Caged field trials using *Culex quinquefasciatus* and *Culex tarsalis* were conducted to evaluate efficacy of a permethrin based product on mosquitoes collected during an outbreak of West Nile virus in Maricopa Co., AZ. Overall mortality in the field trials was less than 40% on *Cx. tarsalis* at .0035 lb/acre and less than 50% at .007 lb/acre. Mortality at the high label rate was higher for *Cx. quinquefasciatus*, overall 76%. Subsequent testing of mosquitoes in the lab for resistance using a variety of methods demonstrated resistance in the population to permethrin, resmethrin, sumethrin and malathion with both altered target site and metabolic resistance as the underlying mechanisms.

169 West Nile virus disease outbreak and case-control investigation: East Valley of the Phoenix metropolitan area, AZ, May 25-July 31, 2010
Katherine B. Gibney, igj6@cdc.gov, James Colborn, Steven Baty, Andrean Bunko-Patterson, Tammy Sylvester, Graham Briggs, Tasha Stewart, Craig Levy, Ken Komatsu, Katherine MacMillan, John-Paul Mutebi, Marc Fischer and J. Erin Staples

Beginning in May 2010, a marked increase in mosquitoes infected with West Nile virus (WNV) and subsequent human infections were noted in the East Valley of the Phoenix metropolitan area. This occurrence of human and mosquito infections remained in a very localized area. We performed a case-control study to evaluate modifiable risk factors for WNV infection and identify possible public health interventions. A case was defined as an East Valley resident with laboratory evidence of WNV infection on specimens collected between May 25 and July 31, 2010. A control was defined as an East Valley resident who was evaluated during this same period but had negative laboratory testing for recent and previous WNV infection. Cases and controls were identified through active surveillance for 1) WNV disease cases or asymptomatic blood donors reported to the county or state health departments, and 2) WNV testing ordered at local hospitals or laboratories. We conducted telephone interviews and household assessments to evaluate patient demographics, behavioral risk factors, and household characteristics. Additional data sources were used to define possible community environmental risk factors (e.g., reported green pools and irrigation systems). This presentation will describe the findings from the case-control study.

170 Entomological assessments during the 2010 West Nile virus outbreak in Maricopa County, AZ
James M. Colborn, jcolborn@cdc.gov, Kristen L. Burkhalter, Marvin S. Godsey and John-Paul Mutebi

During an intense outbreak of West Nile virus (WNV) disease in Maricopa County, AZ, mosquitoes were collected from 31 July - 9 August 2010, using CO_2-baited CDC light traps and CDC gravid traps. Twelve collection sites were utilized: 6 in Gilbert and Queen Creek, the focus of the outbreak, and 6 in the Glendale/Peoria area, an area with low WNV transmission and no reported human cases. A total of 10,876 mosquitoes were collected, comprising 7 species. Species composition and density varied by site. Significantly more *Culex quinquefasciatus* females were collected by gravid traps than by light traps (191.3 per trap night [TN] vs. 13.1 per TN). More *Cx. quinquefasciatus* females were collected by all traps in Gilbert/Queen Creek (148.8 per TN) than in Glendale/Peoria (55.5 per TN). Twenty-three WNV TaqMan RT-PCR positive mosquito pools were identified, including 19 *Cx. quinquefasciatus* pools, 3 *Psorophora columbiae* pools, and 1 *Cx.* sp. pool. No virus was detected in *Culex tarsalis. Culex quinquefasciatus* WNV infection rates and Vector Indices were 11.37 (95% CI= 6.20 - 19.50) and 2.1, respectively, in Gilbert/Queen Creek and 13.94 (95% CI = 5-89 - 28.92) and 0.77 in Glendale/Peoria. Our data suggest that *Cx. quinquefasciatus* was the epidemic vector.

171 Vertebrate amplifiers of West Nile virus in suburban Phoenix, 2010
Nicholas Komar, nck6@cdc.gov, Nicholas A. Panella and Ginger Young

To evaluate the important vertebrate amplifying hosts for West Nile virus (WNV) following the encephalitis outbreak in Pheonix during 2010, we first assessed the seroprevalence patterns in common birds, primarily house sparrows and mourning doves. Seroprevalence (S) was combined with population estimates (P) and vertebrate reservoir competence index values (C) to generate estimates of the mosquito inoculation rate, M, for each candidate amplifying host, using the relationship M=(P)(S)^2(C), where S is a surrogate for infection rate. S was measured by blood-sampling birds captured in mist-nets. An alternative measure of S was derived by analyzing mosquito bloodmeals for specific anti-WNV reactivity in individual mosquitoes that were fully engorged with fresh blood that was linked to a vertebrate host by DNA analysis. These 2 measures of S were compared for sparrows and doves. Both sparrows and mourning doves roost communally at night when *Culex quinquefasciatus* and *Culex tarsalis* are host-seeking. Resting and host-seeking *Culex* mosquitoes were captured at sparrow roosts and non-roost control sites. WNV infection rates were compared for roost and control sites to evaluate whether communal roost sites were associated with elevated mosquito infection rates.

172 Characterization of West Nile virus isolated in the 2010 Arizona outbreak
John-Paul Mutebi, Grv0@cdc.gov, Marvin S. Godsey, Kristen L. Burkhalter and Bethany N. Swope

West Nile virus (WNV) isolates obtained from mosquitoes collected in the 2010 Maricopa County WNV outbreak were sequenced and analyzed to determine how this virus compares to other strains circulating in the U.S. and worldwide. Genetic relationships among the isolates and between the isolates and other strains of WNV are presented and discussed.

Biology and Behavior

173 Observations on flowering plants in north central Florida that might serve as nectar sites
Daniel L. Kline, d*An*.kline@ars.usda.gov and Eric Rohrig

Observations were made on the seasonal phenology of flowering plants along SR24 between Gainesville and Cedar Key, FL, for a period of 1 yr. The objective was to document the seasonality, species composition and relative abundance of flowering plants that might be available as nectar sites for mosquitoes and flies. Chemical analyses were performed on many of the flowering plants to identify the volatiles. This talk will present the results of these studies. Plans have been made to continue to identify volatiles from additional flowering plants. Olfactometer studies are planned to determine the attractancy of whole flowers and individual compounds to several species of mosquitoes and flies.

174 Comparative semi-field evaluations of nonanal, the BG lure, and 1-octen-3-ol for attracting mosquitoes
James Cilek, cilek_j@popmail.firn.edu

Nonanal and the BG lure (the latter a proprietary mixture of lactic acid, ammonia, and fatty acids) were evaluated for their attractiveness to lab-reared adult *Aedes albopictus* and *Culex quinquefasciatus* in large (56.7 m length x 9.4 wide x 2.6 m height, 14-mesh) walk-in cages on the grounds of the Public Health Entomology Research and Education Center, Florida A & M University, Panama City, FL, campus. 1-Octen-3-ol (octenol) was used as a reference in all testing. Both mosquito species were simultaneously released into this cage and the above 3 treatments evaluated on the basis of relative abundance in 24-h MMX-baited trap collections. Results from this study will be presented.

175 Rotary time trapping shows peak flight times for host seeking mosquitoes for greater exposure to adulticides
James H. Burgess, burgess@lcmcd.org, Jonathon Hornby and Wayne Gale

Rotary time traps allow Lee County Mosquito Control District to determine the hours of peak flight times for host seeking mosquitoes. The District has found that from 2200h to 0100h is the peak time for 2 major *Aedes* and *Psorophora* species in Lee County. The District has also found the peak flight time for *Culex nigripalpus* is between 2300h to 0100h. In 2010, the District modified a rotary time trap to resemble an oversized BG Sentinel trap to determine the peak flight times of *Aedes aegypti* and *Aedes albopictus*. This trap has been running for three, 24-h periods for 14 wk. By running these traps in 24-h periods, the District has been able to determine the peak host seeking time for *Ae. aegypti* and *Ae. albopictus*. Knowing the peak flight times of these mosquito species allows the District to time its adulticiding applications for maximum effectiveness. It also gives an economic benefit of more efficient use of equipment and manpower

176 The effects of BG-Sentinel Trap location in *Aedes albopictus* catch in New Jersey
Taryn Crepeau, taryn.crepeau@co.monmouth.nj.us, Sean Healy, Kristen Bartlett-Healy, Ary Farajollahi, Isik Unlu and Dina M. Fonseca

Two studies were performed in Mercer and Monmouth counties in New Jersey. In 2009, over 80 traps were set weekly in 3 study sites in each county, and the temperature and humidity was monitored at each trap using the iButton Hydrocon. The data was analyzed to determine whether traps were placed consistently throughout the study areas based on guidelines provided to seasonal trappers. In 2010, in Monmouth County, 3 properties were chosen to assess the differences in trap abundance of *Aedes albopictus* based on perceived trap location within a property. At each site a BGS trap was placed in partial shade, full shade, and full sun. HOBO data loggers were used to measure temperature and light intensity and iButton Hydrochons measured temperature and humidity at each trap. The abundance of *Ae. albopictus* of each trap was recorded and differences in abundance due to perceived trap location was evaluated.

177 Using LED technology to improve surveillance of *Culicoides* disease vectors based on phototaxis behavior
Lee Cohnstaedt, Lee.Cohnstaedt@ARS.USDA.GOV and Sandy Allan

Effective monitoring of the abundance and distribution of disease vector species is necessary for the early detection of blue tongue and vesicular stomatitis viruses in livestock. Currently, Centers for Disease Control light traps with incandescent lights are used to capture species in the field; however, with the advent of light emitting diode technology, insect traps have become more energy efficient and may be tuned for specific species-based positive phototaxis behavior. The disease vector, *Culicoides sonorensis*, was evaluated for photoattraction to red (620-630 nm), green (565-573 nm), blue (460-465 nm), purple (390-400 nm), near ultraviolet (383 nm), ultraviolet (360 nm) and white (full spectra) light. Results are presented in terms of improving trapping efficiency and species monitoring for population abundance and introduction to new areas.

178 Preliminary tests of double layer net-trap for *Anopheles* mosquito collecting without human-vector contact
Nima W. Gyeltshen, Jean-peirre Dujadin, Supatra Thongrungkiat, Theeraphap Chareonviriyaphap and Sungsit Sungvornyothin

Conventional mosquito sampling by collecting pathogen-transmitted mosquitos landing on human volunteers, or human landing catch (HLC) has been questioned for the risk and the necessity of the method. Even though the volunteers have more chance to become infected by a mosquito bite, the human body is the most suitable attracting subject to the host-seeking mosquito, reflecting the exact behavior and biology of the mosquito. A new multi-

purpose, risk-free of disease transmission, double layer net-trap (DLN), using humans as both the bait and the collector has been developed. The DLN is made of 2 layers. The outer has holes to select the host-seeking mosquitoes pass inside. The inner has sock-like openings distributed in all net sides to allow human bait who, while sitting, uses an aspirator collects mosquito target in the space between the layers. Preliminary tests of DLN in sampling efficiency has been compared with HLC method under semi-field using 3 lab-colonies of *Anopheles aconitus*, *Anopheles dirus* and *Aedes albopictus*. The DLN and HLC have been set at the terminal of each side of chamber. Fifty mosquitoes of each species were released in the middle. Number of collected mosquitoes has been compared between the competitive methods. Both species of *Anopheles* responded similarly to the DLN and the HLC methods, while *Ae. albopictus* responded only to the HLC method. During the testing period, the volunteesr in DLN were bite-free during the entire experiment.

179 Effect of sampling method on the species composition and abundance of adult mosquitoes in a Florida swamp
Don R. Barnard, don.barnard@ars.usda.gov

Samples of adult mosquito populations in a Florida swamp (Sumter Co.) were obtained using suction traps and portable CDC light traps (augmented with CO_2) and the results compared with mosquitoes captured by mechanical aspirator when landing on a human subject. Sixteen mosquito species were collected. Eighty percent of these species were observed in light trap samples and 30% each in suction trap samples and in collections of landing mosquitoes. All species captured by suction traps were present in light trap samples, although the relative abundance of each species differed significantly. Three of the 5 mosquito species collected from human subjects were not obtained in light trap or suction trap samples.

180 Comparative reproductive physiology of an anautogenous mosquito, *Aedes aegypti,* and autogenous mosquito, *Ochlerotatus atropalpus*
Monika Gulia-Nuss, mgulia@uga.edu, Michael R. Strand and Mark R. Brown

Reproduction in female mosquitoes requires energy resources obtained from a vertebrate blood meal and is modulated by several hormones. The hormonal regulation of yolk protein synthesis in autogenous *Ochlerotatus atropalpus* parallels anautogenous *Aedes aegypti* to some extent. The apparent requirement is an increase in ecdysteroids secreted by ovaries. Ovarian ecdysteroidogenic hormone (OEH) secreted from neurosecretory cells stimulates the ovaries to produce ecdyson, and it appears to be necessary for successful yolk deposition in both *Ae. aegypti* and *Oc. atropalpus*. Topical application of the juvenile hormone analogue methoprene resulted in higher level of ecdysteroid secretion by ovaries *in vitro* and in yolk deposition *in vivo* in decapitated *Oc. atropalpus* females; however, methoprene application did not stimulate ecdysteroid production in *Ae. aegypti*. Upon adult emergence, *Oc. atropalpus* females appear to have more glycogen than *Ae. aegypti* but almost equal amount of lipid. Together, our data indicates that differential reproductive physiology is hormonally regulated.

181 Characterization of insulin-like peptide distribution in *Anopheles stephensi* and *Anopheles gambiae*
Andrew Nuss, nuss8@uga.edu and Mark R. Brown

Insulin-like peptides (ILPs) are increasingly recognized as regulators of energy metabolism and reproduction in mosquitoes, largely based on work featuring *Aedes aegypti*, the yellow fever mosquito. As a first step towards understanding the functions of these peptides in anophelines, the presence and distribution of ILPs were examined in *Anopheles stephensi* and *Anopheles gambiae* using immunohistochemistry and RT-PCR. Antisera were generated against *Anopheles gambiae* ILP fragments, affinity purified, and used for whole-tissue immunohistochemistry. An antiserum designed to detect AngILPs 1, 3 and 4 immunostained medial neurosecretory cells of the brain and axons over the anterior midgut in both species. A different population of medial and lateral neurosecretory cells in the brains of both species was stained with antiserum specific for ILP2. Transcripts for ILP2 were also detected in *An. stephensi* with RT-PCR in midguts and ovaries although immunoreactive material was only observed in nervous tissue. ILP5 transcripts were detected in ovaries, midguts and thoracic and abdominal body wall, yet no immunostaining with the ILP5-specific antiserum was observed. Insulin receptor transcripts were expressed in all tissues examined.

182 A comparison of oviposition rates in relation to the presence of various larval control agents
Richard Duhrkopf, rick_duhrkopf@baylor.edu

Ovitraps were used to compare the rates of oviposition of adult female mosquitoes (*Aedes albopictus* and *Aedes epactius)* in water containing methoprene and *Bti* compared with a normal oviptrap solution. No significant differences were found in the numbers of positive ovitrap strips or the numbers of eggs laid on those strips, indicating that females do not avoid water in which larval control agents have been applied.

183 Discarded cigarette butts: Toxic waste to be used in *Aedes albopictus* control
AbuHassan B. Ahmad, aahassan@usm.my, Saifur Rahman and Hamady Dieng

Discarded cigarette butts (CBs) pose a serious litter and toxic waste disposal problem worldwide. There is therefore, a great deal of current research interest in using these polluting chemicals in beneficial ways. Despite evidence that CBs are harmful to water fleas, crustaceans naturally associated with mosquitoes, no study has addressed their significance on dengue vectors. Here, we examined whether *Aedes albopictus* alters its oviposition responses, egg hatching and larval development in response to the presence of decaying CBs in its habitats. We used microcosms to test for the effects of decaying smoked CBs on oviposition and egg hatch responses and on the survival of the

aquatic stages. We found that *Ae. albopictus* showed increased egg deposition activity in the presence of CBs that only reduced over long periods. Larval eclosion was normal, but survival decreased sharply during the early phases of larval development and the CB decomposition process. We also found increased survival of the late developmental stages, but daily input of fresh CBs prevented most young larvae from completing development. Taken together, these observations suggest that smoked CBs introduced into container habitats undergo a decomposition process that induces oviposition and has larvicidal effects in *Ae. albopictus*. Careful use of this waste therefore has the potential to reduce the densities of this vector mosquito.

184 Antimicrobials in maintenance of mermithid cultures

Edward Platzer, edward.platzer@ucr.edu, Ashley Bloxon, Tiffany Butts and Ole Becker

As aquatic mermithid nematodes emerge from their arthropod hosts, they are frequently attacked by fungi such as *Catenaria anguillulae* and *Saprolegnia* sp. These hyperparasites can result in the loss of the postparasitic and adult stages of mermithid nematodes. To alleviate this loss, a number of common antimicrobials were investigated for the control of *C. anguillulae* attack on *Romanomermis* sp. and *Strelkovimermis spiculatus*. Of the 3 mermithid species tested, *Romanomermis culicivorax* was the most sensitive to *C. anguillulae,* while *Romanomermis wuchangensis* was 1.8-fold less sensitive and *S.spiculatus* was 3.3-fold less sensitive. A commercial antimicrobial solution with amphotericin B, penicillin and streptomycin completely inhibited *C. anguillulae* infections in *R. culicivorax*. Saturated clotrimazole solutions completely inhibited infection in *S. spiculatus,* whereas infections were reduced by 11-fold and 19-fold in *R. wuchangensis* and *R. culicivorax,* respectively. These findings demonstrated major differences in susceptibility to fungal attack. In addition, infections by *C. anguillulae* can be prevented with relatively inexpensive and commonly available antimicrobials.

GIS/GPS and Genetics/Systematics

185 MapVision® technology at Beach Mosquito Control District, Panama City Beach, FL

James F. Clauson, jamesclauson@comcast.net

MapVision® is a web-based mapping system designed to consolidate multi-source surveillance data to develop and deploy strategic larvaciding and adulticiding response applications. Beach Mosquito Control has implemented MapVision technology to include real-time tracking, real-time data access and real-time service request. By implementing this real-time information, service request and control measures have been expedited and streamlined. The end result is quicker service response to the taxpayers of the District.

186 Environmental modeling of mosquito population dynamics: A comparison of ground-based measurements and satellite remote sensing

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Understanding mosquito ecology is critical for mosquito control and vector-borne disease prevention, and weather is an important influence on mosquito life cycles. Meteorological measurements are typically acquired from ground-based weather stations; however, weather stations are spatially heterogeneous and measure local environmental conditions. In contrast, environmental measurements from satellite remote sensing appear spatially continuous. This study compared temperature measurements from the Sioux Falls airport weather station, the Advanced Microwave Scanning Radiometer - Earth Observation System (AMSR-E), and the Moderate-Resolution Imaging Spectroradiometer (MODIS) to examine the concordance of these measurements and their ability to predict abundances of 2 mosquito species (*Culex tarsalis* and *Aedes vexans*) from 2005 to 2008. Daily air temperature was measured by the weather station and AMSR-E, and 8-d composites of land surface temperature (LST) were obtained from MODIS. Correlations among these 3 measurements were high (r=0.88-0.95), but AMSR-E had higher variability in winter than the other 2 measurements. Mosquito abundances were predicted well by each temperature dataset, and the AMSR-E product had slightly higher predictive power than weather station data. Our findings indicate that temperature data from remote sensors can be reliable and used to model and forecast mosquito population dynamics when local weather stations are not available.

187 How green was my valley (with pools): When foreclosures, privacy rights and West Nile virus collide

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In 2005, the Consolidated Mosquito Abatement District (CMAD) had 120 unmaintained (green) swimming pools that were mapped and monitored because of mosquito production. By the end of 2010, the number of green pools had grown dramatically to 1,597. With a steady increase in the number of pools that require treatment and monitoring over the past 5 yr, there was a clear need to improve the work-flow and record-keeping related to green swimming pools. Green swimming pools offer a unique set of challenges in that they are numerous, almost always on private property and are often in constant flux from an unmaintained to a maintained state. The District developed a mapping and database-driven system that would direct operational activities specific to green pools. The system also had to accommodate other factors such as suspect pools generated from aerial surveillance and specific properties where an inspection warrant issued by the court was necessary for entry. This was all developed with the resident in mind to minimize district personnel presence while still providing effective mosquito control. To accomplish this, the District developed a series of procedures, notices and records to be maintained in Microsoft® Access™ and ESRI® ArcGIS® 10.

188 Economy as a predictor of West Nile virus
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Understanding the conditions underlying the proliferation of infectious diseases is crucial for mitigating future outbreaks. Since its arrival in North America in 1999, West Nile virus (WNV) has led to population-wide declines of bird species, morbidity and mortality of humans, and expenditures of millions of dollars on treatment and control. To understand the environmental conditions that best explain and predict WNV prevalence, we employed recently developed spatial modeling techniques in a recognized WNV hotspot, Orange County, CA. Our models explained 85-95% of the variation of WNV prevalence in mosquito vectors, and WNV presence in secondary human hosts. Prevalence in both vectors and humans was best explained by economic variables, specifically per capita income, and by anthropogenic characteristics of the environment, particularly human population and neglected swimming pool density. While previous studies have shown associations between anthropogenic change and pathogen presence, results show that poorer economic conditions may act as a direct surrogate for environmental characteristics related to WNV prevalence. Results emphasize the importance and utility of including economic variables in mapping spatial risk assessments of disease, and have assisted the Orange County Vector Control District in planning and focusing its mosquito control efforts at the highest WNV risk areas in the county.

189 Mapping, operational accountability, and Pesticide General Permits
Ryan Pierson, ryan@elecdata.com

Mosquito control operations are adjusting operational procedures and record-keeping activity to meet new federal and state government regulations found in the Pesticide General Permit (PGP). These regulations specifically require organizations to implement integrated mosquito management (IMM) practices that include record-keeping and mapping pesticide application areas. Those organizations successful in meeting these new regulatory requirements will increase their operational accountability, which is good for the mosquito control industry in general. This presentation will demonstrate how Sentinel™ GIS software specifically meets many of the described mapping, record-keeping, and reporting requirements found in the new regulations. The Sentinel™ GIS software functionality includes mapping all pesticide application areas, recording all pesticide use, recording all field activities, and reporting this information to the appropriate regulatory agency. Specifically this presentation will demonstrate procedures for field technicians to manage mosquito habitat, record pesticide applications, perform mosquito and disease surveillance, and report all operational activity. Sentinel™ GIS software is built upon Esri GIS and mapping technology and is proven to increase operational efficiency. Sentinel™ GIS increases an organization's accountability, is built upon industry-standard mapping technology, and meets many of the PGP operational and reporting requirements.

190 Modeling the spatial distribution of *Phlebotomus papatasi* (Diptera: Psychodidae) in Libya
Mahmoud S. Abdeldayem, Mahmoud.Saleh.eg@med.navy.mil, Badereddin B. Annjar, Hanafi A. Hanafi and Peter J. Obenauer

Predictive spatial modeling has been used for various public health management decisions. Regional increases in human cases of *Phlebotomus papatasi*-borne leishmaniasis have prompted an effort to develop predictive models for the distribution of this sand fly in Libya. Records of *P. papatasi* distributions from an ongoing field study and published literature were combined with 21 bioclimactic/geographic variables and evaluated using the MAXENT algorithm to build the model. The model showed an overall performance (AUC= 0.973), indicating that suitable areas are largely confined to the coast (11°33 - 20°35 E) at altitudes less than 600 m. Regions south of 31°50 N latitude were calculated as unsuitable for this sand fly species. Jackknife analysis identified that precipitation related variables and elevation have significantly predictive power, but temperature variables contribute less to the strength of the model. This information may be used for public health and management of leishmaniasis in Libya. Because existing records are strongly biased towards a few geographical regions that contain a high sampling activity, there is a pressing need for additional systematic collection of this species. To increase the model's predictive power, including real-time predictions, NDVI data will be incorporated and sand fly surveillance will be expanded to a larger geographical area.

191 Managing aerial GPS tracks with an enterprise web-based GIS application
Brian Fischer, bfischer@houstoneng.com and Nancy Read

The MMCD provides a variety of services to 2.7 million people living in the 7-county Minneapolis and St. Paul, Minnesota metropolitan area. GPS data has become an expected part of aerial treatment records. In the past, staff used desktop GIS software to view GPS tracks of wetland helicopter treatments, but with multiple field offices and hangars, it was difficult for others to see the data or combine it with other information. MMCD needed an enterprise GIS solution that could provide the District with a more efficient way to manage the hundreds of aerial treatment records generated each year The application provides the ability to upload raw Ag-Nav GPS track files from any office or field computer with a web connection into 1 central database. It also performs complex spatial queries and prepares interactive maps and reports, and is optimized to enable quick performance even with large volumes of data. Helicopter tracks and aerial treatment records are now easily accessible to all staff in the organization, and can also be reviewed by pilots after a mission through password-protected web access. This is one of a series of low-cost web GIS applications Houston Engineering has developed for the MMCD moving towards a long-term strategic goal to manage IT costs by using web-based open source software for accessing and managing critical District data. This approach has kept the overall project cost low and the return on investment has been substantial.

192 Counting and classifying mosquitoes from a distance with ultra cheap sensors
Eamonn Keogh, eamonn@cs.ucr.edu, Gustavo Batista and Agenor Mafra Neto

In the last century, entomologists have developed an arsenal of mechanical, chemical, biological and educational tools to help mitigate the harmful effects of mosquitoes. Since all such interventions are costly, they depend on knowing the best time and place to intervene. As a group of medical entomologists recently noted: "Accurately georeferenced collection data are crucial for understanding mosquito biogeography, ecology, and the impact of environmental changes, as well as for species distribution modeling, planning mosquito surveys, and for determining disease risk" (Foley et al. 2009). Such data is currently obtained by having humans inspect mechanical or "sticky" traps (Bhalala and Arias 2009). As such, the data is typically sparse, error-prone and out of date. In this work we show that with simple low cost sensors we can get counts of flying insects in real-time. In particular we argue that in order for sensors to be used in the field (especially in the developing world) they must be very cheap, otherwise they are vulnerable to thief. We show our initial results on a sensor that we built for less than $40, and which can be mass-produced for less than one dollar.

193 *Aedes* (*Howardina*) *guerrero*: Where did it go?
Aldo Ortega, agrortega@hotmail.com, Ildefonso Fernández and Antonio Cortés

Aedes (*Howardina*) *guerrero* is a tropical mosquito species that has been reported in Mexico and Guatemala. The immature stages develop in epiphytic bromeliads filled with rainwater, while biting adult females can be attracted by humans. The specific name of this species meaning the type loc: Chilpancingo in Guerrero state of Mexico, where it was collected and first described by Berlin in 1969. We conducted a mosquito collection trip in the Guerrero state where *Ae. guerrero* was not collected. The absence of this species is likely a result of climatic change and deforestation over pine-oak in Chilpancingo forests, causing a decrease in the oak tree population, and thus extinction in epiphytic bromeliads, where *Ae. guerrero* develops.

194 Mosquito records from Mexico V: The mosquitoes of Tamaulipas state
Aldo Ortega, agrortega@hotmail.com, Ildefonso Fernández and Quetzaly Siller

Since 2005, we field collected mosquito specimens (Diptera: Culicidae) in northeast Mexico and have produced a current distribution checklist of distinct mosquito species that occur that region. In Tamaulipas state, 1 of states that are part of northeastern Mexico, we obtained 15 genera, 23 subgenera and 38 mosquito species, of which 12 are new records from Tamaulipas state. This novel checklist could be a useful tool in the surveillance and mosquito control programs in Tamaulipas state. The Knight & Stone nomenclature is used in this study.

195 Molecular population genetic studies of a Thai malaria vector (*Anopheles minimus*)
Uraiwan Arunyawat, uraiw*An*.a@ku.ac.th, Prin Phunngam, Aparup Das and Theeraphap Chareonviriyaphap

Understanding the evolutionary factors that shape patterns of genetic variation of the vector species is important for devising new methods for malaria control. In this study, we aim to use population genetic model to find any precise answers to evolutionary questions of *Anopheles minimus*, one of the most widespread malaria vectors in Thailand. We employed a multilocus approach to estimate genetic diversity and to infer population genetic structure of *An. minimus* populations across Thailand by utilizing DNA sequence data for 4 nuclear loci. Our data showed that Kanchanaburi and Chiang Mai populations exhibit low levels of nucleotide diversity; Chantaburi and Surat Thani populations show substantial levels of nucleotide variation, whereas *An. minimus* from Tak province appears to be the most polymorphic populations. Further population genetic analyses of these *An. minmius* populations are discussed.

Insecticide Resistance Management I

196 Overview of insecticide resistance
Janet McAllister, jvm6@cdc.gov

The definition of resistance, how it develops and underlying mechanisms will be presented. Our understanding of the extent of resistance in several vector species can serve as examples of the importance of this phenomenon and the overall goal of management.

197 Overview of pyrethroids development and resistance management strategies
Jing Zhai, jing.zhai@eurofinsagro.com

From the first discovery of pyrethrum plants over 2000 years ago to development of third generation of pyrethroids, this paper provides general background of different forms or shapes of pyrethroids that are important for full insecticidal activity. This paper also discusses pyrethroid resistance management strategies that have been implemented in the mosquito control industry.

198 Inducible esterase expression in different field and colony populations of female *Culex nigripalpus*
Chelsea Smartt, ctsmart@ufl.edu and Shainnel Eans

It is important to understand the mechanisms involved in the development of mosquito resistance to insecticides to be able to predict where targeted control measures may be needed and how mosquitoes will react to new insecticides. Because esterase is an enzymatic protein known to play a role in insecticide resistance formation, an esterase gene (Temsha est-1, TE-1) from *Culex nigripalpus* Theobald (Diptera: Culicidae) was amplified and

sequenced. Previous expression analysis revealed that the messenger RNA encoding TE-1 was detected in head, thoraces, abdomens, and midguts from blood fed and non-blood fed *Cx. nigripalpus* female mosquitoes. Detection of TE-1 in all samples regardless of the presence of blood suggests that this clone serves many functions, including a probable role in heamatophagy. We also found that the level of expression of TE-1 in individual non-blood fed field mosquitoes differed depending on where they were collected. Interestingly, we found TE-1 expression appeared to increase in field-collected non-blood fed individual mosquitoes after prolonged, direct, exposure to the organophosphate, naled. If the differences in expression noted in this study can be correlated to differences in susceptibility towards insecticides, we may be able to use TE-1 as an indicator of the development of tolerance. This would greatly enhance mosquito control efforts.

199 Resistance monitoring of fresh and salt water adult mosquito populations in St. Johns County, FL, from 2005 to 2010

Whitney A. Qualls, quallsamcd@bellsouth.net and Rui-De Xue

Monitoring resistance in adult mosquito populations is important to ensure that adulticiding measures are effective. Anastasia Mosquito Control District of St. Johns County, FL, has monitored adult mosquito resistance using a modification of the Centers for Disease and Control bottle bioassay method since 2005. Naled, malathion, resmethrin, bifenthrin, sumithrin, and permethrin resistance has been monitored 1 or more times in fresh and saltwater mosquito populations. We used the diagnostic dose calibrated by the Public Health Entomology Research and Education Center in Panama City, FL. Since 2005, only malathion resistance in floodwater mosquitoes in 1 location in Elkton, FL, has been recorded. Since 2008, mosquito resistance testing has taken place during the beginning, middle, and end of the mosquito season. Mosquito species that have been monitored for resistance include *Aedes atlanticus, Ae. infirmatus, Ae. taeniorhynchus, Ae. sollicitans*, *Culex quinquefasciatus* , *Cx. nigripalpus*, *Cx. erraticus, Psorophora columbiae*, and *Psorophora ciliata*.

200 Insecticide resistance of the major disease vectors and its influence factors in China

Qiyong Liu, liuqiyong@icdc.cn, Meng Fengxia and Jin Jianchao

In order to know the resistance level in the disease vectors and to establish the strategy of resistance management, a pesticide resistance surveillance program has been carried out in 18 provinces (autonomous regions and municipalities) by the National Institute for Communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention since 2007. According to the surveillance since then, the resistance ratio varies from 10 to 10,000 against the commonly used pesticides for the dengue vector mosquitoes (*Aedes albopictus* and *Ae. aegypti*), the malaria vector *Anopheles sinensis*, the Japanese encephalitis vector *Culex tritaeniorhynchus*, and the nuisance mosquitoes (*Cx. pipiens pallens* and *Cx. pipiens quinquefasciatus*). On the other hand, *Musca domestica* has developed resistance to lots of commonly used insecticides from the North to South China, with the highest resistant level to DDVP, permethrin, beta-cypermethrin, cypermethrin at about 100-500 fold. *Blattella germanica* was insensitive to some of the pyrethroid insecticides in many areas. As for insecticide resistance, the insecticides used for agriculture pests control may play a crucial rule on *Anopheles sinensis* and *Cx. tritaeniorhynchus*.

Pay No Attention to That Mosquito Behind the Curtain: Little-known Mosquito Control Lore I

201 Introduction and overview

Stanton Cope, stanton.cope@osd.mil

There have been many unique individuals and events in the history of medical entomology and mosquito control. This symposium will present some of them.

202 Albert Freeman Africanus King, MD: Scientist/Iconoclast

Joseph Conlon, conlonamcata@gmail.com

Albert Freeman Africanus King studied medicine and taught obstetrics at what was to become George Washington University School of Medicine in Washington, D.C. for almost 50 years. A man of supremely eclectic interests, he read a paper making a case that malaria was transmitted by mosquito bites before the Washington Philosophical Society in 1832. This paper was subsequently published in the Popular Science Monthly in September 1883. The paper was entitled "Insects and Disease - Mosquitoes and Malaria" and in it were listed 19 reasons that Dr. King thought proved that malaria was transmitted by mosquitoes. Although its conclusions were ultimately proven correct by Patrick Manson 10 yr later, the paper was ignored at the time because of King's widely recognized unconventional approach to scientific discovery. A prolific writer, Dr King never pursued any research to test any of the many radical theories he espoused, earning him the title of "armchair scientist" by his biographer. This presentation will discuss Dr. King's contributions to the understanding of the role mosquitoes play in malaria transmission along with several of his peculiar recommendations for the control of malaria and other infectious diseases that underscore his reputation as a scientific gadfly.

203 Patrick Manson and the origin of the mosquito hypothesis

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Patrick Manson was a bright Scot, trained as a physician, who left Britain to make his fortune in the Empire. While he succeeded in making a fortune, he lost it in poor investments, but he permanently transformed medicine and created the discipline of tropical medicine as he was doing so. Manson took to medicine and understood that the progress of science in the late 19th century had the possibility of transforming medical practice, so he read the

literature, even seeking out material when he had questions. He applied it in his clinical experience, and in the case of a servant with elephantiasis, he explored the material on the role of filarial worms in the disease. Noting the nocturnal presence of the worms in the patient's blood he ask himself why, the possible explanation in the natural selection of worms for mosquito transmission led him to the "mosquito theory". While not a full understanding of vector transmission, the mosquito theory would inspire others and allow Manson the credibility to gain government support for the creation of a school to prepare medical officers for Imperial service; the school became the London School of Tropical Medicine & Hygiene and Manson's lectures the first textbook of Tropical Medicine.

204 The story of Clara Maass

Stanton Cope, stanton.cope@osd.mil

The work of the Walter Reed Board demonstrated in Cuba that yellow fever virus was transmitted by mosquito bite and not by putrid air or contaminated objects. However, the conclusion of the Board's work was not the end of human experimentation in Cuba on yellow fever. Cuban physicians conducted a number of experiments, one of which involved a young American nurse named Clara Maass. Unfortunately, Miss Maass died from yellow fever. This presentation will focus on her story, and the uproar and aftermath that followed her untimely death.

Larval Control I

205 Controlling mosquitoes in mangroves 1: Identifying immature habitats using hydrology and detailed elevation data

Pat Dale, p.dale@griffith.edu.au and Jon Knight

Aedes vigilax (Skuse) is a disease vector mosquito (similar to *Aedes taeniorhynchus* (Wied.) in Florida) that thrives in mangrove systems in sub-tropical Australia. Because it is difficult and costly to survey mangrove systems in detail, the distribution of eggshells and larvae has not been well established. The mangrove literature shows that the structure of the forests can be complex, and this implies that immature habitats may not be evenly distributed. Here we report results from a study of 8 mangrove systems in south-east Queensland. The research involved field survey for eggshells and larvae. Analysis of LiDAR elevation data at high resolution, together with tidal modeling, indicated a close relationship between detailed landform structure, tidal patterns and immature habitats. We conclude that areas with a back basin structure, albeit of subtle dimensions, are at greatest risk of providing habitats suitable for *Aedes vigilax* oviposition and larvae (and hence the opportunity for adult emergence). The next step is to plan and implement a modification program to reduce the suitability of the systems for mosquitoes and to improve water quality and fish habitat. This is reported in the next presentation.

206 Controlling mosquitoes in mangroves 2: Modifying immature a*edine* habitats and improving both water quality and fish habitats

Jon M. Knight, j.knight@griffith.edu.au and Pat Dale

Following on from the previous presentation that identified *Aedes vigilax* (Skuse) distribution in mangrove forests, this one reports on the development of a detailed mangrove modification plan and progress in its implementation in a mangrove forest at the Tweed in northern New South Wales, Australia. The underlying rationale was to do as little as possible to the system, while doing enough to achieve our objectives. These were to reduce mosquito production by improving tidal connections, water quality and fish habitat. In 2009-2010, LiDAR data were used to construct high-resolution digital elevation models (DEMs) of mangrove forest topography. Analysis of the DEM indicated a close relationship between detailed landform structure, tidal patterns and larval habitats. A before-after/control-impact adaptive management approach is being used to design modifications to a mangrove basin forest. Modifications include: first, lowering the tidal connection across a perimeter berm to increase the frequency and duration of tidal flooding and second, enhancing the flow of tidal water between pools using direct connections of either pipes or channels. The modifications addressed concerns about impoundment and lack of connectivity that may have contributed to a severe acidity problem at the site, exacerbating mosquito production while inhibiting fish foraging.

207 Efficacy of VectoMax™ CG for the control of various mosquito species in Poland and Germany: A new formulation based on *Bacillus thuringiensis israelensis* and *Bacillus sphaericus*

Norbert W. Becker, norbertfbecker@web.de and Katarzyna Rydzanicz

VectoMax™ CG is a combination formulation of *Bacillus thuringiensis israelensis* (*Bti*-AM65-52) and *B. sphaericus* (Bs s-2362) based on BioFuse™ technology. VectoMax™ CG was evaluated in 2 settings in Northern Europe at rates ranging from 5 to 15 kg/ha. Tests were completed against immature stages of *Aedes caspius* and *Culex pipiens pipiens* in sewage infiltration fields in Wroclaw, Poland. Whole fields were assigned treatments and sampled for 14 d following treatment by taking 20 dips per transect along multiple transects (n=5) in each field. Both species were effectively controlled during the 14-d post-treatment sampling period. A dose-response trend was noted, with >95% suppression of both species achieved at rates >10 kg/ha and nearly complete suppression achieved at 15 kg/ha throughout the sampling period. Similar testing was conducted against mixed *Aedes* spp. larvae in woodland pools formed in bomb craters in Germany. The results also showed a dose-response trend, with the higher rates providing nearly complete control.

208 Efficacy of novel mosquitocidal *Bacillus* sp. isolates and their impact on mosquitofish

He Zhong, he.zhong@famu.edu, Hyun-Woo Park, Sabrina Hayes and Tim Ouimet

Entomopathogenic bacteria are obtaining importance in the control of insecticide-resistant populations of insect pests and vectors of human diseases. Among these entomopathogenic bacteria, *Bacillus thuringiensis* subsp. *israelensis* (*Bti*) and *Bacillus sphaericus* (*Bs*) have been the most extensively used in many regions of the world to control mosquito larvae. Because of its longer persistence in polluted water, *Bs* has been preferably used over *Bti* in many situations. However, high levels of resistance to *Bs* have already been reported in the field in several countries. In this research, we compared 2 newly discovered novel mosquitocidal *Bacillus* sp. isolates - VB17 and VB24 with *Bti* and *Bs* for their mosquito control efficacy and impact on mosquito fish in the laboratory. The bioassay data indicated that all bacterial species did not affect mosquitofish survival. The efficacy data showed that 2 isolates were effective against 2 mosquito species *Culex quinquefasciatus* and *Aedes taeniorhynchus* and are comparable to *Bs*, but less than *Bti*.

209 Aerial application of VectoBac® WDG for container-inhabiting larval control in Key West, FL, USA

Andrea Leal, aleal@keysmosquito.org

Field evaluations of VectoBac® WDG applied via helicopter were conducted in Key West, FL, in August and September of 2010 by the Florida Keys Mosquito Control District in cooperation with Valent BioSciences. These evaluations were performed to determine the efficacy of aerial application of VectoBac WDG for the control of *Aedes aegypti* larvae in dengue-affected areas. All test applications were completed from a Bell Jet Ranger II (206B) equipped with a hydraulic spray system and Micronair AU5000 rotary atomizers. In the first 2 test applications, cups were placed in the field prior to treatment and removed 1 h after treatment to be flooded in the laboratory. The following 2 test applications were conducted over a variety of larval-positive containers that were identified prior to application. Larval mortality observations were made for each container up to 24 h post-treatment. In all trials, significant larval mortality was observed in a variety of containers and locations. Because of the success of the test applications, this particular product and application technique have now been integrated into the Florida Keys Mosquito Control District's general strategy in the control of *Aedes aegypti*.

210 Comparison of three truck-mounted machines for the area-wide application of VectoBac® WDG against *Aedes albopictus* larvae

Gregory M. Williams, gwilliams@hudsonregionalhealth.org, Ary Farajollahi, Sean Healy, Randy Gaugler and Jeffery Stancil

A Clarke Cougar ULV machine, a Buffalo Turbine CSM2 mist sprayer with an atomizing head and a Curtis Dyna-Fog AgMister LV-8 low volume sprayer were evaluated for the application of VectoBac® WDG for area-wide control of *Aedes albopictus* (Skuse). The machines were evaluated at application rates of 400 and 800 g/ha. Droplet spectra were determined under various equipment settings at the Navy Entomology Center for Excellence using a phase doppler particle analyzer. The Turbine and the LV-8 were calibrated at 8.3 L/min. The Cougar was dropped from further trials because it could not generate the required flow rate. The average VMD for the Turbine and LV-8 were 210 and 150 µm respectively. Efficacy and droplet deposition were determined in a 3 x 9 field plot out to 91 m with plastic cups and Kromekote cards at each station. Dye was added to the mix and applications were made at a truck speed of 8 km/h. Each treatment was run in triplicate. Cups were returned to the laboratory, larvae were added and mortality was recorded for 72 h. Droplet deposition from Kromekote cards was determined with DropVision-AG software. Larval mortality was directly correlated to droplet deposition. Mortality was slightly greater at the 800 g/ha rate. Both machines provided satisfactory control, but the average mortality was greater for the Buffalo Turbine.

211 Evaluation of VectoMax™ CG for control of mixed broods of immature mosquitoes in waterfowl wetlands in California

Stacy Bearden, stacken@juno.com, Joel Buettner, Steve Schutz and Carlos Sanabria

VectoMax™ CG is a combination formulation of *Bacillus thuringiensis israelensis* (*Bti*-AM65-52) and *B. sphaericus* (*Bs* s-2362) which is based on BioFuse™ technology and manufactured by Valent BioSciences Corporation. VectoMax™ CG was evaluated in 2 artificially flooded wetlands in Northern California at 8 lb/acre. Tests were completed against mixed broods of immature *Aedes melanimon* and *Culex* spp. in Bull Marsh in Placer County and in a wetland/duck club on Holland Tract in Contra Costa County. Fields were treated by ATV application shortly after flooding when *Aedes* spp. predominated and were repeatedly sampled for 28-35 d following treatment by taking multiple dips along transects (n=5 in Placer County) or at sampling points (n=4 in Contra Costa County) established within each test field. Greater than 95% initial suppression of the *Aedes* spp. broods was realized in both tests. *Culex* spp were controlled for 28 d during the post-treatment sampling period in Placer County and Contra Costa County. No pupae were detected following treatment of the wetland in Placer County during 28 d- of post treatment sampling.

212 Addressing tiger problems with methoprene: There is hope using low volume application methodology and insect growth regulators
Scott C. Crans, scrans@aesop.rutgers.edu, Sean Devaney, Ralph Strano and Tadhgh Raniey

Managing the Asian tiger mosquito has proven to be a difficult task. Locating and treating enough larval habitat within established problem areas to make a noticeable difference with regard to nuisance is something that remains to be accomplished. This work builds upon that of others showing promise in a residential setting.

213 Natular™ and *Aedes albopictus* in container habitat continued: Investigating low and mid label range application rates in the field against container breeding mosquitoes
Scott C. Crans, scrans@aesop.rutgers.edu, Taryn Crepeau, Isik Unlu, Ary Farajollahi, Sean P. Healy, Randy Gaugler and Gregory M. Williams

Two application rates of Natular™ XRG was tested against field populations of container ovipositing mosquitoes utilizing artificial larval habitats over a 12 wk interval. Study sites, experimental design and insecticidal efficacy will be presented.

Insecticide Resistance Management II

214 The Role of Reduced Risk Larvicides in Integrated Mosquito Management
Jack Petersen, drjack3@hotmail.com

The US Environmental Protection Agency gives priority in its registration program to pesticides that meet reduced risk criteria: low impact on human health, low toxicity to non-target organisms, low potential for ground water contamination, lower use rates, low pest resistance potential, and high compatibility with integrated mosquito management (IMM). Natular™ was the first mosquito larvicide to go through this expedited USEPA review. Natular™ was first marketed during 2008. The active ingredient in Natular™ is spinosad, which is classified as a CLASS 5 insecticide by the Insecticide Resistance Action Committee. Spinosad is alone in this class. According to the Natular™ label, the maximum field application rate is 6.4 fl oz per acre (1 ft deep), which is approximately 110 ppb. Baseline dose response data (72 h) for *Aedes albopictus*, the Asian tiger mosquito, are LC_{50}=19 ppb; LC_{95}=40 ppb when test concentrations are prepared in ACS acetone. The baseline dose response data are LC_{50}=82 ppb; LC_{95}=270 ppb when test concentrations are prepared in water. The differences between these values are thought to be a result in the differences in solubility of spinosad in water and acetone. The regular, systematic use of spinosad in an IMM program would be expected to reduce selective pressure on other mosquito larvicides. Over time, such an IMM program should help reduce resistance ratios of these larvicides, helping prolong their effective field usefulness.

215 Dengue fever control and insecticides resistance in *Aedes aegypti* in Taiwan
Err-Lieh Hsu, elhsu@ntu.edu.tw and Hsiu-Hua Pai

Dengue fever is a viral tropical disease transmitted by 2 major vectors, *Aedes aegypti* and *Aedes albopictus* in Taiawn. In the absence of an effective drug or vaccine, the only possible preventive measure is control of the vectors to reduce viral transmission. Dengue fever has troubled Taiwan since 1987; however, we had the very successful control program from 1988 to 2001. Effective control failed in 2002 because of severe permethrin resistance in *Ae. aegypti*. Insecticide resistance detection is an important component in a mosquito abatement program. There were 3 goals for this study: 1) to establish bioassay techniques for *Ae. aegypti* and *Ae. albopictus* for the principal groups of insecticides (organophosphates, carbamates, and pyrethroids); 2) to determine the insecticide susceptibilities of the dengue vectors in southern Taiwan; and 3) to evaluate the potential applicability of the resistance mechanism-specific biochemical tests compared with bioassay as a possible surveillance tool for use by vector control program in Taiwan.

216 Detection of insecticide resistance in *Aedes aegypti* from the Florida Keys
Lawrence J. Hribar, lhribar@keysmosquito.org and Janet McAllister

Bottle assays indicated that *Aedes aegypti* from the Florida Keys were less susceptible to permethrin than was a known susceptible strain, but more susceptible than was a known resistant strain. Eggs collected throughout the Florida Keys were hatched and the incidence of resistance investigated. A low frequency of the altered target site mutation Iso1016 associated with pyrethroid resistance was detected. The ACE-1 mutation associated with organophosphate resistance was widespread. Non-specific esterases are likely the primary metabolic mechanism which can act on both chemical classes.

217 The resistance of *Culex pipiens* complex to insecticide in China
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Culex pipiens complex is widely distribute in China, including of *Cx. pipiens pipiens*, *Cx. pipiens pallens*, *Cx. pipiens quinquefasciatus* and *Cx. pipiens molestus*. Members of the species complex developed resistance to pyrethroids and organophosphate insecticides, and some related mechanism was found.

218 Best management practices (BMP) for insecticide resistance management
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The development of mosquitoes resistant to insecticides is a potential threat and impact to/on any mosquito and mosquito-borne disease control program worldwide. Resistance management with management effect by integrated mosquito management (IMM) is to minimize the exposure of target mosquito species to a given class of insecticides and to improve the control effectiveness. Best management practices (BMP) should form the fundamental approach/guideline for managing insecticide resistance for all mosquito control programs. Also, possible resistance development caused by application of the same class of insecticides for other pest control should be considered and collaborated. The BMP will focus on establishement of baseline for local mosquitoes to common insecticides, regular schedule for resistance monitoring/surveillance, insecticide rotation and promotion of insecticide-alternative methods, such as biocontrol, physical control, and management through public education, community outreach for personal and community protection. The objectives of the BMP are to limit or elminate, or at least postpone, the speed of insecticide resistance development and improve the control efficacy of mosquito and mosquito-borne diseases by IMM.

Pay No Attention to That Mosquito Behind the Curtain: Little-known Mosquito Control Lore II

219 William Gorgas: To Havana and beyond
William Sames, mosquitodoctor@yahoo.com

William Crawford Gorgas, an Army physician and Surgeon General for the U.S. Army, was known for his efforts in preventing yellow fever in Florida, Havana, Cuba, and especially in the Panama Canal Zone. Born in Toulminville, Alabama on 3 October 1854, he grew up during the US Civil War. Later, he earned a bachelor's degree at The University of the South and a medical degree from Bellevue Hospital Medical College in New York. Upon completing his internship, he was appointed as a medical officer in the U.S. Army. His initial duty assignment was in Texas where he survived yellow fever. Now immune to the disease, he was eventually stationed at Fort Barrancas, Florida. After the Walter Reed Commission's proof that *Aedes aegypti* was the vector for yellow fever, Dr. Gorgas initiated successful mosquito control measures in Havana. This led to his historic involvement with mosquito control in the Panama Canal Zone. He retired after WWI to work with the International Health Board and he died in London in 1920 from a stroke of apoplexy. He was buried at Arlington National Cemetery.

220 Flies and lies: A history of clandestine entomological warfare
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For thousands of years, humans have conscripted insects as weapons of war, terror, and torture. And mosquitoes have played in important role in the history of entomological warfare. These insects were employed, albeit without specific entomological knowledge by military commanders, as early as the 5th century BCE. Greek generals forced their enemies into swamps, knowing that the 'bad air' would cause debilitating fevers. Similar methods were employed during the US Civil War and proved decisive at the battle for Richmond. In the 20th century, the most extensive entomological attacks were conducted by the Japanese in World War II using fleas (with bubonic plague) and house flies (with cholera). When the United States military realized how far behind it had fallen in terms of biological warfare, a major research, development and (clandestine) testing program was undertaken which led to a sophisticated *Aedes aegypti*/yellow fever weapon system. Today, there are reports of mosquitoes being used to torture political dissidents and of diseases caused by mosquito-borne pathogens (e.g., Rift Valley fever) that have potential for bioterrorism. Available evidence suggests that the United States and other western nations may be underestimating the risks of insect-based weapons and therefore failing to adequately prepare for such an attack.

Larval Control II

221 Larval control strategies in the area-wide management of *Aedes albopictus*
Sean P. Healy, shealy@co.monmouth.nj.us, Ary Farajollahi, Taryn Crepeau, Isik Unlu, Gregory M. Williams, Randy Gaugler and Dina M. Fonseca

Our objective is to develop an effective and operationally feasible management strategy for the area-wide control of *Aedes albopictus*. In 2010, multiple larvicides, application equipment, and application strategies were evaluated as part of the area-wide control program at suburban and urban sites located in Monmouth and Mercer counties, NJ. This presentation will summarize the project's use of the insect growth regulators, methoprene and pyriproxyfen, as well as the biological larvicides, spinosad, and *Bacillus thuringiensis israelensis*. The results of bioassays performed to assess delivery methodology and field efficacy of several of the products will be presented and future directions will be discussed.

222 Mosquito management in constructed treatment wetlands: Implications of strategies for sequential harvesting of plant biomass
William Walton, william.walton@ucr.edu, Kevin Mai, Yu Tse and Andrew Nguyen

Emergent macrophytes play critical roles in water treatment processes of constructed treatment wetlands. Management strategies for plant biomass affect wetland function and mosquito populations. Sequential harvesting of a subset of the plant biomass annually across multiple years provides an alternative source-reduction strategy to removal of plant biomass across the entire wetland at multi-year intervals. Sinking of harvested macrophyte biomass is thought to retain organic carbon that enhances denitrifying bacteria that are important for nutrient removal while

concomitantly reducing harborage for mosquitoes. The consequences of sinking versus floating dried plant biomass were examined in mesocosms under different flow regimes. Mosquito abundance and water quality parameters (nutrient levels, oxygen demand, and physico-chemical variables) were measured. Mosquito numbers in mesocosms with floating vegetation were greater than in mesocosms with sunken vegetation on most dates during spring. Sinking vegetation will enhance the effectiveness of mosquito control but, depending on water management practices, may raise the concentrations of water quality constituents in discharges that are regulated under the Clean Water Act. Wetland designs that facilitate sequential harvesting of plant biomass have the potential to maintain critical functions of constructed treatment wetlands during source reduction for mosquitoes and to increase the effectiveness of mosquito abatement.

223 One Natular™ XRT treatment controls West Nile virus vectors in Minnesota catch basins all season (June-September)

Jim Stark, jimstark@mmcd.org, Stephen A. Manweiler and Kirk A. Johnson

Three years of testing (2008-2010) have demonstrated that 1 treatment of Natular™ XRT (spinosad) can effectively control West Nile virus (WNV) vectors for the entire season unless heavy rainfall (2+ in/24 h) occurs. In 2008, 1 Natular™ XRT per catch basin controlled over 99% of mosquitoes for the entire season. The 2009 test was more rigorous because 4 daily rainfall events of more than 1 in occurred in August (none occurred during the 2008 test). One Natular™ XRT treatment again controlled mosquitoes the entire season (84% for 13 wk). In 2010 Natular™ XRT achieved 99-100% control until 2 wk after 2 consecutive d (June 26, 27) when daily rainfall was greater than 2 in. Additional Natular™ XRT treatments applied to different catch basins after these rainfall events effectively controlled WNV vectors.

224 Use of Natular™ DT and Natular™ XRT for larval control in the Florida Keys

Mikki Coss, mcoss@keysmosquito.org

Because of the growing number of locally acquired dengue cases in Key West, FL, the Florida Keys Mosquito Control District (FKMCD) was in search of additional products to add to its already extensive larval control efforts. In the summer of 2010, FKMCD began use of both Natular™ DT and Natular XRT products in the control of container-inhabiting mosquito larvae, primarily the dengue vector, *Aedes aegypti*. These products have been applied to a number of different containers, as well as cisterns, wells, and catch basins. Future use of both Natular DT and Natular XRT will be extended throughout the Florida Keys in a variety of domestic environments.

225 Efficacy assessment of Natular™ 2EC in the aerial larviciding program of the Merced County Mosquito Abatement District

Jason Bakken, jasonwbakken@gmail.com, Allan Inman, Jim McNelly and David Dame

Aerial larviciding is a key component of the integrated mosquito management program practiced by the Merced County Mosquito Abatement District (MCMAD). Since 2008, the District has larvicided between 60,000 - 200,000 acres annually by fixed-wing aircraft. In 2010, the MCMAD introduced Natular™ 2EC into the larviciding regimen. Over 4,000 acres of irrigated pasture and seasonal wetlands were treated with this spinosad-based larvicide at a rate of 2.8 oz per acre. Excellent control of *Culex tarsalis* in seasonal wetlands was achieved. *Culex tarsalis* larvae were reduced an average of 97%, from 92% - 100% in the 9 sampled areas. Control of *Aedes nigromaculis* in recently irrigated pastures and *Aedes melanimon* larvae in recently flooded seasonal wetlands was variable but ranged as high as 97%. Potential sources of variability will be discussed, as well as the potential for Natular™ 2EC as a rotational larviciding tool.

226 Natular™ challenges air, ground and boat sites

Jonas Stewart, jkstewart8@yahoo.com

Natular™ XRG controlled 2 species of midges at 2 locations in Lake Monroe, FL. Junk car salvage lots were treated using a hand spreader and a helicopter granular spray system to control 2 species of container habitat mosquitoes. Good larval control was achieved by ground and aerial application of Natular™ XRG to junk cars.

227 Pyriproxyfen, autodissemination and the Asian tiger mosquito

Randy Gaugler, gaugler@rci.rutgers.edu, Sean P. Healy, Ary Farajollahi, Greg Williams, Muhammad Farooq, Devi Suman, Yi Wang, Aaron Lloyd, Dina M. Fonseca and George Schoeler

Pyriproxyfen is an exceptionally low risk IGR that is active against mosquito larvae at minute concentrations. Yet this insecticide has seen virtually no use in mosquito control. The recent Devine and co-workers demonstration of pyriproxyfen autodissemination by *Aedes aegypti* females to larval habitats has generated fresh interest in exploiting the compound. Although hampered by regulatory constraints limiting applications to less than 10 acres with backpack sprayers, we are attempting the next phase of study: operational research in which autodissemination moves toward implementation. Experiments have been initiated to develop a practical application strategy that uses a commercially available product (NyGuard® EC10, MGK Corp.), conventional equipment, and optimized spray parameters. This work is focused in urban environments against *Aedes albopictus*. Our 2010 studies indicate broadcast treatments can result in toxic concentrations of pyriproxyfen being transferred to new larval habitats at least 200 m distant from the point of application.

228 Pyriproxyfen persistence in the control of *Aedes aegypti* (Diptera: Culicidae) in plastic tanks of 100 l with constant water replacement in Barranquilla City (northern Colombia)

Jorge L. De las salas Ali, jldali@yahoo.com.mx, Jesús E. Manotas and Pedro J. Arango

In Barranquilla, plastic tanks are an excellent ovipositing site for *Aedes aegypti*. As an alternative to control it, the replacement of water was evaluated in the persistence of pyriproxyfen in plastic tanks of 100 liters, in 2 atmospheres (inside laboratory and outdoor), in Barranquilla, determining its use frequency for these. Each test had 4 treatments and 4 controls respectively. Tanks were filled up to 80 l adding 0.16 g of pyriproxyfen to achieve 0.01 ppm. Lots of 25 larvae (late L3 and/or early L4) were introduced into the container; these were observed every 24 h. Once all individuals died, 60 l were replaced and the next batch evaluated until emergence as adults. Mortality of larvae, pupae, total mortality, pupae formation, mortality in hatching and hatching were analyzed. The outdoor test lasted 100 d, watching loss of effect since the 70, with an 86% of pupae mortality and adult viability until 90. There was less persistence in laboratory testing, loss of effect at 50 d and viability at 70. Larval mortality, total mortality, mortality in hatching and hatching, were significantly different ($P < 0.05$). It suggests the use of the product in plastic tanks of 100 l with a frequency of 10 wk.

229 Field portable acoustic larvicide design and performance

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Acoustic larvicide is the process of killing mosquito larvae by using sound energy waves matched to the resonance of the internal air volume of mosquito larvae. Because of the various sizes and associated air volumes to maintain their buoyant condition, the resonant frequency they are susceptible to changes. The design of a field portable system requires the full spectrum of sound be introduced to the water at such an energy level and a rate that an operator can briskly walk and cover a large area. This paper discusses the design considerations and operational results obtained to date with a field portable system. The field portable system is battery powered and emits pulses of sufficient power to have an effective range of over 12 ft for the entire acoustic spectrum of sound emitted. It operates at a 35% duty cycle and takes less than 2 sec to transmit the full range of frequencies allowing the operator to move at a normal walking pace.

Where the Wild Things Are: Wildlife, Exotic Animals, Vectors and the Diseases They Share

230 American White Pelican (*Pelecanus erythrorhynchos*) mortality surveillance for West Nile virus in Montana

Gregory Johnson, gdj@montana.edu, Nicole Nemeth, Kristina Hale, Nicole Lindsey, Nicholas Panella and Nicholas Komar

This presentation will summarize monitoring efforts during 2006-2007 of West Nile virus-associated die-offs of American White Pelican (*Pelecanus erythrorhynchos*) chicks at Medicine Lake National Wildlife Refuge in northeast Montana. Mortality of pre-fledged pelicans in nesting colonies in the northern Great Plains sharply increased from an average 4% to >35% following the arrival of West Nile virus to the area. We monitored the Medicine Lake colony to document WNV infection, identify vectors, and determine specimen type for most efficient detection of WNV in pelican carcasses. WNV-infected *Culex tarsalis* mosquitoes were detected and blood-engorged *Cx. tarsalis* contained pelican DNA. Viral loads and detection consistency among pelican tissues was greatest in feather pulp, brain, heart and skin. In addition, pre-fledged die-offs at various nesting colonies in the U.S. were evaluated for a potential association with incidence of human West Nile neuroinvasive disease (WNND), and we found a 5-fold increase in risk of human WNND in counties hosting these pelican nesting colonies. Thus, given the risks posed to wildlife and human health, coordinated efforts among wildlife and public health authorities to monitor American White Pelican colonies for WNV activity is potentially useful.

231 West Nile virus seroprevalence, clinical signs and response to vaccinations in camelids within the United States

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In the U.S., 77% of camelid farms tested had 1 or more WNV seropositive animals, some with a seropositivity rate ≥70%. Similar to humans and horses, clinical manifestation of WNV disease in camelids is broad. With rare exception, once neurologic signs develop, the animal succumbs to fatal WNV encephalitis within 4 d. We developed an IgM capture ELISA assay for differentiating between acute and previous subclinical infection or vaccination titer. We also demonstrated the efficacy of administering normal llama plasma with high antibody titers against WNV to healthy naive alpacas as well as in alpacas with clinical WNV encephalitis. Lastly, we performed a vaccination trial with 84 camelids using a commercial WNV vaccine. All camelids received 3 vaccinations (1-ml IM) at 3-wk intervals. Following third vaccination, 100% of alpacas and 96% of llamas developed virus-neutralizing antibody titers of 545±4 and 446±4 (mean±SD), respectively. Virus-neutralizing antibody titers were still present in 93% of alpacas at 42 wk and 81% of llamas at 27 wk following initial immunization. One year after vaccination, vaccinated and unvaccinated alpacas were experimentally challenged with WNV. While neither treatment group showed clinical evidence of WNV, unvaccinated alpacas became viremic following the challenge whereas vaccinated alpacas did not.

232 Eurasian Collared-Doves (*Streptopelia decaocto*) and their role as West Nile virus amplification hosts
Nicholas Panella, nap4@cdc.gov

The Eurasian Collared-Dove (*Streptopelia decaocto*) is an introduced species to North America and has expanded its range rapidly since 1985, arriving in Colorado in 1996. These invasive doves now occupy almost every county of Colorado and are becoming abundant, especially in small towns in rural, agricultural settings. This species was the third most abundant among almost 100 species recorded on the 2007 Christmas Bird Count in Fort Collins, CO. Populations of these birds may play a significant role in the amplification of West Nile virus (WNV) in these environments. This study will describe the viremic response of adult Eurasian Collared-Doves to infection with a 2007 Colorado strain and a New York 1999 strain of West Nile virus. Eurasian Collared-Doves are hypothesized to effect WNV transmission dynamics in certain locations of the USA because of their expanding population.

233 Investigating disease in declining Thick-billed Parrot populations in northern Mexico
Nadine Lamberski, nlamberski@sandiegozoo.org, Simon Anthony, Jean-Pierre Montagne, Javier Cruz Nieto, Sonia Gabriela Ortiz Maciel and Edward J. Dubovi

The endangered Thick-billed Parrot (TBP) (*Rhynchopsitta pachyrhyncha pachyrhyncha*) once ranged from the southwestern U.S. to northern Mexico. They exist today only in the pine forests of Mexico's Sierra Madre Occidental. Current populations are threatened by habitat destruction and degradation. Information regarding the role of disease in population declines is lacking. We hypothesize that climate change leading to changes in vector prevalence increases disease threats to wild populations. In 2003, 20% of all deaths of captive TBPs in the U.S. were a result of West Nile virus (WNV) infection. TBPs nest at elevations >2000m. These high-elevation habitats may limit mosquito activity. With limited mosquito activity, exposure to other flaviviruses that cross-protect against WNV is also limited. We initiated a TBP health and habitat monitoring program to better define disease concerns in the region. We identified mosquito vectors for WNV, *Culex quinquefasciatus* and *Culex tarsalis*, at 2 sites. Serum samples from 24 TBP chicks were negative for WNV and St. Louis encephalitis virus. Using a mobile molecular laboratory, in-situ field diagnostics were performed on liver and spleen collected from a dead chick and were positive for a non-WNV flavivirus. We were unable to confirm that this virus contributed to the bird's death.

234 Modeling West Nile virus under present and future climate conditions
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West Nile virus (WNV) is one of the most prevalent flaviviruses in the world, transmitted by vectors to primary and secondary hosts. Since its recent introduction, the disease has spread rapidly across North America, leading to annual avian and mammalian epidemics, and serious health risk to humans. WNV incidence is correlated with environmental factors, yet little is known about which environmental conditions best explain spatial and temporal variation in WNV incidence, and how these relationships might change under future climate. We modeled WNV incidence under current and future climate conditions using an underutilized dataset on WNV infections in vectors and hosts collected from 2001-present, in conjunction with observed and projected climate data and high-resolution satellite remote sensing data that capture ecological surface attributes. These models were used to link the broad continental patterns of WNV presence to fine-scale prevalence variation that may influence local transmission events. Understanding the relationship between regional environmental conditions and outbreaks of WNV will improve geographic risk assessments for particular viral hotspots and will shed new light on how exotic diseases may be impacted under climate change.

235 Avian malaria in a changing world
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We conducted a study of the effects of deforestation on the spread of blood parasites in African rainforest birds. Over the past 17 yr, we have collected more than 10,000 individual blood samples from over 200 rainforest bird species in a variety of habitats across Central and West Africa. Using complementary techniques of blood smear analysis and molecular biology, samples are assayed for *Plasmodium*, *Haemoproteus*, *Leucocytozoon* and *Trypanosoma*. We have obtained results regarding the host-specificity, prevalence and lineage diversity of these parasites in rainforest birds. As part of the larger project, we collected blood samples from 2 bird species from 8 paired disturbed and undisturbed sites in southern Cameroon. We describe the parasite lineages in 2 common bird species. Linking these DNA sequence lineages with identified parasite morphospecies, we describe significant differences in prevalence between habitat types in the haemosporidian parasites. We incorporate satellite imagery data to quantify differences among the sites, and predict how changes in forest composition may affect the spread of diseases. With the combined information we have developed models to help predict how deforestation will influence future disease outbreaks, thus facilitating the development of reforestation strategies.

236 Sentinels of West Nile virus: West Nile virus effects on exotic game birds and poultry production
Teresa Y. Morishita, tmorishita@westernu.edu

West Nile virus (WNV) has spread across the country, affecting both human and animal health. Its effect on the health of avian species varies depending on the age and species involved. Domestic chickens have long been the species of choice to serve as sentinels for the monitoring of arthropod-borne viral diseases, including WNV. This presentation will discuss how to have effective WNV monitoring programs utilizing domestic chickens. In addition, the effects of WNV on other species of poultry, both domestic and exotic, will be discussed so that one will become

more familiar in using the morbidity and mortality of these exotic and domestic poultry production flocks to develop effective WNV monitoring programs.

237 West Nile virus infection in neotropical raptors
Miguel D. Saggese, msaggese@westernu.edu

Since its appearance in North America in 1999, birds of prey have been particularly susceptible to West Nile virus (WNV). Species commonly affected included Great Horned Owls (*Bubo virginianus*), Cooper's Hawks (*Accipiter cooperi*) and Red-Tailed Hawks (*Buteo jamaicencis*) among wild birds, and Gyrfalcons (*Falco rusticolus*) and Goshawks (*Accipiter gentilis*) in captive collections, but reports exists for almost all species of raptors present in North America. WNV infection is capable of causing fatal disease in most raptors species, usually after a course of several weeks post infection but can also presents as an acute and fatal form. Clinical signs in these birds include altered mental status, head tremors, seizures, paresis and paralysis, retinal degeneration and detachment, anorexia, weight loss, dehydration, anemia and leucocytosis. Recently, WNV has been reported in South America. WNV infection could have detrimental impact on naïve populations of threatened or endangered Neotropical birds of prey. Adequate surveillance programs are needed for early detection of this disease. Ornithologists, virologists, and veterinarians may play an important role in the early detection and study of the effect of WNV infection in Neotropical birds of prey. This presentation will discuss ecoepidemiology of WNV and its possible effects on Neotropical raptors.

238 Lyme disease in the Far West: Looking beyond rodents
Stan A. Wright, swright@sac-yolomvcd.com, James R. Tucker, Anne Donohue, Martin Castro, Kara Kelley, Mark G. Novak and Paula A. Macedo

Reptiles, mammals, and birds were sampled simultaneously in an oak woodland habitat on the UC Quail Ridge preserve in the coastal foothills of northern California for the presence of larval and nymphal *Ixodes pacificus*. Larvae from birds and rodents were tested via RT-PCR for the presence of *Borrelia burgdorferi* sensu stricto. Mean infestations of subadults of *I. pacificus* for this location were greatest on *B. burgdorferi* refractive lizards, followed by birds and lastly rodents. Some mean infestations from individual bird species equal that of the lizards and are multiple times greater than those on the *B. burgdorferi* reservoir, competent dusky-footed woodrats. *Borrelia burgdorferi* infected larvae were detected from 1 dusky-footed woodrat, *Neotoma fuscipes* and 2 Oregon Juncos, *Junco hyemalis*. Larval infection with *B. burgdorferi* is rarely transovarial suggesting that juncos may be a competent vertebrate reservoir, as are woodrats, and therefore may contribute to the cycle of Lyme disease.

239 Potential role of crocodilian species in West Nile virus enzootic cycle
Tejbir S. Sandhu, tsandhu@northwestmvcd.org and Major S. Dhillon

Crocodilia (or Crocodylia) is an order of large reptiles that appeared about 84 million years ago in the late Cretaceous Period (Campanian stage) and is the closest living relative of birds. The primary enzootic cycle for West Nile virus (WNV) is between adult ornithophilic mosquitoes and birds, while humans and horses act as incidental hosts. Reptiles are known to be infected with several mosquito-borne viruses. Extensive review of literature has shown that there is very little evidence available with respect to disease ecology of WNV in crocodilians. It has been reported from various crocodilian species, including the American alligator, Nile crocodile and Morelet's crocodile (*Crocodylus moreletti*). This presentation will discuss field reports and some of the experimental studies for possible routes of infection; clinical symptoms of resulting disease; gross and microscopic changes in different organs; antigenic distribution of WNV in different organs; extent of viremia; effect of age, environmental temperature and stress on the outcome of this disease; screening ability of available diagnostic tests; zoonotic evidence; and their suspected role in natural enzootic cycle of this virus. Further research to establish susceptibility and role of individual species of this order as amplifying and reservoir hosts need to be evaluated.

240 What was learned from study of West Nile virus in zoo species?
Tracey McNamara, tmcNamara@westernu.edu

This presentation will be about the lessons, which potentially we have learned or could have learned from the introduction of West Nile virus (WNV) to USA, in our quest for preparedness to tackle emerging zoonotic/biological warfare threats. Clinical experience of WNV infection in different zoo species will be presented with emphasis on what we learned from them.

The Other Flies: There Are More than Just Mosquitoes Out There I

241 Introduction and a brief history of one district's work with the "other flies"
Jamesina J. Scott, jjscott@lcvcd.org

Although mosquitoes are the best known and, arguably, the most important disease-transmitting arthropod in the world, there are numerous other flies that cause problems for humans and animals. Many of us at universities and mosquito control agencies are called upon to apply our expertise to "other flies" that are important regionally, including black flies, biting and non-biting midges and gnats, deer and horse flies, and many muscid flies. This symposium will provide a forum for sharing control strategies, knowledge about their biology, and other recent developments in the "other flies." The Lake County Vector Control District was established as the Mosquito Abatement District in 1948 to control the Clear Lake gnat (*Chaoborus astictopus*), a non-biting midge that reached great nuisance densities along the lake shorelines, affecting the Lake County tourism industry. The District's

responsibilities were expanded a few years later to include mosquito control and over the years the District has worked with other locally important vectors as needed, including various *Culicoides* species.

242 Ecological variables influencing habitat distribution of larval *Culicoides* (Diptera: Ceratopogonidae
Dustin A. Swanson, dswanso@clemson.edu

The immature stages of *Culicoides* have gone largely unstudied (only 19% of species have descriptions of the immature stages), resulting in a large gap in our knowledge of their ecology. This missing ecological data hampers vector management and epidemiological studies of *Culicoides*-borne disease. To better understand the ecology of *Culicoides*, larval presence/absence and abundance is being measured against 16 ecological variables. A total of 530 samples from 8 sites have been collected. Species identifications are in progress to assess which variables significantly influence larval habitat use.

243 A review of some *Culicoides* control techniques used in Florida
Roxanne Connelly, crr@ufl.edu and Jonathan Day

No-see-ums (*Culicoides* spp.) are especially troublesome in coastal areas of Florida and are particularly abundant in and around mangrove swamps and salt marshes. Removal trapping has been conducted using CO_2 as an attractant to lure the biting midges to an insecticide-treated target where they are killed. Research from the IFAS Florida Medical Entomology Laboratory showed that biting midge populations were reduced in test areas of Vero Beach and Boynton Beach, FL, and Castaway Cay, Bahamas, using removal trapping. This method of control is more appropriate for islands and specific inland areas where pest control personnel can make a long-term commitment to this technique. Recommendations to homeowners are limited to physical barriers such as screening for windows and the use of fans. A review of some experimental techniques tried in Florida, and a discussion of their practicality will be presented.

244 Nuisance chironomid control in Los Angeles County
Mark Daniel, mdaniel@glacvcd.org and Susanne Kluh

When midges emerge in enormous numbers, they can cause discomfort or irritation by entering the eyes, ears, nose, and mouth, and, though not capable of transmitting diseases, they have been documented to cause allergic reactions, to lessen real estate value in residential areas and can interfere with processing of food, paper products, plastic, and automotive refinishing operations in industrial situations, causing significant economic impact. In Los Angeles County, CA, where the demand for water continually exceeds local water availability, rain and snowmelt water retention and infiltration are a high priority. Thus, all of the major water ways are accompanied by extensive spreading basins to allow ground water recharge. During years of drought or periods with moderate rainfall, water can be rotated between basins to prevent chironomid mass emergences. In spring, when the available water volume exceeds spreading ground capacities, rotation is no longer a possibility and treatment becomes necessary. At the same time, overwatering of green spaces and lawns creates a constant nuisance flow resulting in permanent slow flowing water in some of the flood control channels, which, in combination with algae build up, creates midge habitat that will, on occasion, warrant control activities. In 2010, 177 acres were treated with Dimilin® sand. To help further reduce nuisance pressure in adjacent neighborhoods, surrounding areas were treated with Scourge®, using truck mounted ULV foggers.

245 *Bti* for chironomid midge control: it's a little different than mosquito control
Robert A. Fusco, robert.fusco@valent.com

Chironomids are the most widely distributed and, frequently, the most abundant insects, produced in a variety of aquatic habitats. When they emerge in large numbers in eutrophic urban water bodies, the adults may create serious nuisance and economic problems, and control measures often have to be implemented. As with mosquitoes, chironomid midges are best controlled as larvae in the aquatic habitat, but control methodology is a lot different than the control of mosquito larvae. Midge larvae live in the bottom substrates and are not as mobile as mosquito larvae, and thus it is important that the *Bti* be delivered to the benthic surface where they are feeding to be effective. Chironomid assemblages in this habitat require different sampling methods, and identification of the assemblages is very important because not all midge species are susceptible to *Bti*. Late instar larvae are also less sensitive than early stages and even age within instar stages make timing of applications critical. Another concern is quantification of midge density to establish what nuisance levels or economic impacts are acceptable under differing circumstances.

246 Black fly control in southern California
Kenn Fujioka, kfujioka@sgvmosquito.org and Kelly Middleton

Black flies do not transmit diseases among humans in southern California. However, they can be considerable nuisances and their bites can cause allergic reactions or be infected secondarily. Here we discuss various methods vector control districts use in southern California to manage their black fly populations.

247 Larval black fly (Diptera: Simuliidae) distribution and diversity in the upper San Gabriel River catchment (Los Angeles County, CA)

Christopher Solek, chriss@sccwrp.org and Vincent Resh

The distribution and seasonal abundance of black fly larvae (Diptera: Simuliidae) were examined in relation to selected stream physical properties and other environmental variables in 9 stream sites in the upper San Gabriel River catchment (Los Angeles Co., CA). A total of 12 morphologically distinguishable species of black flies were collected from this catchment. Species composition and abundance were not the same among sites and varied significantly throughout the year. Multi-response permutation procedures and indicator species analysis indicated very highly significant among-group differences in species assemblages among the 9 study streams. Elevation, slope, minimal channel alteration, substrate type, the presence of pools, algae, fines/fine gravel, increased conductivity and salinity, and indicators of channel modification by humans were the physical variables most related to the black fly species composition in streams. In addition, the influence of recreational rock dams and littered trash on the abundance and species occurrence of larval black flies was investigated. Significant differences in the densities of black fly larvae on the dam structures, compared to locations upstream and downstream of the dams, were detected. Ordination techniques did not reveal any patterns to suggest differences in the use and time to colonization of experimental trash substrates compared to natural substrates by black fly larvae.

248 Black fly suppression activities on the Delaware River: A cooperative program between two states

Andy Kyle, akyle@state.pa.us and Robert A. Fusco

Beginning in 1995, a Joint Black Fly Suppression Project was initiated between Pennsylvania and New Jersey to determine what streams were responsible for adult black fly activity along the Delaware River. Biologists from the PA-Department of Environmental Protection (DEP) and Rutgers University began to extensively survey black flies in the Delaware River and its larger tributaries in Pennsylvania and New Jersey from Trenton upriver to the Delaware Water Gap National Recreation Area. The purpose of the survey was to determine the size of the black fly larval populations and locate the exact location of production areas of the pest species, *Simulium jenningsi* complex. In 1996, New Jersey issued the first pesticide permit for Pennsylvania to begin aerial black fly suppression activities using *Bacillus thuringiensis israelensis* (*Bti*) on the Delaware River. The application cost of these spray activities was evenly divided by the 2 states. Things have changed over the past few years because of the economic hardship affecting the State of New Jersey. Pennsylvania continues to aerially treat the Delaware River but receives no financial support from New Jersey. Rutgers University is longer involved in field surveillance on the river. However, NJ-DEP does continue to process and approve the pesticide permit for Pennsylvania allowing the suppression activities on the Delaware River to continue.

The Other Flies: There Are More than Just Mosquitoes Out There II

249 The University of Georgia: Black fly colony and bioassay laboratory

Elmer W. Gray, ewgray@uga.edu

The Department of Entomology is home to a dynamic and diverse black fly research program that houses the world's only black fly colony. This colony of *Simulium vittatum* produces ~250,000 larvae weekly, and is central to our research. The colony was established in 1981 from collections near Cambridge, NY, and operates as a modified version of the Cornell Automated System developed by Dr. Ed Cupp at Cornell University. The system incorporates a closed-circulation trough system. Water is pumped from a lower reservoir to upper chambers; it then flows through a wooden trough creating ideal larval habitat in an artificial stream system. The colony has associated systems that automatically feed the larvae, capture emerging adults, and provide suitable substrates for oviposition. The colony is operated throughout the year and many of the larvae are used weekly in an orbital shaker-based bioassay system for developmental research and related experiments with VectoBac® 12AS. Recent experiments have focused on factors affecting *Bti* toxin activity in rivers and streams. A controlled current toxicity test was also developed to evaluate the toxicity of various materials on larval black flies. Our colony provides research material to, and facilitates collaboration with colleagues on various research projects. Support for this work provided by Valent Biosciences Corporation.

250 Black flies in the 21st Century: A past or future problem?

Peter H. Adler, padler@clemson.edu

Historical and current trends in pest problems and the management of black flies in North America are examined as a means of inferring the future probability of problems and the need for management programs. The principal pest species, the types of problems they cause including swarming and biting of humans, livestock, and poultry, and the transmission of disease agents are evaluated, along with the associated economic losses. Black flies are nearly unique in the frequency with which they kill animals directly through exsanguination or toxic shock from salivary secretions. The longevity, locations, and expenditures for various management programs also are reviewed to determine future needs. The relationships of pest problems to environmental factors, such as size of the larval habitat, are presented along with factors, such as river eutrophication, that drive the appearance of new pest problems. Novel possibilities for black fly management programs are considered, including those for endangered and threatened wildlife.

251 Eye gnat control in the Coachella Valley
Jeremy Wittie, jwittie@cvmvcd.org

In 1928, the Coachella Valley MVCD was established primarily to control eye gnats (*Hippelates* spp.). Eye gnats have been a persistent problem in the Coachella Valley since agriculture was introduced. Primarily, they are nuisance pests and do not bite. Eye gnats may be present all year if the weather is mild, but are most numerous from March to November. They can act as mechanical vectors and spread infectious diseases to humans such as conjunctivitis, commonly called "pink eye." District surveillance staff setegg-baited eye gnat traps on a weekly basis. Traps are located throughout the Coachella Valley at sites such as golf courses, date groves, residences and schools. Weekly trap data is used throughout the season to assist in deployment of thousands of egg-baited traps to reduce and control the valley eye gnat populations.

252 The remarkable canyon fly
Bradley A. Mullens, mullens@mail.ucr.edu and Alec C. Gerry

Canyon flies (*Fannia benjamini* complex, Muscidae) are nuisance pests in the western USA coastal mountains. *Fannia conspicua* natural developmental sites are unknown, but in suburbs larvae develop on the surface of decaying leaves of the succulent "red apple." The leathery larvae resist desiccation and soil moisture as low as 10%. They probably aestivate and resume development after winter/spring rains. Females are powerfully attracted to animals and CO_2, synergized by ammonia. Over 500 females can be taken in 5 min using a sweep net around the body. They cannot make a wound, but likely require liquid protein (tears, bloody wounds, etc.), and gather on sweaty body areas. Sugar feeding (R. Mohr et al.) is ubiquitous (99-100%) and tracks diel rhythms in swarming (males) and host seeking (females). Female activity peaks in early to mid-morning and again in early evening, but stops abruptly at sunset. A mark-release-recapture study revealed high site fidelity, and marked females were recovered up to 33 d post-release, indicating a relatively long-lived species. The powerful attraction to baited traps, known affinity for succulent plantings, and rather focal and long-lived nature of the adults may make them amenable to control via adult trap-out programs or vegetation management.

253 Yellow flies: What are they? And how do you control them?
James E. Cilek, cilek_J@popmail.firn.edu

In the southeastern USA, yellow flies denote a group of yellow tinted deerflies (*Chrysops*). But in a 1904 note published in Entomological News (15:290-291), Nathan Banks formally linked the word "yellow fly" with *Diachlorus ferrugatus* as one of the worst biting flies found in the Dismal Swamp located in Virginia and North Carolina. The daily and seasonal occurrence as well as biting behavior of various yellow flies will be discussed. Also some management strategies at reducing pest annoyance to these biting flies will be presented.

Poster Abstracts

Adult Control

P-01 Evaluating the efficacy of truck-mounted ULV applications of DUET™ using two different methods in southeastern Massachusetts
Ellen P. Bidlack, ebidlack@yahoo.com

Increasing regulation of pesticide applications is demanding better documentation of efficacy. In 2010, Plymouth County Mosquito Control Project set out to better document the efficacy of our truck mounted ULV applications. Our goal was to conduct a series of cage tests in different habitats and evaluate how efficacy changes. We reared *Culex* mosquitoes and placed 10 to 20 female mosquitoes in each cage. Sixteen cages were placed in a block 300 x 300 ft in an old-field setting. Unfortunately, circumstances did not allow for further cage testing. However, high eastern equine encephalitis virus activity allowed us to evaluate the efficacy of a truck mounted ULV application in an urban setting using CDC light traps baited with CO_2.

P-02 Ultra-low-volume spray deposition on mosquitoes in bio-assay cages in a wind tunnel
Muhammad Farooq, muhammad.farooq@med.navy.mil, Aaron Lloyd, Todd W. Walker, Alden Estep, Jeffery Stancil and Craig Stoops

The goal of any ultra low volume (ULV) spray application is to deposit insecticide on the target insect. Frequently, the efficacy of ULV machinery and insecticide formulations for vector control is measured utilizing adult mosquitoes housed in bioassay cages; however, it has been demonstrated that not all of the spray enters the cages. Currently, the proportion of ULV sprayed insecticide that deposits on caged mosquito is not known. To determine the fraction of spray material that deposits on caged mosquitoes, a known amount of dye and BVA oil solution was sprayed onto cages holding 20 adult mosquitoes from a distance of 0.6 m in a controlled wind tunnel. Four spray settings producing droplets with volume medium diameters (VMD) of 28.9, 25.6, 22.8, and 20.5 µm were replicated 5 times with an air flow speed of 6.5 km/h. The amount of dye on the mosquitoes was determined using fluorometery. Results show that the fraction of spray deposited on each mosquito increased significantly with the decrease in VMD and ranged from 0.030% to 0.0576% of the total volume applied. It was also found that droplet

size significantly impacted the volume of deposition with a range of 2273 to 9383 droplets of respective VMD per mosquito.

P-03 Characterization of public health and citrus spraying equipment
Wesley Hoffmann, clint.hoffmann@ars.usda.gov, Bradley K. Fritz, Todd W. Walker and Muhammad Farooq

The control of arthropods that are vectors of human and animal disease is a high priority for both public health and military officials. As droplet size is a critical factor affecting vector control applications, the droplet size spectra produced by public health and citrus sprayers and both water- and oil-based solutions needs to be monitored. The public health sprayers are used to control vectors of diseases such as mosquitoes and flies. The citrus sprayers tested are being used to control Asian citrus psyllid. Many of the sprayers were evaluated over their full range of spray rates and pressures. The information presented can be used by applicators to better understand the effects of spray rates and pressures on different sprayers.

P-04 To kill an Asian tiger mosquito: Using DUET™ and truck-mounted ULV machines against field populations of *Aedes albopictus*
Ary Farajollahi, afarajollahi@mercercounty.org, Sean P. Healy, Isik Unlu, Taryn Crepeau, Randy Gaugler and Dina M. Fonseca

Aedes albopictus, the Asian tiger mosquito, is a diurnal mosquito with considerable nuisance and medical importance. Where abundant, this mosquito is responsible for most service requests to local mosquito control programs; however, control of this pest is problematic because larval sources are difficult to access and ubiquitous in urban/suburban habitats. Operational adulticide applications are generally not effective and transient at best. We conducted several truck-mounted ULV applications using DUET™ within 4 large study sites in 2 counties in New Jersey. We evaluated single (1-night) applications and double (2 continuous nights or 2 nights within 1 wk) applications in our study sites. Mosquito populations were monitored using BGS and oviposition traps throughout the active mosquito season. We provide data on our single and dual applications of DUET against *Ae. albopictus* and their impact on populations within our study sites.

P-05 Design, synthesis and bioassay of new mosquito insecticides and repellents
Maia Tsikolia, maia.tsikolia@ARS.USDA.GOV, Ulrich R. Bernier, Natasha M. Elejalde, Gary G. Clark, Kenneth J. Linthicum, Alan R. Katritzky, Svetoslav Slavov and Dennis C. Hall

New compounds and classes of compounds are needed to protect deployed military personnel from diseases transmitted by medically important arthropods. Historically, the synthetic insecticides and repellents have been effective tools for mosquito control. To develop new synthetic insecticides and repellents, a combined approach was applied which involved modeling and synthesis of compounds followed by laboratory bioassays using human volunteers. The initial data for compounds used in models were extracted from the 30,000 compound USDA archives. From these data, quantitative structure activity relationship (QSAR) models were developed and used to predict novel insecticide structures. Repellent models were based on 200 acylpiperidines and 167 carboxamides as the training and validation sets. From this, predicted novel acylpiperidines and carboxamides were synthesized and some had a repellency duration up to 5 times as long as N,N-diethyl-3-methylbenzamide (DEET). Another model was developed based on larger dataset that contained 1410 compounds. From this model, 4 novel compounds with minimum effective dosage (MED) similar to or better than DEET were discovered. Additional models using datasets of “house fly residual,” “house fly contact” and “malaria mosquito insecticides” data have been developed, leading to the discovery of 7 efficacious insecticides. This presentation will cover the QSAR modeling approaches along with the results of screening and toxicological testing.

P-06 Mosquito movement patterns and the development of barrier trapping strategies for mosquito control
Cynthia C. Lord, Joseph J. Pohedra and Roxanne Connelly

Establishing trap barriers to protect people in specific areas from mosquitoes is of increasing interest. Developing these methods would allow protection in key sites, while reducing reliance on pesticides. The salt marsh mosquito, *Aedes taeniorhynchus*, is a serious pest in coastal areas of Florida. We developed a model focused on mosquito movement and wind influences to identify the trapping strategy that best protected a target area in a public garden. One goal of the study was to determine if a simplified model could accurately predict which strategies would be most successful; therefore, the landscape was relatively simple. Sensitivity analyses were used to assess the effect of mosquito movement, attractiveness of traps and wind on the efficacy of trapping strategies. The 2 most effective strategies were chosen for use in a field study using CDC light traps. Each chosen strategy and no traps were alternated weekly, with a sentinel trap and landing rates measured in the center of the area. The relative efficacy of the 2 trapping strategies was compared to the outcome of the model. We found that a model with a simplified landscape could predict effective barrier trapping strategies and a simple line of traps can reduce biting pressure in the target zone with this landscape. Further data are needed on mosquito movement patterns including collection patterns across traps in field and model data, and species with different emergence and movement patterns.

Abstracts

Biology and Behavior

P-07 Life history studies of *Aedes sierrensis*, the western treehole mosquito
David L. Woodward, dwoodward@lcvcd.org, Brittany M. Nelms, Bonnie M. Ryan and Jamesina J. Scott

During the past 25 years, the Lake County Vector Control District has conducted numerous studies of the emergence, host-seeking, ovipositional and resting behaviors of *Aedes sierrensis*. Females are economically important biting pests of people and known vectors of *Dirofilaria immitis*, the canine heartworm, within much of temperate western North America. Life history studies of the adults are particularly important for this species because the immature stages often occur in cryptic or elevated treeholes where they are difficult to locate or control. We present here the results of diel, seasonal and long-term studies of adult activity. We also correlate these data to environmental variables that can be used to explain differences in biting intensity and population size over time and space.

P-08 Distribution of *Anopheles arabiensis* and *Anopheles gambiae* in Kenya
Kyoko Futami, futami@nagasaki-u.ac.jp, Peter Lutiali, Gabriel Dida, Mercy Mwania, Gordon Opiyo, Schola Wagalla, James Kongere, Jecinta Lumumba, George Sonye, Sammy Njenga and Noboru Minakawa

Distribution and relative abundance of sympatric vectors are important factors that affect malaria transmission because vectorial capacity may differ among them. Major malaria vectors, *Anopheles gambiae* and *Anopheles arabiensis* inhabit similar habitats, but their biting behaviors are quite different. Although distribution of these species has been reported, the available information was too old to illustrate current distribution. We collected *An. gambiae* complex larvae at more than 500 sites in Kenya from 2008 to 2009 and determined relative abundance of the 2 species. This study revealed that 1) *An. arabiensis* is distributed in most part of Kenya, while *An. gambiae* was not found in Central Kenya; 2) *An. arabiensis* also occurred in high altitude areas including Nairobi where malaria vectors had not been recorded for decades; and 3) density of *An. arabiensis* remained high even in low malaria transmission area. This study added several new distributional records, and the distribution of malaria vectors in Kenya became clearer than ever.

P-09 An investigation of Placer County's snowmelt mosquito species
Angella M. Falco, angellaf@placermosquito.org and Mary A. Sorensen

The yearly spring emergence of the prolific and pestiferous snowmelt *Aedes* mosquitoes in the mountain regions of the Tahoe basin present public health agencies with the unique challenge of protecting residents in this unique and ecologically diverse area. A thorough investigation was undertaken to document the diversity, distribution, and abundance of snowmelt *Aedes* at 5 selected study sites. Weekly larval mosquito surveillance began at the sites in March 2010. Larval surveillance involved sampling standing water at each study site using a long handled dipper with white cup and visually looking for larvae. When larvae were detected, samples were taken for identification, and the following information was recorded: date, temperature, elevation, latitude, longitude as well as a description of the larval source including pool size, substrate, sunlit or shaded and surrounding vegetation. Once pupae were detected at a site, adult surveillance also began weekly using a CO_2 baited Fay-Prince trap. Surveillance continued until larval habitat dried up or larvae were no longer detected. This study will be continued in 2011 to increase our understanding and knowledge of snowmelt *Aedes* and make our control efforts as effective as possible.

Disease and Vector Studies

P-10 Potential of azadirachtin (Neem)-treated *Culex pipiens*, the vector of *Wuchereria bancrofti*
Belal A. Soliman, ba.soliman@yahoo.com and Maha K. Tewfick

The effect of neem on the vector potential of *Culex (Cx.) pipiens* for filariasis was investigated based on the biological attributes of neem-treated mosquitoes, and its vector competence to *Wuchereria (W.) bancrofti*. The calculated median lethal concentration (LC50) of azadirachtin (Az) to *Cx. pipiens* larvae was 1.32 mg/L (1.07-1.64 mg/L. Among ovipositional attributes of neem-treated mosquitoes, fertility of oviposited eggs (58.33%) was significantly reduced comparing to eggs laid by non-treated mosquitoes (95.30%), while oviposition rate, gonotrophic cycle, and fecundity of mosquitoes were not affected by larval neem treatment. Treatment of *Cx. pipiens* larvae with a sublethal dose of Az (1.07 mg/L) caused a reduction in mosquito infection rate with *W. bancrofti* and survival to infectivity. The present study suggests that minute dose of the environmentally safe agent, azadirachtin, could effectively control *Cx. pipiens* on one hand and could interfere with its transmission to *W. bancrofti* on the other hand.

P-11 An established population of *Amblyomma maculatum* at a closed landfill in Fairfax County, VA
Joshua Smith, Joshua.Smith@fairfaxcounty.gov, Douglas Norris, Sonya Graves, Christopher Eliff, Xing Zhang and Jorge Arias

In 5 yr of tick surveillance in Fairfax County, only 8 *Amblyomma maculatum*, a *Rickettsia parkeri* vector, had been collected using a variety of collection methods. In June 2010, a wounded fawn was found at an old landfill (closed since 1982) and brought to the animal shelter. Examination of the animal yielded 73 *A. maculatum* adults (53 ♂, 20 ♀). Outside of the landfill area, only 4 other *A. maculatum* were collected through regular surveillance in 2010 in Fairfax County. Follow-up surveillance activities (dragging, flagging, trapping) at the landfill yielded 224 more *A. maculatum* (89 ♂, 132 ♀, 3 nymphs). No *A. maculatum* were detected in the areas surrounding the landfill. *Amblyomma maculatum* were tested via PCR for *R. parkeri* and approximately 40% were positive. Deer and small mammals were also examined for ticks and tissue samples were taken for future *R. parkeri* testing. One *Am.*

maculatum tested positive for *R. andeanii*. Other tick species collected at the landfill include *Dermacentor variablis*, *A. americanum*, and *Ixodes scapularis*. We treated approximately 80 acres of landfill vegetation with 177 gal of 0.5% permethrin spray in late August in an effort to control the ticks and try to prevent them from spreading outside the landfill. Post-spray sampling showed a reduction in the overall number of ticks. Surveillance will continue in 2011 and the area will be treated again if surveillance indicates *A. maculatum* activity.

P-12 Adult mosquito surveys of Saint Kitts and Nevis, 2010

Joshua Smith, Joshua.Smith@fairfaxcounty.gov, Hamish Mohammed, Floyd Revan and RC (Tammi) Krecek

Classic mosquito surveillance studies in the Federation of Saint Kitts and Nevis (SKN) predate the major range expansion of *Aedes albopictus*. To update these studies and determine whether any novel species have been introduced, a mosquito survey was performed. Surveys were performed in the dry season (Mar. 16-23, 2010) in St. Kitts and repeated in the rainy season (Oct. 18-25, 2010) in SKN. BG Sentinel™ traps were set with CO_2 in a variety of habitats (urban, rural, rainforest, mangrove, dry forest). Identification was performed using morphological keys, and RT-PCR testing for dengue and West Nile virus is pending. In the dry season, 4,279 mosquitoes were trapped in 73 trap periods. In the rainy season, 2,626 mosquitoes were collected in St Kitts in 56 trap periods. The most abundant species during both phases were *Culex quinquefasciatus* (68% dry, 40% rainy), *Aedes taeniorhynchus* (19%, 42%), and *Aedes aegypti* (8%, 11%). Urban and semi-urban sites mainly yielded *Cx. quinquefasciatus* and *Ae. aegypti*, while those near mangroves yielded more species diversity. A new record for St. Kitts was *Anopheles albimanus*. Traps were set for 5 trap periods in Nevis and 659 mosquitoes were collected. This is the first time a potential malaria vector has been identified from St. Kitts. Other potential disease vectors, *Cx. quinquefasciatus* and *Ae. aegypti*, were found throughout SKN. No *Ae. albopictus* were found during the surveys.

P-13 The use of a hand-held net gun to trap American Crows (*Corvus brachyrhynchos*) for West Nile virus surveillance in Orange County, CA

Tim Morgan, interns@ocvcd.org, Kiet Nguyen, Martine Jozan, Francisco Flores and Robert Cummings

Trapping of birds for disease surveillance in urban/suburban areas is logistically challenging and inconsistent, especially when targeting the American Crow (*Corvus brachyrhynchos*). The American Crow has been implicated as an important amplifying host in the West Nile virus (WNV) transmission cycle and has been the focus of many public health-related studies. Obtaining serologic data from wild crows is difficult because of the bird's ability to avoid capture. Traditional baited traps, such as drop down, walk-in, and fixed net cannons, have proven time-consuming with limited success. We found that, alternatively, an inconspicuous hand-held net gun can be used to catch foraging crows without baiting or loitering. Since crows are habituated to humans and automobiles in urban areas, the gun can be used while walking in proximity to crows or from the open window of a moving vehicle. During a 14-wk trapping effort by Orange County Vector Control, 99 crows were captured in urban/suburban areas with an effective trap-hour-to-bird ratio of 1.13. Seven of 97 (7.21%) American Crows tested WNV-seropositive. Previous studies have reported 100% mortality in American Crows experimentally infected with WNV (NY99). Our preliminary serologic data suggests that despite high mortality in American Crows due to WNV, some conspecifics are surviving infection.

P-14 Overview of the Deployed War-Fighter Protection Program (DWFP) research activities administered by the Armed Forces Pest Management Board (AFPMB)

Douglas A. Burkett, douglas.burkett@osd.mil, Stanton Cope, Dan Strickman and Graham White

The Deployed War-Fighter Protection (DWFP) Research Program is an initiative from the U.S. Armed Forces Pest Management Board (www.afpmb.org) to develop new materials and methods for protection against flying pests and vectors of pathogens threatening deployed soldiers. The DWFP program (annual funding $5 million) reinvigorates the partnership between the Department of Defense and the USDA Agricultural Research Service to support for military preventive medicine. Three pillars of DWFP research are (1) development of novel insecticides and formulations for control of mosquitoes, sand flies and other vectors; (2) development of personal protection equipment and repellents; (3) development of new and improved equipment for insecticide application. Since the DWFP program began in 2004, this effort has yielded 5 new classes of insecticides, 5 new repellents, filed 13 patents, licensed several products for commercialization, put 6 new products in the National Military Stock System, scientifically evaluated nearly all types of pesticide application equipment marketed in the U.S., and published over 220 papers in peer-reviewed journals. This poster displays some DWFP highlights, with wider value for public health vector control.

P-15 Continuing studies on host-seeking behavior and seasonality of West Nile vectors in northern Colorado

Marvin S. Godsey, mjg9@cdc.gov, Kristen Burkhalter and Harry M. Savage

Studies we conducted in northern Colorado during 2006-2007 using John Hock collection bottle rotator traps indicated that *Culex tarsalis* host-seeking peaked 1.2—4.5 h post-sunset. During 2008 and 2009, these studies continued with the following modifications; 1) collection sites were changed to maximize collection of *Culex pipiens* as well as *Cx. tarsalis*; 2) collection times were adjusted during each collection date to conform to times of sunset and sunrise; 3) collection intervals were increased from 7 per night to 14 per night and were multiples of the time between sunset and civil twilight at each collection date (27-34 min); and 4) temperature, humidity, and wind speed data were collected at each site during collection times. Analysis of this data will be presented, along with data on seasonality and West Nile virus detection in mosquito collections.

P-16 Comparison of four traps to sample *Aedes triseriatus, Ae. albopictus* and *Ae. j. japonicus* in a La Crosse virus endemic area

Brian Byrd, bdbyrd@wcu.edu, Laura White, Charles Sither, Alan Goggins, Bruce Harrison and Gideon Wasserberg

Adult female *Aedes triseriatus, Ae. albopictus* and *Ae. j. japonicus* mosquitoes were sampled in peridomestic areas of western North Carolina by 4 different techniques: CO_2-baited CDC light trap, CO_2-baited Fay-Prince trap, infusion-baited gravid trap and the CO_2-baited BG-Sentinel trap using a 4 x 4 x 4 Latin square design during June and August 2010. The BG Sentinel trap was found to be the most efficient trap collecting 58% of the total number of mosquitoes sampled. The BG Sentinel trap collected 68.4% of the total *Ae. triseriatus*, 57.8% of the total *Ae. albopictus* and 46.7% of the total *Ae. japonicus*. The gravid trap was the most efficient trap for *Ae. japonicus* (53.3% overall) and the second best trap for *Ae. triseriatus* (22.6% overall). The Fay-Prince trap was the second best trap for *Ae. albopictus* (24.5% overall). Taken together, the abundance data suggest that the BG-Sentinel trap is an effective trap for the collection of known and suspected La Crosse virus vectors in endemic areas. The parity status of the collections was determined by the tracheal skeins method and used to establish whether biases exist between the sampling methods in relation to gonotrophic status. These data are presented in the context of La Crosse virus surveillance and ecology.

P-17 Host preference of *Culex stigmatosoma* and *Aedes sierrensis* in Lake County, CA

Tara C. Thiemann, tcthiemann@ucdavis.edu, David L. Woodward, Brittany Nelms, Ying Fang, Jamesina J. Scott and William Reisen

Host selection by arthropod vectors plays an important role in the transmission dynamics of the pathogens they carry. While the feeding patterns of West Nile virus (WNV) vectors *Culex pipiens* and *Culex tarsalis* have been relatively well categorized in California, few studies have explored host selection in other vector species. *Culex stigmatosoma* is highly competent for WNV in the laboratory. However, adult *Cx. stigmatosoma* are difficult to collect, so little is known about its role in WNV transmission. *Aedes sierrensis* is a diurnal biting mosquito that has been found infected with Northway virus and is thought to be a vector of dog heartworm. To explore the feeding patterns of these potentially important vectors, blood-engorged females were collected from an oak woodland area in Lake County, CA, where avian and mammalian species have routinely been surveyed. Bloodmeals were identified either by a newly-developed microsphere-based assay or by DNA sequencing of the mitochondrial gene cytochrome c oxidase I (*COI*). Blood-feeding patterns and host preferences were assessed for both *Cx. stigmatosoma* and *Ae. sierrensis* to better understand their role in the transmission of arboviral filarial pathogens.

P-48 Parasitic nematode efficacy studies

Gabriela Harvey, gharvey@cvmvcd.org, Greg White and Jeremy Wittie

Romanomermis iyengari is a host-specific aquatic parasite that infects early instar mosquito larvae. The Coachella Valley Mosquito and Vector Control District has raised this species of nematode and conducted laboratory infection studies to see if it is able to parasitize, establish, and recycle in different mosquito habitat substrates. The studies demonstrated that the nematodes prefer to parasitize, establish, and recycle in gravel substrate better than soil substrate.

Genetics

P-18 Cloning and transcription profiling of trypsin in *Aedes taeniorhynchus* (Diptera: Culicidae)

Liming Zhao, Liming.Zhao@ars.usda.gov, Jain Chen, James J. Becnel, Daniel L. Kline, Gary G. Clark and Kenneth J. Linthicum

The cDNA of a trypsin gene from *Aedes* (*Ochlerotatus*) *taeniorhynchus* (Weidemann) was cloned and sequenced. The full-length mRNA sequence (874 bp) for trypsin from *Ae. taeniorhynchus* (AetTryp) was obtained which encodes an open reading frame of 717 bp (i.e., 239 aa). To detect whether AetTryp is developmentally regulated, a quantitative real-time polymerase chain reaction (qPCR) was used to examine AetTryp mRNA expression levels in different developmental stages of *Ae. taeniorhynchus*. AetTryp was expressed at low levels in egg, larval, and pupal stages but was differentially expressed in adult *Ae. taeniorhynchus*, with highest levels found in 5-d-old female adults when compared to teneral adults. In addition, AetTryp mRNA expression differed between sexes, with expression levels much lower in males. However, in both males and females there was a significant increase in AetTryp transcription levels as age increased and peaked in 5-d-old adults. The mRNA transcription levels of AetTryp mRNA expression in response to a blood meal and permethrin treatment in female *Ae. taeniorhynchus* was determined.

P-19 Strongly expanded 28srdna through first domain (D1) of *Aedes detritus* (Haliday) correlated with other *Aedes* species

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First domain (D1) of 28SrDNA of *Aedes detritus, Ae. caspius* and *Ae. aegypti* were amplified using PCR, cloned and sequenced. Amplicons fluctuated from 485 bp long in *Ae. detritus* to 272bp & 284 bp in *Ae. caspius* and *Ae. aegypti* respectively. Alignment the first domain (D1) of 28SrDNA of *Ae. detritus* and *Ae. aegypti* are nearly identical 96.9% and decreased to 88.7% with *Ae. caspius* through the highly conserved region. An unexpectedly extra segment (260 bp long) was inserted between the 2 positions 96 bp and 366 bp in (D1) of 28SrDNA of *Ae. detritus* and interrupts

the sequence homology which had no counterpart in those of the other 2 species. This extra segment will be called an expansion segment. Four deletions were recorded at base positions, 351, 352,398 and 420.

GIS/GPS

P-20 Mosquito habitat identification using GIS: A step towards predicting mosquito-borne disease risk in Djibouti
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Urbanization, demographic changes and refugee migration from Somalia and Ethiopia have heightened concerns for public health issues, including mosquito-borne disease, in Djibouti. To determine current mosquito species distributions, a surveillance project was implemented from November 2009 to July 2010, using larval sampling and CDC light trapping at 25 sites in 3 districts. Over 5,000 mosquitoes were collected representing 7 species from 3 genera, the most common being *Culex quinquefasciatus*, *Culex sitiens*, *Aedes aegypti* and *Anopheles dthali*. Using ArcGIS 9.3, geo-referenced surveillance data were overlaid on digital maps of Djibouti to determine specific mosquito habitats. The Arhiba area has numerous polluted canals, likely contributing to observed high capture rates of *Culex* spp. *Anopheles dthali* was largely confined to areas of high vegetation. *Anopheles gambiae* co-occurred with transitory water habitats at the Aii Adde refugee camp. *Aedes aegypti* were collected from urban littorals. High capture rates of 2 proven vectors (*An. dthali* and *An. gambiae*) near the refugee camp evinces a malaria risk and emphasizes the importance of mosquito control in the region.

Larval Control

P-21 Introduction to the San Diego County Vector Habitat Remediation Program
Arleen Lim, arleen.lim@sdcounty.ca.gov, Christopher Conlan, Gregory Slawson and Rebecca Lafreniere

In 2005, a San Diego County ballot measure approved by property owners allowed the San Diego County Vector Control Program (SDCVCP) to receive additional funding for vector and disease control services. Property owners were advised that a portion of the money raised by the measure would be used for a Vector Habitat Remediation Program (VHRP or Program). This Program would implement long-term solutions for controlling mosquito habitats and improve public protection from vector-borne diseases. Under the VHRP, grant funding is available to landowners and managers, including public sector entities, to physically alter chronic mosquito oviposition sites. The objective of the Program is to reduce or eliminate mosquito habitats while balancing the water quality, biological, hydrological and aesthetic values of the project. The VHRP provides a strong focus on designing, modifying and maintaining wetlands and stormwater facilities to improve the effectiveness of mosquito control measures in an environmentally friendly way. The VHRP development phase is complete and has been approved by the County of San Diego Board of Supervisors. The SDCVCP is currently accepting grant applications for review. Approved projects must be carried out in a manner that complies with CEQA, land use regulations and applicable state and federal wetland and endangered species regulations.

P-22 Production, formulation and evaluation of a mosquito baculovirus from *Culex quinquefasciatus*
James J. Becnel, james.becnel@ars.usda.gov, Richard Levy, Michael A. Nichols and Neil Sanscrainte

A new group of microbial agents with potential for control of mosquitoes are viral pathogens belonging to the family Baculoviridae. Mosquito baculoviruses are highly pathogenic, specific for their hosts and can recycle in the aquatic environment without adverse effects on other organisms or water quality. We have discovered a baculovirus (designated CuniNPV) that caused repeated and extended epizootics in field populations of the mosquitoes *Culex nigripalpus* and *Culex quinquefasciatus*. We found that transmission of this baculovirus is mediated by divalent cations; magnesium is essential for transmission, whereas the presence of calcium inhibits the activity of magnesium to mediate transmission. Because *Culex* spp. are important vectors of encephalitis, we have undertaken studies to investigate the production, formulation and evaluation of the baculovirus CuniNPV as a control agent for *Cx. quinquefasciatus*. Development of new biological pesticides for mosquitoes becomes increasingly important as human populations grow, and new and exotic disease agents appear, and to help prevent contamination of the environment with chemical pesticides that threaten man and contribute to a decline in biodiversity.

P-23 Screening of *Bacillus sphaericus* resistance alleles in *Culex quinquefasciatus* populations
Karlos Diogo M. Chalegre, Tatiany Patricia A. Romao, Eloina M. Santos, Claudia Maria F. Oliveira, Osvaldo P. de-Melo-Neto and Maria Helena N. Silva-Filha

Resistance is a challenge for the utilization of *Bacillus sphaericus* biolarvicides. Failure of *B. sphaericus* binary toxin to bind its midgut receptor Cqm1/Cpm1 in *Culex* larvae can provoke larval resistance. Recent characterization of mutations on the receptor gene allowed the development of specific PCR to detect such alleles. A 19-bp deletion from the *cqm1rec* and a single mutation found in *cpm1geo* are associated with resistance and these alleles were characterized in laboratory-selected colonies from Brazil and USA, respectively. The goal of this study was to perform the screening of these alleles in *Culex quinquefasciatus* populations from Brazil. PCR reactions based on specific primers were developed to detect each allele in larval samples from treated and non-treated areas. The *cqm1rec* frequency was between 0.003 and 0.01 in 3 non-treated areas because of the detection of heterozygous larvae for this allele. In Água Fria treated area, its frequency, in 5 moments over a 4-yr period, was between 0.01 and 0.07 and both heterozygous and homozygous larvae for this allele were detected. The *cpm1geo* was investigated in Água Fria and larvae carrying this allele in heterozygosis were found. Data showed that both alleles co-exist in

this area regardless of their characterization being performed in geographically isolated populations. Further analysis will be performed in order provide database for resistance management.

P-24 Evaluation of Natular™ G30 against nonbiting midges (Chironomidae) in Florida
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Nonbiting midges of the family Chironomidae are one of the most abundant organisms in inland natural and man-made aquatic eco-systems. Man-made urban and suburban aquatic environments, such as those commonly found in Florida, provide these midges with conditions in which propagation is rapid. As a result adult chironomid populations can be an extreme nuisance covering the sides of homes and screened enclosures, and at times creating foul odors and conditions affecting individuals suffering from asthma. This work utilized larval surveillance in shallow lentic habitats to evaluate several rates - 7, 12.5 and 20lb per acre - of Natular™ G30 against Chironomidae species and supports the use of this formulation to mitigate their populations.

Legislative and Regulatory

P-25 Good laboratory practice standards (GLP): From regulations to reality
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Following years of investigations of several laboratories in the US, the Federal Food and Drug Administration published standards for measuring the performance of research laboratories to ensure the accuracy of data being submitted to the administration. GLP regulations were proposed in 1976 for assuring a study's validity and were implemented into law in 1978. USEPA issued almost identical regulations in 1983 which were then amended in 1989 to include all studies that support registration for all pesticides. This poster will discuss the history, challenges and triumphs of developing a program for conducting both laboratory and field studies under GLP standards as mandated by EPA for the development and registration of public health pesticides.

P-26 *Aedes aegypti* and its implications as a dengue and chikungunya vector in Arizona
Kirk Smith, ksmith@mail.maricopa.gov, John Townsend and Craig Levy

Aedes aegypti is usually considered a tropical - subtropical mosquito species. However, it has regained a foothold in the southern portions of the United States including Arizona. Most literature does not recognize the Arizona threat as a result of our extreme desert conditions. We will demonstrate that *Aedes aegypti* is in fact a significant nuisance mosquito in the larger metropolitan cities in southern Arizona. Because of the continuous movement of people across our common border with Mexico, there is a significant risk of our local mosquito populations becoming vectors of these 2 diseases.

Operations

P-27 Comparing two new mosquito traps to the BG Sentinel™ in Fairfax County, VA
Joshua Smith, Joshua.Smith@fairfaxcounty.gov and Jorge Arias

Collecting adult mosquitoes is one of the fundamentals of mosquito surveillance and control. Finding the best trap(s) for your program's needs depends on the mosquitoes present. *Aedes albopictus*, a potential vector of several diseases, is not always easily collected. In previous studies, the BG Sentinel's™ effectiveness at collecting *Ae. albopictus* has been demonstrated. In the summer of 2010, we tested 2 new mosquito traps: the Mosquitaire™ and the Mosquitito™. Using a Latin square design, we compared 3 different traps in 4 different combinations. The BG Sentinel, the Mosquitaire, and the Mosquitito were set with the lures provided with the traps and were supplemented with CO_2. The Mosquitaire was also set with lure, but without CO_2, as directed. The 3 traps baited with CO_2 collected significantly more *Ae. albopictus* than the trap without CO_2 ($p<0.05$), but were not significantly different from each other. Significant variation in the ability to collect *Ae. albopictus* was not seen between sites throughout the study or between sites within each week nor was there any significant trap-site effect. The Mosquitito collected more mosquitoes than the other traps and also collected greater species diversity. The addition of CO_2 to the Mosquitaire improved its ability to collect *Ae. albopictus* and allowed it to catch *Ae. albopictus* in numbers similar to the BG Sentinel trap. The Mosquitito also caught similar numbers of *Ae. albopictus* to the BG Sentinel.

Public Relations

P-28 From facsimile to web site: The evolution to digital communication
Aaron P. Devencenzi, adevencenzi@sjmosquito.org

Methods used to communicate to the public are in a continuum of change. From facsimiles to internet-based communication, we are faced with new technology. Society has changed the way it prefers to receive information. The San Joaquin County Mosquito and Vector Control District (District) recognized the need and took action. With the formation of a local West Nile virus task force, web site postings of news releases and alerts became the responsibility of the San Joaquin County Office of Emergency Services. With multiple agency coordination, the electronic messages reached the public but lacked efficiency. To increase efficiency and flexibility in posting web site messages, the District developed a web site to meet the demands for rapid and accurate public information. The District web site was made public on August 14, 2007. Initially, the first full month had 2,194 hits resulting in 87 visitors. With advertisement and print publications promoting the web site, there has been a substantial increase in its use. During the 6 mo period starting April 2010 to September 2010 there were an average of 37,550 hits and 6,019 visitors to the site. In October of 2010, the District added a digital subscription management platform by GovDelivery® (www.govdelivery.com). This system allows web site visitors to sign up for news releases, news

alerts and annual reports. The web site and its applications are tools used to meet the demand for fast and easily accessible communication.

P-29 Using the spectrum of prevention in establishing social norm change around vector-borne disease prevention
Ada Barros Heiser, adab@placermosquito.org

Objective: Identify or develop and implement a framework for conducting a social norm change campaign around vector-borne disease prevention that could be evaluated with objective measures. Methods: Research was done on potential models that delivered similar public health social norm change messages, as well as identification of potential resources and partners for campaign implementation. Recruitment of partners and partner agencies is ongoing. We conducted a baseline telephone survey to establish a level of public awareness and knowledge of our district and vector-borne disease prevention strategies. This survey will be conducted 3 yr after implementation of the project. We have been able to garner support from different sectors of the community such as public health, education, recreation, and private industry, each with compatible goals and values. We plan to establish formal coalitions of community members, stakeholders, and youth representatives. Social norm change strategies have proven successful for several public health campaigns, most notably for tobacco and obesity prevention. These programs implement a multi-pronged approach to achieving behavior change from the individual level to influencing organizational change and establishing policies to support individual behavior change. By changing the community norms, programs establish broad-impact and long-lasting change well beyond the duration of individual campaigns and projects.

Latin American

P-30 Potential vectors of *Dirofilaria immitis* in dogs from inland Yucatan, Mexico
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Mosquito collections were done on microfilaremic dogs, positive for *Dirofilaria immitis,* for 10 consecutive nights in Molas (Municipality of Merida, Yucatan, southeastern Mexico) during the rainy season (August) 2010. A total of 496 mosquitoes (385 females and 111 males) of 6 species were collected: *Aedes aegypti* (L.), *Culex quinquefasciatus* Say, *Cx. interrogator* (Dyar & Knab), *Cx. coronator* Dyar and Knab, *Ochlerotatus taeniorhynchus* (Wiedemann) and *Psorophora ferox* (Humboldt, 1819). *Culex quinquefasciatus*, *Oc. taeniorhynchus* and *Ae. aegypti* were the species most frequently collected, and they had the highest rate of feeding success (the percentage of the total catch for each species that was blood fed) and the highest attack rates (the number of mosquitoes trapped in dogs per h of mosquito exposure). Filarial worms (L1 and/or L3 instars of *D* immitis) were microscopically observed in all mosquito species collected except for *Ps. ferox*, with a filarial infection rate of 9.6% of total examined mosquitoes at Molas. Further confirmative PCR analysis is currently underway. These preliminary results are part of a larger body of work undertaken in this area to understand the epidemiology of *D. immitis* in the Peninsula of Yucatan.

P-31 A targeted intervention to reduce rain-filled buckets/pots against two non-targeted interventions for *Aedes aegypti* control in Merida, Mexico
Pablo Manrique-Saide, msaide@uady.mx, Eduardo A. Rebollar-Téllez, Alejandra González-Moreno, Adán Zapata-Peniche, Guillermo Guillermo-May, Laura Buenfil-Silva and Mario Barrera-Pérez

We report results of a cluster-randomized-controlled trial evaluating the effect of targeting *Aedes aegypti* pupae breeding-sites in Merida, Mexico. The methodology integrated 3 phases: 1) baseline pupal-survey to identify the most productive containers; 2) interventions in 3 groups of AGEBs (Basic Geo-statistical Areas): one where buckets/pots were reduced-managed vs. total elimination of rubbish from the backyards and traditional control carried out by health authorities; and 3) follow-up survey 2 wk after the intervention. Key outcome variables consisted in the number of wet-containers, total positive-containers (both for immature and pupae only), their relative contribution to total pupal production and pupae per person, Breteau (BI) and house indices (HI). The baseline survey confirmed that buckets/pots were the most productive containers producing 55.5% of pupae. After a targeted intervention based on the efficient use of abandoned buckets/pots, there was a substantial decrease (67%) on the number of immature and pupae-positive buckets/pots in the group with the bucket/pot management. The HI decreased (-6.9%); the PUHI ([Number of houses infested by *Ae. aegypti* pupae/houses inspected] × 100) decreased (-31.3%); the BI decreased (-34.3%) and the PUPER (pupae per person) decreased (-96.6%) in the bucket/pot management group. *Aedes aegypti* pupae per container recorded in both bucket/pot management and tidy backyard groups decreased similarly in ca. 30%, at the same time as there was a 75% increase in the control group.

P-32 Container types and characteristics associated with *Aedes aegypti* pupal productivity in localities of high risk of dengue transmission of Morelos state, Mexico
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Cross-sectional *Aedes aegypti* pupal surveys were performed by direct inspection inside/around 1,713 houses from 88 clusters (neighborhoods) during the dry and rainy seasons of 2008 in Cuautla, Jojutla and Tlaquiltenango, Morelos state, Mexico. Every type of container was described and categorized according to their location (outdoors/indoors), material and use (disposable/useful). All pupae were collected from each positive container. The

relative importance for each type of container considered their contribution (%) to total pupae production. Overall, 73-97% of containers with *Ae. aegypti* pupae were considered useful by the communities. During the dry season, large cement washbasins and potted plants produced 48% and 60-98% of total pupae collected in Cuautla, Jojutla and Tlaquiltenango. During the wet season, the diversity of productive containers varied and increased: small diverse containers (21%) and buckets (19%) for Cuautla, potted plants (20%) and small diverse items (20%) for Jojutla, and small diverse (34%) and large cement washbasins (12%) for Tlaquiltenango. A targeted strategy focused on these containers could greatly improve current control and reduce *Ae. aegypti* populations. Future *Ae. aegypti* control program in Morelos will need to involve community participation and try to find communication/educational approaches throughout messages focused on the management of these containers.

P-33 Identification of floral volatiles and their effect on *Aedes aegypti* and *Aedes albopictus*

Santiago Von Oppen, Héctor M. Masuh, hmasuh@gmail.com, Susana Licastro and Paola A. González Audino

The use of nectar as an energy source for mosquitoes has been widely established. Although the selection mechanism of floral hosts is not fully understood, it has been proven that visual and odor cues are involved. In the search for new compounds that could be used as an additional tool for the attraction of mosquitoes to a trap, our laboratory began the study of volatiles obtained from different plant species (e.g., *Calendula* spp., *Primula* spp., *Lobularia* spp., *Plectrantus* spp. and *Bellis* spp.). In the present study, the floral volatile components were determined in optimized conditions, through the adsorption in Solid Phase Micro Extraction (SPME) and the later analysis by GS-MS. In each species, the chemical components were separated and the major components were identified. The volatile source was either fresh plant material, or a mixture of its pure constituents. In order to determine the effects of the flower volatile components on *Ae. aegypti* and *Ae. albopictus* mosquitoes, preliminary behavior assays of main compounds were performed in the Y-tube olfactometer. The aim of this study was to develop a cost effective, environmentally friendly method of controlling the disease transmitting *Aedes* mosquitoes.

P-34 Effect of sublethal exposure of pyriproxyfen released in a fumigant formulation on *Aedes aegypti* fertility and fecundity

Laura Harburguer, Eduardo Zerba, Héctor M. Masuh, hmasuh@gmail.com, and Susana Licastro

Insect growth regulators (IGRs) are considered a new generation of insecticides having great prospects for insect control. The activity of IGRs generally results in the reduction of adult emergence of the target insect. However, they seem to have side effects, particularly on female reproduction following larval IGR treatments, for example, effects on fecundity (increase or diminution of the number of eggs laid) and on fertility (reduction of hatchability or viability of eggs). This study evaluated the effect of treatment with a sublethal dose of pyriproxyfen, released in a fumigant formulation, on fecundity and fertility of *Aedes aegypti*. Early 4th instar larvae were treated with a dose that caused between 40 and 50% of adult emergence inhibition. Three to 4 d after emergence, surviving females were fed and mean number of eggs laid was noted. Ten to 14 d later, eggs were placed in water to evaluate their viability. Ovaries of surviving females were dissected and mean ovariole number was registered. Results showed a decrease in the mean number of eggs laid by treated females and a reduction of viability of those eggs, however, no difference was observed in the mean ovariole number between treated and "control" females. This indicates that the use of this new formulation combined with an adulticide, as has been proposed in previous work from our laboratory, not only produce larvae and adult mortality of those individuals present at time of application but also produce a reduction in fertility and fecundity of surviving females.

P-35 Droplet size and effectiveness on *Aedes aegypti* of an ULV adulticide-larvicide formulation using different solvents

Laura Harburguer, Alejandro Lucía, Emilia Seccacini, Susana Licastro, Eduardo Zerba and Héctor M. Masuh, hmasuh@gmail.com

One of the most common methods for controlling arthropod vectors, particularly mosquitoes, is the application of insecticides by ground sprayers. When selecting spray equipment and insecticides, factors such as the recommended dose, the droplet size, the moving speed of the vehicle, the sprayer cost, etc., are very important. Droplet size is one of the most significant factors that affects how well a vector control application works, and depends on, among other factors, the solvent used. The use of gasoil as solvent is often recommended, invoking better insecticidal effect, more aerosol dispersion and high visual impact at the time of application. In this work, we measured the droplet size during application of a ULV formulation containing permethrin as an adulticide and pyriproxyfen as a larvicide. This formulation was applied with a thermal fogger using water, diesel or biodiesel as solvents, and with a water-based cold fogger. We evaluated the effectiveness of these formulations on late 3rd or early 4th instar larvae and adults of *Aedes aegypti* in semi-field scale and in a field trial performed in Puerto Libertad, Misiones, Argentina. We found that the average droplet size of aqueous formulations was higher than oil-based ones. All formulations were equally effective on adults at all distances tested; however, the effect on larvae mortality, measured as emergence inhibition (% EI) was higher for the aqueous formulation.

P-36 Efficacy of chemical control interventions on *Aedes aegypti* in Guerrero, Mexico

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The Mexican national dengue program employs as chemical interventions for *Aedes aegypti* control: 1) "Abatización" (1% granules of Temephos®, T.M.FOS®) for permanent breeding-sites; 2) ground vehicle-mounted,

ultra-low-volume (ULV) space-spraying (Sumithrin®, ANVIL® 2+2 ULV®) in areas/clusters with dengue outbreaks and/or entomological risk and 3) indoor rapid residual-spraying (RRS) at houses of probable dengue cases (with of a variety of insecticides). Here we report a comparison of the immediate-efficacy of interventions (single/combined and evaluated 24 h and 1 wk post-application) on the prevalence/abundance of i) *Ae. aegypti* pupae in containers; ii) indoor-resting adults collected with back-pack aspirators; and iii) gravid females inferred by outdoor-located ovitraps in Iguala, Guerrero state, Mexico. "Abatización" alone reduced 100% of pupal populations immediately and after 1 wk. ULV had a significant effect immediately on oviposition rates (≅30% and ≅50% reduction on the prevalence of positive-ovitraps and average of eggs/ovitrap, respectively) and was sustained 1 wk after. RRS using lambda-cyhalothrin (ICON® 10 PH) had an effect on the prevalence of houses with indoor-resting adults and their abundance after 24 h and1 wk later. The combined-application of interventions reduced both pupae and adults 24 h and 1 wk later. Results are discussed in the context for improving *Ae. aegypti* control in Mexico.

P-37 Susceptibility of seven *Aedes aegypti* populations from Medellín, Colombia to pyrethroid and organophosphate insecticides

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In Medellín, Colombia, *Aedes aegypti* is the main vector for dengue viruses. Besides the use of commercial insecticides in the community, authorities have used the organophosphate insecticide malathion to control dengue since 1987. Between 2007 and 2008, 223,010 houses were fumigated through indoor spraying and conducted 465 h of outdoors spraying with a truck-mounted machine. In 2003, studies showed that in the Buenos Aires neighborhood of Medellín, the population of *Ae. aegypti* was resistant to the organophosphate insecticide fenitrothion and at the same time the population from Santa Cruz neighborhood showed a resistance risk to the same insecticide and also to malathion and to the pyrethroid deltamethrin. In this paper, we assessed the susceptibility of 7 *Ae. aegypti* populations from Medellín to pyrethroid and organophosphate insecticides. The results showed different susceptibility profiles and the resistance seems to be a risk factor for dengue in the city. This paper contributes to the design of strategies for improved dengue control by the authorities, based on field evaluations.

P-38 Application of a geographical information system in the establishing of the dengue entomologic risk in Medellín, Colombia

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Dengue is a serious public health problem in Colombia. Epidemiologic assessments of this disease have been done with geographical information systems (GIS) and it has been proven that this is a useful tool for the identification of risk areas, where the actions for the control of the disease should be focused. In this investigation, entomologic risk maps were created with GIS and different variables as house, container, Breteau and adults indices were analyzed and associated with the number of cases and environmental and socioeconomic variables. The analysis of these patterns revealed that, for the city, the entomologic factors did not show a relationship with the number of cases in the years of our study, but a relationship between the environmental and socioeconomic variables was found. This study, through the establishment of risk areas, contributes to the design of correct and appropriate strategies for the control and prevention of the disease by the health care authorities in Medellín.

P-39 Genital morphology of *Trichoprosopon* spp. males for the description of a new species from the *pallidiventer* complex (Diptera: Culicidae)

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The *Trichoprosopon* genus is represented by 13 species in the neotropical region. Some of these species are of medical importance because they are vectors for emerging and re-emerging viruses. Some species of *Trichoprosopon* are known from Colombia and there may be other undescribed species. With the objective of establishing new *Trichiprosopon* species (in the *pallidiventer* complex) larvae and pupae were collected from *Guadua angustifolia* stumps in the town of Jardín, Antioquia and a series of adults were obtained as well as the morphological description of the male genitalia. A detailed study of the diagnostic morphological structures was made in the Centers for Disease Control and Prevention in Atlanta, GA (USA) and in the National University of Colombia in Medellín, Antioquia. The structures were described using conventional microscopy and a scanning electron microscope. The morphological variations in the mesosome and in the dististyle were established and these detailed characteristics were very useful for the assignment of the new species. This new record contributes to our improved morphological and taxonomic knowledge of the country`s mosquitoes fauna and specifically the potential vectorial role of species from the *pallidiventer* complex.

P-40 Susceptibility status of *Anopheles albimanus* (Wiedemann, 1820) to insecticides used in public health in Atlántico, Colombiain 2010

Paula X. Pareja Loaiza, paxipa@yahoo.com.ar, Gabriela Rey Vega and Ronald Y. Maestre Serrano

The department of Atlántico is not in the endemic region for malaria; however, there are risks factors that have precipitated outbreaks of this disease during recent years. *Anopheles albimanus* is the main vector with wide distribution throughout the department. The insecticide susceptibility for this species is unknown and unavailable for the definition of prevention and control strategies. The susceptibility to organochlorine, organophosphates, pyrethroids and carbamate was evaluated in a population of *An. albimanus* from Santo Tomas, Atlántico during 2010. Bottle bioassays were performed following the Centers for Disease Control and Prevention (CDC)

methodology, using doses and diagnostic time for deltamethrin (12.5 µg/30 min), lambdacyhalothrin (12.5 µg/30 min), cyfluthrin (12.5 µg/30 min), permethrin (12.5 µg/30 min), alphacypermethrin (6.25 µg/30 min), alphacypermethrin (12.5 µg/min), DDT (100 µg/45 min), malathion (50 µg/30 minl), fenitrothion (50 µg/45 min) and bendiocarb (12.5 µg/30 min) on a field population of *An. albimanus* mosquitoes. Three repetitions, each 1 with 4 replicates and 1 control, were carried out. The population of *An. albimanus* evaluated was susceptible to all insecticides evaluated. This result was probably due to the low selection pressure for insecticides, because of the epidemiological profile of the disease in this zone. Therefore, we recommend the use of these insecticides to control future outbreaks of malaria in the region.

P-41 Behavior of *Culex quinquefasciatus* (Say, 1823) in response to permethrin

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West Nile virus (WNV) is a member of the family Flaviviridae. WNV infects over 150 species of birds as well as mammals such as squirrels, dogs, wolves, horses and mountain goats. Birds are the natural reservoir hosts, and WNV is maintained in nature in a mosquito-bird-mosquito transmission cycle primarily involving *Culex* spp. (especially *Culex quinquefasciatus*) mosquitoes. WNV was introduced to North America in 1999 during an epidemic of meningoencephalitis in New York City, New York. During 1999-2002, the virus extended its range throughout much of the eastern parts of the USA. In Mexico, particularly in the northeast, WNV has been detected, but control is not performed, because dengue is more important vector-borne disease. Therefore, this study examined the behavioral response of *Cx. quinquefasciatus* using the HITSS system; this system has a modular design that examines several aspects (contact irritation, spatial repellency and toxicity). The behavior response of *Cx. quinquefasciatus* to the several doses (0.025 nmol/cm^2, 0.25 nmol/cm^2, 2.5 nmol/cm^2 and 25 nmol/cm^2) of topically applied permethrin was evaluated. In a concentration 25nmol/cm^2 48.0% contact irritation was obtained, in a concentration 25 nmol/cm^2 4% toxicity was obtained, and in a concentration 2.5 nmol/cm^2 the spatial repellency of 11.0% was obtained.

P-42 An update on the mosquito fauna (Diptera: Culicidae) and its distribution in the Mexican state of Guerrero

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The aim of this study was to review and update the species of mosquitoes and their distribution in the Mexican state of Guerrero. We created a database containing historical and recent records from mosquito collections made by the Ministry of Health of Guerrero. This database was then exported to Maxent software (including bioclimatic variables) to create predicted distribution maps (PDM). We listed a total of 70 species belonging to 16 genera (**in bold**) in Guerrero: ***Anopheles*** *albimanus, apicimacula, argyritarsis, crucians, eiseni, pseudopunctipennis, punctimacula;* ***Aedeomyia*** *squamipennis;* ***Aedes*** *aegypti, angustivittatus, atropalpus, epactius, guerrero, idanus, lorraineae, nigromaculis, scapularis, serratus, taeniorhynchus, terrenstortilis, trivittatus;* ***Haemagogus*** *anastasionis, equinus, mesodentatus;* ***Psorophora*** *ciliata, cilipes, confinnis, cyanescens, ferox, howardii, lutzii, totonaci, varipes;* ***Lutzia*** *bigoti;* ***Culex*** *bidens, cedecei, conspirator, corniger, coronator, erraticus, inflictus, interrogator, iolambdis, nigripalpus, peccator, pilosus, pinarocampa, quinquefasciatus, restuans, sandrae, stigmatosoma, tarsalis, thriambus, trifidus, schicki;* ***Deinocerites*** *howardi, pseudes;* ***Coquillettidia*** *nigricans;* ***Mansonia*** *indubitans, titillans;* ***Orthopodomyia*** *kummi;* ***Limatus*** *durhamii;* ***Sabethes*** *chloropterus;* ***Uranotaenia*** *lowii, pulcherrima, sapphirina;* ***Toxorhynchites*** *(Tx.) grandiosus.* We report 3 new state records: *Tx. theobaldi, Culiseta particeps* and *Wyeomyia arthrostigma*. *Aedes aegypti, Cx. coronator* and *Cx. quinquefasciatus* were the species with the broadest recorded and predicted distributions.

P-43 An update on the scorpion fauna of Guerrero, Mexico

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More than 150,000 cases of scorpion sting intoxication, by far the highest rates in the world, are reported annually in Mexico. Considering that correct identification of scorpions is important to prevent and control their populations, we are currently updating of the species of scorpions and their distribution in the Mexican state of Guerrero. Specimens were obtained from entomological surveillance collections carried out by Ministry of Health personnel, community-based monitoring, from historical records and from the National Commission for Knoweldge and Use of Biodiversity (CONABIO) databases. We report 31 species in 5 genera (**in bold**) from Guerrero. **Bioculus** *parvulus*; **Centruroides** *balsasensis, elegans, fulvipes, gracilis, limpidus, margaritatus septentrionalis, meisei, nigrescens, nigrimanus, nigrovariatus*; **Diplocentrus** *bellator, coylei, majahuensis, magnus, tehuacanus*; **Hoffmannihadrurus** *gertschi*; and **Vaejovis** *acapulco, atenango, crassimanus, curvidigitus, mexicanus mexicanus, mexicanus smithi, noteno, occidentalis, punctatus spadix, punctatus variegatus, puritanus, pusillus, sprusei, vaquero*. Three widely-distributed *Centruroides* species (*C. balsasensis, C. meisei* and *C. limpidus*) are important for public health and associated with the high number of human intoxication cases caused by scorpion stings.

P-44 Experimental trial of bed nets impregnated with Fendona® for control of *Musca domestica* (Diptera: Muscidae)

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Bednets impregnated with insecticide are attracting increasing interest to control *Musca domestica*. Our study was to measure the efficacy of bednets impregnated with Fendona® to control *Musca domestica*. Bednets impregnated with and another bednet without insecticide were placed over a bed. Twenty adult *M. domestica* were placed cones on the top, middle and bottom sections of the bednet. After 24 h of exposure, mortality was recorded. Insecticide impregnated bednets showed high control efficacy for *M. domestica* adults.

P-45 Morphological deformities in *Chironomus* spp. larvae from Pesqueria River in Nuevo Leon State, Mexico

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Morphological alterations of mouthparts in the larvae of midges have been related to water contamination by heavy metals. The objective of this study was to determine the frequency of deformities in larvae of *Chironomus* spp. in two localities of the Rio Pesqueria. The larvae were collected with a benthic net, preserved in ethyl alcohol, identified and processed in the laboratory. Preparations for microscopic examination of the head were made, recording the type and frequency of deformities. The mentum was the most common site of morphological alteration, followed by the pecten, mandibles and finally the antennae. No statistical difference was found between the localities sampled.

P-46 Triatominae (Hemiptera: Reduviidae) of Oaxaca, Mexico

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Three of the most important genera (*Triatoma, Rhodnius* and *Panstrongylus)* involved in the transmission of the Chagas disease are present in Oaxaca state, Mexico. FromJuly 1997 to July 2010, 7,191 triatomines were collected and identified from 157 municipalities. A total of 2,623 were adults, belonging to 3 genera and 9 species. In addition, there were 4,568 nymphs from different instars. The identified genera and species were *Triatoma barberi, T. nitida, T. phyllosoma, T. mazzottii, T. pallidipennis, T. dimidiata, T. gestaeckeri, Rhodnius prolixu* and *Panstrongylus rufotuberculatus*. In total, 673 (25.6 %) specimens had natural *Trypanosoma cruzi* infections. *Rhodnius prolixus, Triatoma phyllosoma, T. mazzottii, T. dimidiata, T. gerstaeckeri, T. pallidipennis, T. barberi* and *T. nitida* presented a high indices of natural infection. Additionally, 206 (4.5 %) nymphs were positive for *T. cruzi*. A total of 7,023 triatomine bugs, 1,668 adults and 5,355 nymphs were negative for natural *T. cruzi* infections. The species with the highest density of *T. cruzi* was *T. dimidiata* whereas *T. pallidipennis, R. prolixus* and *P. rufotuberculatus* were of lower density.

P-47 New distributional records of phlebotomine (Diptera: Psychodidae) sand flies in northern Mexico

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Cutaneous leishmaniasis is a tropical disease and in México, the highest incidence rates are reported in the southern states. Nevertheless, in northern Mexico, there have been reports of human cases in Coahuila (COA), Nuevo León (NL) and Tamaulipas (TAM). These Mexican states are located along the southern border with the USA, particularly with the state of Texas, where in the last decade the number of cases of cutaneous leishmaniasis has increased. Unlike the USA, in northern Mexico there has been no study to document the fauna and evaluate the potential vectors. A thorough review of published literature reveals the presence of 4 sand fly species in COA, NL, and TAM: *Lutzomyia diabolica, L. anthophora, L. oppidana* and *L. cruciata*. The records are comprised by 51 females in COA; 14 females and 35 males in NL, and 1 female in TAM. The earliest records are represented by specimens caught in 1936, other collections date back from 1955 in NL; and from 1970 in COA. Other unpublished records are collections carried out in NL during 1993. The aim of this study was to increase the number of species as well as the number of geographical locations where sand flies occur. Collections from 2009 to date have so far yielded 98 specimens (59 females and 39 males) in NL and 692 (369 females and 323 males) from TAM.

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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)

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1968 George H. Bradley (USDA/USPHS)

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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.

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	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)		
	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)

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)

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

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

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	

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)		

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, Oregon
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

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.	2000	Jason L. Rasgon	U. California, Davis
1990	Andrea Brown	Peru State Coll.		Hope Q. Liu*	Virginia Polytechnic Inst.
1991	John Paul Mutebi	Notre Dame U.	2001	No competition	
1992	Rosmarie Kelly	U. Massachusetts	2002	Laura B. Goddard	U. California, Davis
1993	Merry L. Holliday-Hanson	U. California, Davis		Sharon L. Minnick*	U. California, Davis
1994	John E. Gimnig	U. California, Davis		Margaret Sherriffs*	Yale U.
	Alice Shaeffer*	U. Mainz, Germany	2003	Sarah Yaremych	U. Illinois
1995	Glen Scoles	Notre Dame U.		Laura Goddard*	U. California
	Jittawadee Rochaeroen*	U. California, Riverside		Jason L. Rasgon*	U. California, Davis
1996	Esther Chow Schaeffer	U. Maryland	2004	Gregory M. Williams	U. Delaware
1997	Lynn Cooper	U. Maryland		Stephen Aspen*	Colorado State U.
1998	C. Roxanne Rutledge	Louisiana State U.		Christian Kaufmann*	U. Zurich
	Emmalee Kennedy*	U. Illinois	2005	Wesley Rubio	San Diego State U.
	Timothy Schaub*	U. Illinois		Whitney Qualls*	Auburn University
1999	Laura Harrington	U. Massachusetts		Rebecca Trout*	University of Kentucky
	Adam S. Jones*	U. Massachusetts			
	Hillary Reno*	U. Illinois			

Continued on next page

STUDENT PAPER COMPETITION AWARDS (continued)

2006	Robert D. Anderson	University of Winnipeg	2009	Alexandra Chaskopoulou	University of Florida
	Linda O'Connor**	University of Delaware		Stephanie Larick*	University of Florida
	Joshua R. Ogawa*	Oregon State University	2010	Sarah Wheeler	University of California,
	Matthew Eaton*	Concordia College		Kimmy Mains	University of Kentucky
	Linda M. Styer*	U. California, Davis		Holly Tuten	Clemson University
2007	Jennifer Armistead	University of Florida			
	Robert D. Anderson*	University of Delaware			
	Thomas M. Mascari*	Louisiana State U.			
2008	Jerome Schleier	Montana State			
	Christopher Barker*	U. California, Davis			
	Lisa Reimer*	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.		
1964-1965	John A. Mulrennan, Sr.	1988-1989	Bruce F. Eldridge		

* - Eastern Association of Mosquito Control Workers

AMCA TREASURERS

1935-1943	Thomas D. Mulhern *
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-present	Allan D. Inman

* - 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


printed on recycled paper