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Abstracts

SUBMITTED PAPERS, POSTERS, AND SYMPOSIUM PRESENTATIONS

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The 2010 AMCA Memorial Lecture Honoree: Dr. Harold Clyde Chapman, 1921-2008

Dr. Harold C. Chapman died on November 16, 2008, in Lake Charles, Louisiana. Chappie, as he was affectionately known by his friends and colleagues, was born in Kalamazoo, Michigan, in 1921, graduating from Harbor Beach High School, Michigan, in 1939. He then joined the Army Air Corps where he honorably served his country during World War II flying on 35 bombing missions with the 6th Bomber Group from Tinian Island in B-29 bombers over Japan. He was very proud of his service, earning the Air Medal with Oak Leaf Clusters and the Distinguished Flying Cross.

Following his military service he entered Michigan State University earning a BS degree in forestry in 1948 and a master's degree in entomology in 1950. After 5 years with the USDA first as a forest entomologist in Wisconsin then as a medical entomologist in Florida, he moved to New Brunswick, New Jersey, as a research associate at Rutgers University. It was at Rutgers that he received his PhD in entomology in 1959.

Chappie was then appointed Entomologist in Charge of the USDA-ARS Station in Reno, Nevada, until 1961 when he moved to Fresno, California in a similar position. In 1964 he made what was to be his final move with the USDA as he established and became Head of the Gulf Coast Mosquito Research Laboratory in Lake Charles, LA, where he retired in 1981 after 33 years of service.

During his career he is credited with publishing over 134 scientific papers including bulletins and book chapters. He authored or co-authored the description of 27 species of aquatic and semi-aquatic Hemiptera, 1 species of mosquito and 1 protozoan. There have been 8 pathogens and parasites, and 1 hemipteran named after him: protozoa – *Nosema chapmani, Plestophora chapmani, Hyalinocysta chapmani, Pilosporella chapmani, Chapmanium cerritus;* nematode – *Aproctonema chapmani;* fungi – *Coelomomyces stegomyiae* var, *chapmani, Leptolegnia chapmani;* semi-aquatic Hemiptera – *Loscytus chapmani.*

His reputation in the field kept him in high demand as a committee member, advisor or consultant both nationally and internationally. Some of the highlights of his career include: member of the USDA-ARS Southern Region Advisory Group on Biological Control of Insects and Weeds (1972-74); member of the National Academy of Sciences Committee that culminated in the NAS bulletin, "*Mosquito Control – Some Prospectives for Developing Countries*" (1972-75); member of the Technical Committee of the Regional Project S-122 – Biology, Ecology and Management of Riceland Mosquito Populations (1977-81); member of the WHO Scientific Working Group of Insect Vectors of Diseases (1977-78, 1980-84); appointed to the Scientific Working Group-Biological Control of Vectors Steering Committee by Dr. A.D. Lucas, Director, Special Programme for Research and Training in Tropical Diseases, WHO (1981-89), served as Chairman from 1983-86; between 1966-1985 served as a consultant for numerous WHO projects (Nauru Islands, Central Pacific, Taipei, Taiwan, Bangkok, Thailand, Ivory Coast, Korea, just to name a few). Chappie was a member of LMCA, providing over 40 years of leadership, service, and guidance and serving as President in 1979 and Acting President in 1992. He was a multi-term member of the LMCA BOD and 1st recipient of its prestigious Hathaway-Ritter Award.

AMCA was also one of his passions. He was active in the Association early in his career and served as a member of the Board of Directors from 1973-78, serving as President from 1975-1976. In 1979 and 1980 he served as Chairman of the Editorial Board of *Mosquito News*, and in 1985 he was Editor of AMCA Bulletin 6, *Biological Control of Mosquitoes*. The highlight of his service to AMCA was his appointment to the position of Executive Director of the Association in 1986. He served in this capacity until 1991 when he was named Executive Director Emeritus. His service to AMCA has not gone unnoticed as he has been the recipient of several awards: 1976 – Meritorious Service Award for Outstanding Service as President; 1991 – Medal of Honor (highest award given by AMCA); and, 1994 – Honorary AMCA Member, of which there have only been 37 recipients since AMCA's founding in 1935.

Dr. Chapman's passing brings to a close the career of a truly brilliant scientist who made major contributions to our profession locally, nationally and internationally. To all who were fortunate to have known him, he will also be remembered as a true gentleman who loved people and greeted everyone with a very vibrant, friendly smile. He will always be remembered as a loving husband to his wife of 64 years, Frankie Holbert Chapman, and as a devoted father and grandfather. It was very easy to see that he loved life and lived it to its fullest, whether it was pulling a good natured joke on a colleague to stay one-up, smoking a good cigar, or sipping on a glass of George Dickel. He will always be missed!

The 2010 AMCA Memorial Lecturer: Tokua Fukuda

Tokuo Fukuda was born and raised in the small agricultural town of Kingsburg, CA, a community known for its Swedish heritage and influence, as well as being the hometown of Rafer Johnson, 1960 Olympic decathlon champion. He grew up on his family's vineyard farm, which produced quality raisin grapes and devoted sons. Tok attended Reedley College, a local junior college, until he was drafted into the United States Army where he served his country for a two year stint as a Medical Corpsman at Fort Lewis, WA. With the realization that the military life was not for him and, after being honorably discharged, he went back to complete his Bachelor of Science degree from Fresno State College in 1966.

After graduation, Tok joined the staff at the University of California (Berkeley) Mosquito Control Research Laboratory in Fresno, CA as a Biological Research Technician. He worked there a year and then accepted the position of Biological Laboratory Technician with the USDA ARS Gulf Coast Mosquito Research Laboratory in Lake Charles, LA, under the direction of Dr. Harold C. "Chappie" Chapman. Tok worked with Chappie until Dr. Chapman's retirement in 1981 and the two developed a very close and lifelong professional and personal bond.

Tok continued to work at the Lake Charles lab as a microbiologist until 1985 when he transferred to the USDA ARS lab in Gainesville, FL. He worked there until his retirement in 1999.

During his professional research career, Tok has authored and coauthored numerous scientific publications in journals ranging from JAMCA to the Journal of Invertebrate Pathology in topics ranging from mosquito hybridization to mosquito trap evaluations to his main focus of parasites and pathogens of mosquitoes. His major research accomplishments have included the completion of a three year survey for parasites and pathogens of *Aedes albopictus* and associated container-inhabiting mosquitoes of north central Florida. In other microbiological research, he demonstrated successful *per os* transmission of a virus of non-mosquito origin, *Chilo* iridescent virus, to several genera of mosquitoes and *per* os transmission of *Helicosporidium* sp., a protozoan of interest as a biocontrol agent, to 17 species of mosquitoes in the genera *Aedes, Anopheles, Culex, Culiseta, Psorophora,* and *Uranotaenia*. Tok also worked on developing successful induced copulation techniques to establish laboratory colonies of *Aedes nigromaculis* and *Ae. sollicitans* for hybridization and genetic compatibility studies.

Tok worked as a consultant to the Malaria Control Project (MCP) of Pakistan on alternative malaria control methodologies and gave field demonstrations to MCP entomologists on parasite and pathogen identification and isolation in Lahore, Pakistan in 1986.

After his retirement, Tok returned to Kingsburg, and in 2004 he was appointed to the Board of Trustees of the Consolidated Mosquito Abatement District as the representative from the City of Kingsburg. Currently he serves as the Vice President/Secretary of the Board. He also serves as a Director on the Board of Directors of the Vector Control Joint Powers Agency which provides self-insurance programs and coverage to mosquito and vector control agencies in California. Tok has been a member of the American Mosquito Control Association since 1971 and has been a member of the Louisiana Mosquito Control Association, serving on the Board of Directors and as President in 1985, and the Florida Mosquito Control Association.

Oral Presentation Abstracts

Plenary Session

PL8 The evolving range of challenges currently confronting the U.S. horse industry
Peter J. Timoney, ptimoney@uky.edu

A range of challenges currently confront the US horse industry, some of which have the potential to significantly affect its sustainability and economic viability. The most readily apparent and easily understood is the impact that the financial recession which the country is going through, has on an industry whose continued success is highly dependent on the state of the national economy. When the economy is buoyant, the industry flourishes, and when the economy takes a down-turn, the first industry to be negatively affected is the horse industry. The significance of the horse industry to the economy will be commented on both at the national level and with respect to the Commonwealth of Kentucky. Consideration will also be given to the changing trends in both breeding and racing industries and the impact that these changes are having, especially in a state such as Kentucky. Not all the major challenges presently facing the equine industry relate directly to the state of the economy. There are a variety of other issues that are the subject of vigorous and sometimes, contentious debate both among membership of the industry and in some cases, the public at large. The issues of horse slaughter, the "unwanted horse" and expanded gambling, deserve special mention in this regard. Yet another challenge that must not be overlooked is that of the increasing threat of the introduction of certain foreign animal diseases. The impact that such incursions can have was dramatically illustrated in the years immediately following the initial discovery of West Nile virus in the northeast US in 1999. In 2002 alone, close to 15,000 horses succumbed to this disease. This pales into insignificance however, compared to the losses that would result were another vector-borne disease, African horsesickness, to gain entry into the totally unprotected US equine population. The veterinary medical and economic consequences for the industry of such an event would simply be catastrophic. Ensuring the continued health and well-being of the horse is of paramount importance to the sustainability and future success of an industry of such significance to the national economy.

PL9 Our Latin American Symposium: AMCA's best kept secret?
Yasmin Rubio-Palis, rubiopalis@gmail.com, Gary G. Clark, and Marco F. Suarez

The American Mosquito Control Association (AMCA) is dedicated to the study and control of mosquitoes, vectors, and arthropods and promotes cooperation and interaction among professionals and students in this field in the U.S. and internationally. To promote greater participation among international members, a Spanish language symposium was held at the 1991 Annual Meeting of the AMCA in New Orleans, LA and at 19 subsequent meetings. The principal objectives were to: (1) provide a forum for participants from Latin America to speak in Spanish and (2) promote participant interaction with mosquito control industry representatives and professional colleagues in the USA who are involved in mosquito control, training, and research in universities and state and federal agencies. Over 600 presentations, by attendees from 10 countries in the Americas, have been given and simultaneously translated into English. Topics addressed each year typically include mosquito control; dengue; malaria; West Nile virus; insecticide resistance; and population genetics, molecular, taxonomic, ecological, and/or behavioral studies of many mosquito species. Many of those at the plenary session here in Lexington are probably unaware of the "AMCA's Best Kept Secret" and all members are encouraged to stop by tomorrow's session and see what is going on.

PL10 Invasive species to green card in 10 years: West Nile virus as a permanent resident
Roger Nasci, rsn0@cdc.gov

West Nile virus was first detected in the United States in 1999. The virus quickly found a home in the various ecosystems across the country, and can now be found annually in most every county. Since 1999, there have been approximately 1.7 million human infections, resulting in 12,000 WNV encephalitis/meningitis cases, and an unknown number of milder disease cases. The full burden of WNV disease is still being tallied. The nation responded with the establishment of an unprecedented surveillance and response program that increased capacity to detect and respond to other exotic pathogens in addition to WNV and the other endemic arboviruses. Now that WNV is becoming routine, emphasis on maintaining that capacity is waning, and the future of critical public health capacity is questionable.

AMCA Student Paper 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 2010 contest will be the 21st time the competition has occurred.

2 Spatial relationships of WNV human cases in Texas High Plains
Christena Stephens, christena.stephens@tiehh.ttu.edu

On the Texas High Plains,>1400 humans have contracted WNV during 2002 to 2008. The region has > 20,000 playa lakes and 541 confined livestock operations (CLOs). We investigated spatial relationships existing between regional WNV cases,

locations of CLOs and playa lakes, and mosquito control practices from 2002 to 2008. Distribution patterns of WNV were determined by ArcGIS®. Our findings indicate correlations do exist between all three factors.

3 Isolation of Mosquitocidal *Bacillus* species toxic to several Mosquito species
Sabrina R. Hayes, sabrina.hayes@famu.edu

VB17 and VB24 were isolated from soil samples collected in Vero Beach. Bacterial identification was achieved through gas chromatographic analysis of fatty acid methyl esters and 16s rRna gene sequence alignment. Bioassay results showed that VB17 and VB24 are toxic to *Aedes taeniorhynchus, Culex quinquefasicatus, Anophles gambiae, and An. quadrimaculatus*. Interestingly, isolates were not active against *Ae. aegypti*. However, both exhibited higher toxicity to mosquitoes compared to Bs 2362.

4 Impacts of endosymbionts on laboratory *Aedes albopictus* populations
Jimmy Mains, jimmymains@uky.edu

Wolbachia is an endosymbiont that occurs naturally in *Aedes albopictus*. Here we use an experimental model system to examine the impacts of *Wolbachia* infection. Replicate populations of infected and aposymbiotic mosquitos were compared. Differences in population size, sex ratio, death rate and fecundity were found between the infection types. Our results offer evidence for fitness effects that may explain the persistence of *Wolbachia* in *Ae. albopictus*.

5 The influence of selected antibiotics on the response of black fly (*Simulium vittatum*) larvae to insecticidal proteins produced by *Bacillus thuringiensis subsp. israelensis*
Joseph Iburg, jpiburg@gmail.com

Experiments were conducted to determine if selected antibiotics could mitigate the efficacy of *Bti* on black fly larvae. Larvae were exposed to anthropogenic levels of antibiotics prior to *Bti*, with no effect on larval mortality. Antibiotic concentrations 10,000-80,000 times higher than those found in contaminated rivers also showed no reduction in *Bti* efficacy. Larvae exposed to high concentrations of certain antibiotics were more susceptible to *Bti*.

6 Physical characteristics of larval mosquito habitats in two South Carolina zoological parks
Holly C. Tuten, htuten@gmail.com

Habitats were sampled in 2008-2009 and classified as artificial/natural, container/pool, and disturbed/undisturbed. Canopy cover/height, conductivity, depth, D.O., temperature, pH, precipitation, surface area, and plants were measured. Sixteen species (1,630 larvae) were collected. Dominant species were *Aedes albopictus*, *Culex pipiens* complex, *Cx. restuans*, and *Oc. triseriatus*. Larval presence was significantly associated with temperature, precipitation, D.O., natural habitats, and no plants.

7 Bloodfeeding behaviors and deet repellency in Sindbis virus-infected *Aedes aegypti*
Whitney A. Qualls, quallsamcd@bellsouth.net

Sindbis virus (SIN), SVHR, was orally fed to *Aedes aegypti* (Linnaeus) to evaluate behavioral changes associated with virus infection and dissemination affecting bloodfeeding behavior and repellent response time. Sindbis-infected mosquitoes took 22% longer to locate the bloodmeal than un-infected mosquitoes on day seven and 52% longer on day 14. Sindbis-infected mosquitoes took 52% longer to engorge on day 14. Sindbis-infection decreased deet protection by 32% on day seven and 42% on day 14.

8 Reproductive consequences of a novel *Wolbachia* infection in *Aedes albopictus*
Elizabeth Andrews, elizabeth.andrews@uky.edu

Wolbachia are bacteria that cause cytoplasmic incompatibility (CI), reduced or absent egg hatch in crosses between individuals with different infections. Using tetracycline and embryonic microinjection, *Aedes albopictus* was cleared of its *Wolbachia* infection and artificially infected with a strain from *Ae. riversi*. A series of crossing experiments were carried out to determine if CI was present between naturally superinfected, artificially infected and uninfected mosquitoes.

9 Persistent infections in avian hosts: A possible overwintering mechanism for West Nile virus?
Sarah Wheeler, sswheeler@ucdavis.edu

It is hypothesized that recrudescing persistent West Nile virus (WNV) infections in avian hosts play a role in maintaining the WNV transmission cycle. House Sparrows and House Finches were infected with WNV and held in captivity overwinter. 82% of the birds maintained antibodies against WNV. 53% of the House Finches and 35% of the House Sparrows had tissues positive for WNV RNA. Persistence of elevated antibody titers and RNA positive tissues suggests potential long term shedding of WNV.

10 Improved Sampling and Identification Methods for North American Sand Flies
Logan M. Minter, log_mint@yahoo.com

Fundamental components of any integrated pest management program are reliable surveillance and identification techniques. The biology of *Lutzomyia shannoni* (Dyar), a potential vector of human and livestock pathogens, has largely been unknown. Therefore, we describe methods to capture sand flies through use of a heat unit accumulation model and

habitat clues. Due to the difficult nature of sand fly identification, we also developed a DNA based tool for detection of local and nonnative species.

11 Creating an attractive synthetic floral blend for *Culex pipiens*
Philip E. Otienoburu, otienoburu.1@buckeyemail.osu.edu

Culex pipiens is one of the most important vectors of West Nile virus in the United States. We have developed synthetic floral blends based on the headspace profiles of Common Milkweed, *Asclepias syriaca*, and Canada Goldenrod, *Solidago canadensis*, which both sexes of *Culex pipiens* frequent for nectar. We have demonstrated an attraction to these synthetic blends in olfactometer experiments. The most attractive of these blends are expected to be useful when deployed in surveillance traps.

12 Insecticide Resistance in the Southern House Mosquito, *Culex* pipiens quinquefasciatus (Diptera: Culicidae)
Jennifer R. Gordon, jgord13@lsu.edu

Biochemical and biological assays were used to characterize insecticide resistance on multiple populations of *Culex* quinquefasciatus collected from East Baton Rouge Parish. Bioassays measured susceptibility to naled and resmethrin and found levels of resistance varied. Esterase activities were measured using spectrophotometric assays with model substrates and were visualized using gel electrophoresis. Results are discussed with respect to current management strategies for this species.

13 Impact of life-shortening *Wolbachia* infection on immature competitiveness in *Aedes aegypti*
Eunho Suh, eunho.suh@uky.edu

In order to evaluate relative competitiveness of life-shortening *Wolbachia* infected immature, we examine cohort larvae competing within and between strains (infected and uninfected). The results demonstrate significantly reduced competitiveness in infected larvae with decreased survival and increased development time particularly when competitive effects were high. The results are discussed within the context of using *Wolbachia* infections to reduce transmission of the dengue virus by *A. aegypti*.

14 Do *An. gambiae* females really blood feed before mating?
Chris Stone, stone.361@osu.edu

The sugar feeding behavior of *An. gambiae* females through their early adult life was studied in mesocosms. We show that the use of sugar as an energetic resource is common in this species during this period, and show that mating rarely occurs before a sugar or blood meal is taken. This reconciles the findings of Gillies that females typically blood feed before mating with theoretical findings that indicate females should opportunistically blood feed before or after mating.

Legislative & Regulatory Symposium I: Protecting our Existing Chemical Toolbox

15 Introduction
Karl Malamud-Roam, kmr@aesop.rutgers.edu, Kevin J. Sweeney, Ed Ruckert, William H. Meredith and Gary Goodman

Legislative, regulatory, and legal challenges to mosquito and other vector control practices have accelerated in recent years, and protecting our ability to use existing chemical vector control tools is a major challenge. In this session, we will update AMCA members on areas of particular concern, including new restrictions under the Clean Water Act and the Endangered Species Act, EPA's endocrine disruption screening protocol and other new pesticide evaluation criteria, the potential effects of the European hazard-based pesticide evaluation program in the U.S., restrictions on particular federal lands such as wildlife refuges, and the challenges of maintaining federal funding for vector control support.

16 NPDES permit process in California
Gary Goodman, gwgoodman@fightthebite.net

The Mosquito and Vector Control Association of California entered into negotiations with the State Water Resources Control Board of California for the development of the National Pollutant Discharge Elimination System permit. This presentation will discuss the process to date and the intricacies of the California permit.

17 Mosquito control and the Endangered Species Act
Michael Hudon, m.hudon@irmosquito2.org

The Endangered Species Act will continue to have effects on mosquito control operations as more creatures are added to the federal list of threatened or endangered species. Of special concern to mosquito control activities are the growing number of listed arthropods. Among many factors contributing to species decline, loss of habitat is often the major one. As human population growth continues, it is likely that more habitats will be lost and more creatures will be listed. Other federal agencies that authorize, permit, or fund mosquito control activities are required to consult with the U.S. Fish and Wildlife Service (USFWS) whenever approved actions may affect these creatures. Consultations between local mosquito control and the USFWS are mandatory whenever their actions will affect and have unavoidable effects on endangered species. This presentation will offer advice for the consultation process. In addition, information about the AMCA's Legislative and Regulatory Subcommittee on endangered species will be provided.

18 FMCA's Tallahassee Days

Dennis Moore, dmoore@pascomosquito.org and Doug Carlson

Beginning in 1993, the Florida Mosquito Control Association began the tradition of our legislative days in Tallahassee, FL. This 2-day event is patterned after AMCA's Washington Day. On the evening prior to our full-day visitation with key legislators, we gather to review the talking points with our lobbyist, hand out team assignments and address questions. On the following morning, we regroup and head off to the capitol for our scheduled meetings. We have had a great response from our members and the results from these efforts have been very beneficial.

Biology/Behavior I

19 Mermithids in mosquitoes on Baffin Island

Edward Platzer, edward.platzer@ucr.edu

Three species of mosquito larvae (*Aedes hexodontus*, *Aedes impiger*, *Aedes nigripes*) were collected from 18 snow-melt pools in the vicinity of Iqaluit, Baffin Island, Nunavut, in June 2004. Mermithid nematode infections were found in 5 snow-melt pools, and the infections ranged from 3 to 96% of the mosquitoes. The infections were mainly in *Ae. nigripes*. In 2008, only 2 species of mosquito larvae (*Ae. impiger, Ae. nigripes*) were collected from 16 snow-melt pools in the vicinity of Iqaluit. Mermithid nematode infections were found in 6 snow-melt pools, and the infections ranged from 2 to 96% of the mosquitoes. Mermithids were only recovered from the predominant larval mosquito, *Ae. nigripes*. *Aedes hexodontus* was absent from the pools sampled and very few *Ae. impiger* were present. The presence of infected mosquito larvae at Iqaluit was first noted by Jenkins and West (1954) who related correspondence from a Canadian entomologist, T. N. Freeman, who collected mosquito larvae at Iqaluit in 1948 and found up to 60% of the larvae were infected by nematodes. This current report indicates that the mermithids continue to thrive at this location despite the development of an airport and the capital city of Iqaluit.

20 Resting patterns for the infectious juveniles of four species of mermithid nematodes

Minette Finney, minfin2008@yahoo.com and Edward Platzer

Larval mosquitoes are attacked by the second stage juvenile (J2) of mermithid nematode parasites. In general, the J2 are active swimming forms but also suddenly assume a static out-stretched and non-motile profile that we designated "resting". Because the resting behaviors of these nematodes are not widely known, we conducted a comparative study of resting using 4 species, *Romanomermis culicivorax* (RC), *Romanomermis iyengari* (RI), *Romanomermis wuchangensis* (RW), and *Stelkovimermis spiculatus* (SS). Behavior of individual J2s was observed with a stereomicroscope in small volumes of water for 300-sec intervals. The average resting phase for *Romanomermis* species was 17% of the observation period. In contrast, *Strelkovimermis* J2s exhibited very little resting behavior. We observed individual J2s of each species during a 24-h period to determine if resting was consistent during aging. Resting varied during each observation period but only increased in the last observation on J2s of RW. Overall, these results suggest that resting is not necessary for metabolic reasons but may represent an avoidance response related to potential aquatic predators.

21 Malaria transmission dynamics and *Anopheles* species in San Jose del Guaviare under INAP Project

Patricia Gutierrez Dueñas, pgutierrezduenas@gmail.com and Mosquera Laureano

An integrated surveillance and control malaria system based on early warning system, the final goal of the INAP Project requires knowledge of vector species and transmission dynamics of each municipality. It presents an approach to the dynamics of transmission and the preliminary results of the entomological characterization in San Jose. In the village Barrancón, composed of indigenous people and colones, we identified oviposition sites for *Anopheles*, and human landing catches were made during Dec 2007 to Sept 2009 from 18-22 h, in 3 houses/3 nights at intra and 1800-0600 h in peridomiciliary areas. We identified 26 sites, 69% of them used for breeding fish, with the exception of a wetland and a small lake, all located in the Colones. *Anopheles darlingi* was identified in 1 site. *Anopheles marajoara* was the most abundant species in summer; other species found were *An. braziliensis*, *An. triannulatus* and *An. oswaldoi*. *Anopheles darlingi* bites all night with a peak between 2300 and 0300 h; presents exophagic activity (I:P= 0,204/0,972) with an increase inside the houses (I:P= 1,344/2,448) during wet season when the density is higher. We observed an increase of non-incriminated malaria species in Colombia (*An. marajoara* and *An. braziliensis*) when *An. darlingi* decreases during the dry season. It is important also to point out the strong incursion of rice crop during 2009 accompanied with a drastic decrease of larval densities and an increase in the number of malaria cases in this municipality.

22 Evaluation of mosquito sampling methods in Luangwa, Zambia

Chadwick H. Sikaala, chsikaala@yahoo.co.uk, Aklilu Seyoum, Tanya Russell, Javan Chanda and Gerry Killeen

We evaluated the effectiveness of mosquito sampling methods in Luangwa district valley of Zambia during the dry season (September - October, 2009). A 3 x 3 Latin square design was applied for a total of 30 d. Human landing catches (HLC) both indoor and outdoor, CDC light trap and Ifakara tent trap (ITT) design C and resting boxes (inside and outside) together with a window trap were evaluated. A total of 1,433 mosquitoes was collected with 48% (691) anophelines and 52% (742) belonging to the culicine genera. Of these, 250 were *Anopheles gambiae* s.l, 259 *Anopheles funestus* complex, and 68 other anophelines.The mean catches per trap night for the anophelines mosquitoes in the HLC both indoor and outdoors on average was 0.2. ITT caught more *An. funestus* with a mean catch of 0.4 compared to 0.09 and 0.06 for *An. gambiae* s.l and other anophelines respectively. CDC light traps had a mean catch of between 0.09 and 1.52 for all the anophelines species caught. The resting boxes both in and out and the window traps caught between 0.00 and 0.2 per night trap. In conclusion,

the CDC light trap was the most efficient trapping tool for the malaria vectors in Luangwa. HLC caught more culicine mosquitoes with fewer anophelines. ITT sampled more *An.funestus* and fewer *An. gambiae* s.l. Window traps and resting boxes indoor performed poorly in the area.

23 Domestication process and the gonotrophic performance of the dengue vector *Aedes albopictus*: Epidemiological implications

Abu Hassan B. Ahmad, aahassan@usm.my, Hamady Dieng and Saifur Rahman

The ongoing domestication of *Aedes albopictus* in northern peninsular Malaysia (larvae and adults are commonly found inside houses) provides an ideal opportunity for investigating this topic. Here, we examined the question of whether *Ae. albopictus* exhibits increased survival, gonotrophic activity (GA) and fecundity in response to potentially greater blood feeding opportunities. To this end, we first assessed daily oviposition patterns in the newly colonized females (NCFs). When blood-fed at different times of a day, they rarely oviposited at night, but exhibited 2 distinct oviposition peaks during the day. The timing of oviposition peak tended to vary with feeding time. The biting activity of NCFs usually was high and constant during the night. We then performed a series of GC trials, involving NFs and their daughters of the 5th generation. Overall, the domesticated females (DFs) had better survival and fecundity. The NCFs lived shorter than DFs. The number of GCs was much higher in DFs, but the 2 types of females did not differ in their egg production during the 1st 5 GCs. In DFs population, the number of eggs produced was greater during the 3 1st GCs but tended to decrease gradually as rank of GCs progressed. NCFs were similar to DFs in body size. GA is directly related to disease transmission. Generally, increased GA will favor host-mosquito contact and thus vectorial capacity.

24 The effects of microclimate on trap abundance of *Aedes albopictus* in New Jersey

Taryn N. Crepeau, tcrepeau@co.monmouth.nj.us, Sean Healy, Ary Farajollahi, Isik Unlu, Kristen Bartlett-Healy, Randy Gaugler and Dina Fonseca

The effects of microclimate conditions on trap abundance of *Aedes albopictus* was examined in both the city of Trenton and along the Raritan Bay shore in New Jersey. BioGents BG Sentinel Traps were set for approximately 24 h to capture *Ae. albopictus* on a weekly basis in several study sites. Surveillance was conducted in both suburban and urban environments. Each trap was set with an iButton Hydrochon, placed in a specific location on the trap, which measures temperature and humidity at set intervals. Climate conditions as recorded by the iButtons were compared between traps as well as to regional data. The abundance of *Ae. albopictus* in traps was analyzed for correlation with subtle temperature and humidity differences.

25 Evaluation of teneral mosquitoes *Aedes aegypti* emerged from four artificial containers

Armando Ulloa, aulloa@insp.mx, Carmen J. Santiago, Teresa Lopez-ordoñez, Jose A. Juarez-Ordaz, Mauricio casas-Martinez and Juan G. Bond-Compean

We examined the relationship among body size, pre-gravid state, and concentration of carbohydrates from teneral mosquitoes emerged from cement tanks, plastic or metal drums, flowerpots, and tires. Pupae were collected in each container; after females emerged, wing-length was measured as an index of mosquito size. Anthrone method was used to determine the amount of glycogen, sucrose, and trehalose in female mosquitoes. A total of 166 females were dissected. From these 48 and 118 were classified as pre-gravid and gravid respectively. The results suggested that small mosquitoes present mostly the pre-gravity state compared with bigger mosquitoes ($t = 8.009$ $P = <0.0001$). The trehalose level was directly associated with the largest male and female of *Aedes aegypti* mosquitoes ($r^2 = 0.95$ $P = 0.185$ and $r^2 = 0.216$ $P = 0.038$). The pre-gravid state was mostly frequent in small mosquitoes, suggesting that multiple feeding is a common behavior for mosquitoes of smaller size, but not so frequent in large *Ae. aegypti* mosquitoes.

26 Utilization of artificial and natural container habitats by *Aedes albopictus* in urban, suburban, and rural areas of New Jersey

Kristen Bartlett-Healy, krisb@rci.rutgers.edu, Isik Unlu, Peter Obenauer, Sean Healy, Taryn Crepeau, Ary Farajollahi, Tony Hughes, Randy Gaugler and Dina Fonseca

The Asian tiger mosquito has become a severe nuisance mosquito in New Jersey, where it reaches its northern overwintering limit on the east coast. In 2008, we began developing an area-wide management project for the Asian tiger mosquito, with study areas being located in 2 central counties (Monmouth and Mercer). In September and October of 2009, we examined both artificial and natural containers in urban, suburban, and rural areas of New Jersey, in order to determine the most productive habitats for *Aedes albopictus*. In rural sites, we sampled all containers and tree-holes along 2 transects. In the urban and suburban sites, blocks were selected randomly. We examined containers from all accessible homes in the selected blocks. All larvae and pupae were collected and counted from all artificial and natural containers. All pupae were allowed to emerge and were identified to species. A subsample of 30 larvae was identified to species. We also determined tree species, pH, water temperature, shade level, container color, container type, container material, ground cover, container diameter, container volume, water depth, container height above ground, water color, presence/absence of leaves, water condition, and the presence/absence of *Toxorhynchites*. Factors contributing to the productivity of *Ae. albopictus* and *Aedes japonicus* will be discussed.

27 Do I stay or do I go? Predicting mosquito behavior in the presence of repellents, insecticides, and attractants
Lee W. Cohnstaedt, cohnstaedt@hotmail.com, Sandra A. Allan and Uli Bernier

Personal protective measures, such as repellents and insecticides, are designed to prevent arthropods from landing, feeding, and transmitting disease to humans. Although chemical products are effective and frequently used, their affects beyond reducing biting rates is rarely studied. The behavior of *Culex quinquefasciatus* was filmed in a special bioassay box designed to restrict movement to a single plane around the attractant. Mosquito movements were tracked through time to analyze behavior in the presence of an untreated-, DEET (N,N-Diethyl-3-methylbenzamide)- or permethrin-treated sleeve on a human arm. Detected behavioral changes will be discussed in terms of differences in "modes of action" between the 2 chemicals and the potential role of behavioral analysis in evaluation of future chemical repellents.

Legislative & Regulatory Symposium II: Adding New Tools to our Toolbox: Understanding the Pesticide Development Process

28 Introduction
Karl Malamud-Roam, kmr@aesop.rutgers.edu, Jerry Baron, Kevin J. Sweeney, Ed Ruckert, Tom MacLean and Kate Aultman

The toolbox of chemical vector control tools has been shrinking over the last years, while the need for more and better tools increases. A number of promising active ingredients have been discovered or created recently, and the gap between research successes and a shrinking set of operational tools indicates a clogged innovation pipeline. In this symposium we will explore the reasons for the slow and expensive pesticide development process and will present several recent initiatives to reverse the process and bring new products into our hands. Commercial companies typically screen over 100,000 potential molecules for each product brought to market, because useful pesticides must not only be effective, but also safe and affordable. Thus, once a novel AI is demonstrated to work, the process has only begun. Screening for environmental fate, toxicology, breakdown products, large-scale formulation, etc. can all eliminate from consideration otherwise promising candidates. Also, private partners must make profits, a major challenge in the small market represented by vector control. In this symposium we will first illuminate the process of developing and registering pesticides. We will then discuss the challenges of encouraging innovation and collaboration while protecting intellectual property rights. We will conclude with presentations of recent initiatives aimed at opening the pipeline and adding significant number of new and better tools to our box in the next few years.

29 The AMCA's Pesticide Environmental Stewardship Program 2010
Doug Wassmer, dwassmer@pascomosquito.org

The AMCA became a voluntary Pesticide Environmental Stewardship Program (PESP) partner with the EPA in February 1997. Over the past 13 years, program elements have been modified by both the EPA and the AMCA. A historical description of the AMCA's PESP participation is followed by a synopsis of the EPA's new PESP initiatives as revealed at the Nov 16-18, 2009, National PESP Conference in Arlington, VA.

Biology/Behavior II

30 ***Withdrawn***

31 Effect of pesticide treatment of vegetation on landing behavior of mosquitoes and sand flies
Sandra A. Allan, sandy.allan@ars.usda.gov

Treatment of vegetation with residual pesticide is an effective tool for mosquito management. Commercial formulations for barrier treatment against mosquitoes with different active ingredients were applied to wax myrtle at maximum label rate. Behaviors of mosquitoes (*Aedes albopictus*) and sand flies (*Lutzomyia shannoni*, *Phlebotomus papatasi*) were video-taped and analyzed using behavioral analysis software. Pesticide treatments significantly affected landing frequency and flight duration.

32 Colorado *Culex tarsalis* captured in light traps contain more fructose than their *Aedes vexans* counterparts
Amber L. Partridge, apartrid@mscd.edu, Calvin J. Vialpando, Matthew E. Hendrix, Meghan M. Chapple, Gillian Andersen and Robert G. Hancock

A highly-sensitive colorimetric test for fructose using an anthrone-tryptophan-sulfuric acid reagent was used to assess nectar feeding in nulliparous mosquitoes captured in CO_2-baited mini-CDC light traps during the summers of 2008 and 2009 in 5 counties in northeastern Colorado (Adams, Boulder, Broomfield, Morgan and Weld Counties). When suitable numbers of both *Aedes vexans* and *Culex tarsalis* were found in the same trap, comparisons were made between the 2 species. The proportions of nulliparous *Cx. tarsalis* mosquitoes with detectable fructose were significantly higher than in their *Ae. vexans* counterparts. Furthermore, for those mosquitoes with detectable fructose, *Cx. tarsalis* contained nearly 1.5 times more than their *Ae. vexans* counterparts. These results support laboratory findings by Hancock & Foster (1993) that demonstrate a behavioral switch mechanism in *Culex* mosquitoes whereby orienting to nectar stimuli after emergence is temporally prioritized (over host stimuli) by a physiological mechanism.

33 Diversity, biogeography and population dynamics of Colorado mosquitoes collected in CO_2-baited CDC light traps
Meghan M. Chapple, Mchapple@mscd.edu, Amber L. Partridge, Matthew E. Hendrix and Robert G. Hancock

Adult female mosquitoes (Diptera: Culicidae) were collected using CO_2-baited CDC mini-light traps on weekly intervals from late May 2009 through late September 2009 at 137 sites in 14 counties in Colorado. Three of the 4 recognized ecoregions of the Rocky Mountains were represented in the survey: the Colorado Plateau (western CO), the Rocky Mountains, and the Great Plains (eastern CO). Species diversity and relative abundance were determined and compared between ecoregions and in several habitat categories. Throughout the season a total of 340,591 mosquitoes of 27 different species were identified. With few exceptions, *Aedes vexans* (Meigen) and *Culex tarsalis* (Coquillett) were the first and second most-abundant species, respectively. *Aedes* (*Ochlerotatus*) *nigromaculis* (Ludlow), relatively uncommon in previous survey years, was found in all ecoregions except the Colorado Plateau. The dynamics of diversity and catch-size were related to seasonal and weather-related (precipitation and temperature) variables. The implications of these findings on mosquito pestilence and disease-vectoring are discussed.

34 Mosquito community structure and arbovirus incidence in Lowndes County, GA
Mark S. Blackmore, mblackmo@valdosta.edu, Steven Golladay, Jessica Clark, Laura Simmons and Lauren Williams

Adult female mosquitoes were collected using gravid traps and CO_2-baited light traps from 2004-2009 in conjunction with surveillance for West Nile virus and other arboviruses. Collection records for 17 locations in Lowndes Co., GA, were analyzed to determine species associations and relationships of species "groups" to environmental factors and virus prevalence. The results of these analyses will be discussed.

35 Distribution and abundance of West Nile virus vectors in Chicago
John-Paul Mutebi, grv0@cdc.gov and Bethany N. Swope

In 2008 and 2009 population studies were conducted on West Nile virus (WNV) vector mosquitoes in Chicago. The aim was to identify mosquito population parameters associated with the non-uniform distribution of WNV in Chicago. In 2008, a higher proportion of *Culex pipiens* (L.) egg rafts (49.9%) were collected in areas where WNV positive mosquitoes were high compared to areas where WNV positive mosquitoes were low (9.4%). Similarly, in 2009, proportions of *Cx. pipiens* levels were higher (26.72%) in areas where WNV positive mosquitoes were high compared to areas where WNV positive mosquitoes were low (4.48%). In 2008, *Cx. pipiens* abundance was higher in areas where WNV positive mosquitoes were high 6.85 egg rafts/trapnight, compared to where WNV positive mosquitoes were low 1.75 egg rafts/trapnight ($U = 6.5$; $P = 0.009$). The association between *Cx. pipiens* population levels and WNV activity in Chicago is intriguing and may partially explain the non-uniform distribution of WNV in Chicago.

36 Host-seeking preferences of three species of *Culex* mosquitoes in southern California
Taylor Lura, Robert Cummings, Robert Velten, Karin De Collibus, Tim Morgan, Kiet Nguyen and Alec Gerry

The intrinsic biting preference of common southern California *Culex* mosquitoes was examined in the field by determining their feeding success on 4 bird species, American crow (*Corvus brachyrhynchos* Brehm), house sparrow (*Passer domesticus* Linnaeus), house finch (*Carpodacus mexicanus* Muller), and mourning dove (*Zenaida macroura* Linnaeus), presented equally within a net trap to wild, host-seeking mosquitoes. Blood meals in engorged mosquitoes captured within the net trap were identified to avian species using a multi-plex PCR assay targeting the *cytochrome b* gene sequence. There were significant differences in host biting preference for all 3 *Culex* species, with *Culex tarsalis* preferentially biting house finches and house sparrows over mourning doves ($P=0.001$), *Culex quinquefasciatus* preferentially biting house finches and American crows over mourning doves ($P=0.0001$), and *Culex erythrothorax* preferentially biting American crows over mourning doves ($P=0.0001$). The greater intrinsic biting preference of all 3 *Culex* species for feeding on the passerine birds (sparrows, finches, and crows) relative to the non-passerine mourning dove may result in higher infection prevalence in wild populations of these mosquito species when passerine bird species are available.

37 Peak flight times for host seeking females of the two major pest species, *Aedes taeniorhynchus* and *Psorophora columbiae*, in Lee County, Florida
James H. Burgess, burgess@lcmcd.org, T. Wayne Gale and Jonathan Hornby

In 2008, Lee County Mosquito Control District began the studies of the flight times of host seeking female *Culex nigripalpus* mosquitoes. In 2009, this study was continued as well as the study of Lee County's 2 major pest species. From mid-April till the end of July, the flight times of host-seeking female *Aedes taeniorhynchus* was studied. From August 1 till October 31, the flight times of host-seeking female *Psorophora columbiae* were studied. Rotator adult traps were used to collect mosquitoes on an hourly basis from 1700 to 0800. The traps were baited with dry ice and octenol for the sampling of host-seeking females. The traps were run for 3 d a week.

20th Annual Latin American Symposium I

38 Time and cost comparisons of total counting and rapid sweeping estimations for *Aedes aegypti* pupae surveillance
Claudia M. Romero-Vivas, clromero@uninorte.edu.co and Andrew K. Falconar

Aedes aegypti pupae surveillance, based on total counts is time-consuming and, therefore, expensive and unpractical. A simple, rapid and robust sweeping method was developed (Romero-Vivas et al., 2007) to accurately estimate pupal numbers in their most productive habitats, large domestic water-storage containers. In this study, we performed time comparisons

between the sweeping method and total counts. The average time to estimate and count 200 pupae in a 220-liter drum, a <1,000-liter tank (GT1) and a >1,000-liter tank (GT2) per container type and water level (1/3, 2/3 and 3/3) (repeated 10 times) were then used to estimate the times and costs of field-surveillance data of 329 water-storage containers distributed in 319 houses. In the semi-field and field conditions, the sweeping method was 9.0 and 5.2 times, 5.0 and 5.5 times and 3.0 and 3.0 times faster than total counts for GT2, GT1 and drums, respectively, with an average of 4 times faster. The sweeping method took 1 d to survey the 329 pupae-positive containers, at an estimated cost of US $132, compared to 4 d, at an estimated cost of US $528 using total counts. We, therefore, strongly recommend using our sweeping method for *Ae. aegypti* surveillance and control programs.

39 Toxicity of spinosad and temephos against mosquito larvae in a tire cemetery of Allende, Nuevo León, México
Humberto Quiroz-Martinez, hqm_uanl@yahoo.com, Violeta A. Rodriguez-Castro, Argentina A. Garza-Robledo, Juan F. Martinez-Perales and Armando Elizondo-Quiroga

Toxicity of spinosad and temephos were evaluated in a tire cemetery in Allende, Nuevo León. A total of 30 tires was used in this evaluation. Groups of 10 were used for each larvicide and a control. Samples were taken weekly after treatments application. Statistical difference was found among treatments. Mosquito larvae were found only in the control treatment.

40 Results using different formulations of Natular™ (active ingredient spinosad) in Kentucky
Grifith S. Lizarraga, glizarraga@clarke.com and Grayson Brown

The active ingredient of Natular™, spinosad, is a product derived from a naturally occurring soil bacterium. Spinosad represents a unique chemical class and mode of action different from all other existing larvicides. During Kentucky's 2008 and 2009 season, several evaluations were designed to measure efficacy and performance of Natular™. Results indicate efficacy against an array of mosquito species including *Aedes japonicus*, *Aedes triseriatus*, *Aedes trivittatus* and *Anopheles quadrimaculatus*. Species susceptibility was achieved at label rates in several habitats, including abandoned swimming pools.

41 Evaluations of the new pyriproxyfen slow-release resin against wild strains of *Aedes aegypti* in semi-field conditions
Claudia M. Romero-Vivas, clromero@uninorte.edu.co and Andrew K. Falconar

We tested 2 different pyroproxyfen formulations (granules and slow-release resin: 50 ppb (manufacturer's suggestions) in 250-liter drums under semi-field conditions. For this study, 2 liters of water was collected from these containers on d 0, 2, 4 and 7 and subsequently every 7 days until d 70 after treatment for laboratory analyses. For these analyses, food and 25 early 4th-instar *Aedes aegypti* larvae of either the reference (LSHTM Gower) strain or 2 strains from dengue virus endemic areas (Los Olivos and Soledad) were added to 4, 250-ml replicates of each water-treated formulation, and, after 7 d, the emergence inhibition (% EI) was determined. In this study, water from the pyriproxyfen granule-treated drums inhibited the emergence of all of these *Ae. aegypti* strains by greater than 50% for over 1 mo (d 36) and there were no significant differences between their susceptibilities to this hormone analogue. In contrast, the slow-release resin formulation showed greater than 50% EI of these mosquito strains for a period of only 4 d after treatment. These results suggest that the dosage of the pyroproxyfen slow-release resin formulation must be increased for effective *Ae. aegypti* control in their principal oviposition sites (water storage tanks and drums).

42 Field evaluation of ULV adulticide insecticides: Aquareslin Super, Bistar ULV and Anvil UnoMex 2 + 2 ULV, against the dengue vector *Aedes aegypti*, in Monterrey, Mexico
Ildefonso Fernandez-Salas, ifernand1@hotmail.com, R. M. Sanchez-Casas, O. S. Sanchez-Rodriguez, Luis A. Ibarra, E. Zarate-Nahon, R. Ramirez-Jimenez, M. Alvarado-Moreno, M. Laguna-Aguilar and Jorge Rodriguez-Rojas

Space spraying insecticidal treatment is a critical factor in eliminating dengue-infected *Aedes aegypti* females during severe outbreaks. Field evaluation and comparison of mortality effectiveness were conducted for 3 ULV adulticides: Aquareslin Super (permethrin), Bistar ULV (bifenthrin), and Anvil Unomex 2 + 2 (fenothrine). Linear 90-m transects were settled to check for mortality through distance. Every 10 m, cages with 20 mosquito females were placed at 1.80 m height and exposed to individual insecticide testing. A second test was run placing mosquito cages inside houses: porch, living room, and backyard. Bioassays to check for insecticide susceptibility/resistance using whole formulations were also conducted in wheaton bottles. Droplet size was determined using a CD-III laser reader. A London 18-20 ULV vehicle-mounted sprayer was used. Flow rate was used based on Mexico Vector Control Program Regulations, i.e., Aquareslin 416 ml/min, Bistar ULV 180 ml/min, and Anvil Unomex 130 ml/min. Linear tests showed highest 24-h mortality for Bistar ULV (99.3%) and Aquareslin (94.6%), while Anvil Unomex produced 84.6% mortality. House test showed highest average mortality for Aquareslin (79.7%) and Bistar ULV (78.7%), while Anvil Unomex resulted in 38.0%. Susceptibility/resistance bioassays showed 100% mortality for the 3 tested adulticides. Our results demonstrated the importance of performing field evaluations using the 3 supplementary field and lab tests to support decision-making of government dengue control programs.

43 Resistance to deltamethrin and enzymes associated in *Aedes aegypti* from western Venezuela
Leslie Alvarez, hleslieag@hotmail.com, Milagros Oviedo, Ponce Gustavo and Adriana E. Flores

Susceptibility to deltamethrin of adult mosquitoes of 4 populations of *Aedes aegypti* (L.) collected from 3 states of Venezuela; resistance mechanisms were determinated. Bioassays were carried out using the bottle assay and the biochemical assay in microplates. New Orleans (NO) strain was used as reference. Results showed resistance to

deltamethrin in 3 populations: Tres Esquinas (RR= 8.06), Pampanito (RR= 6.9), and Lara (RR= 9.05). Ureña proved susceptible with RR=3.4. GST was found in females from Lara and Ureña exceeding the resistance threshold established by NO strain, suggesting cross- resistance with DDT. Pampanito showed increased levels of β esterases, GST and insensitive acethylcholinesterase (iAChE), while Tres Esquinas showed all enzymes elevated with the exception of GST in comparing with NO strain suggesting resistance to different insecticide groups.

44 KDR mutation (val1016) in *Aedes aegypti* (L) from Mexico

Gustavo Ponce, gponcealfa@gmail.com, Adriana E. Flores, Karla Saavedra, Saul Lozano and William C. Black IV

Pyrethroids are commonly used as mosquito adulticides and the evolution of resistance to these compounds is a major threat to public health. 'Knockdown resistance' to pyrethroids (KDR) is frequently caused by nonsynonymous mutations in the voltage-gated sodium channel transmembrane protein (para) that reduce pyrethroid binding. Early detection of Kdr is critical to the development of resistance management strategies in mosquitoes including *Aedes aegypti*, the most prevalent vector of dengue and yellow fever viruses. Brengues et al. described 7 novel mutations in hydrophobic segment 6 of domain II of para in *Ae. aegypti*. We found 2 new mutations never detected in Latin America in these same codons. A transition in the first position of codon 1011 encodes a Val replacement while a transition in the first position of codon 1016 encodes an Iso replacement. The present study analyzed the rise of KDR mutation in 14 states of Mexico, over the past 7 yr and determined that the mutation KDR has been increasing considerably, mainly in the state of Veracruz, where people like Martinez de la Torre, Tantoyuca and Poza Rica did not present frequencies KDR in 2000 and for 2007 frequencies increased to 0.43, 0.38 and 0.70 respectively.

45 Susceptibility status of *Aedes aegypti* to cyfluthrin and permethrin in Atlántico, Colombia

Ronald Y. Maestre Serrano, rmaestre22@yahoo.com and Sergio J. Goenaga-Olaya

The use of insecticides for the control of dengue fever (DF) in the Department of Atlántico for more than 3 decades has generated the appearance of resistant populations to temephos, fenitothrion, lambda-cyhalotrin and dichlorodiphenyltrichloroethane (DDT). It is necessary to evaluate other insecticides as an alternative for the chemical control of the disease. Objective: to evaluate the susceptibility status to cyfluthrin and permethrin in 4 populations of *Aedes aegypti* of the Department of Atlántico, Colombia. Bottle bioassays were performed following the Center for Disease Control and Prevention methodology, using diagnostic doses for cyfluthrin (25 µg/ml) and permethrin (21.5 µg/ml) on *Ae. aegypti* mosquitoes (F1) from the municipality of Soledad, Puerto Colombia and Juan de Acosta in the Department of the Atlántico during 2009. Three repetitions, each with 4 replicates and 1 control, were carried out. Susceptibility to cyfluthrin and permethrin was registered in the evaluated populations (mortality rate: 100%). The use of insecticides cyfluthrin and permethrin is recommended as an alternative control measure for dengue fever in Atlántico, Colombia.

46 Enzymes associated with pyrethroid resistance in *Aedes aegypti* (L.) from Veracruz, Mexico

Brenda G. Silva, silvaqbp@gmail.com, Selene M. Gutierrez, Ma.Cristina Bobadilla, Gustavo Ponce and Adriana E. Flores

We have used existing biochemical assays to identify and document mechanisms of resistance of 7 populations of *Aedes aegypti* from Veracruz, Mexico. Baseline information on susceptibility of *Ae. aegypti* showed resistance ratios from 10X to 675X to d-phenothrin, permethrin, deltamethrin, lambda-cyalothrin, bifenthrin, cypermethrin, alpha-cypermethrin and z-cypermethrin. Results indicate that esterases (alpha and beta) are the main resistance mechanisms in pyrethroid-selected populations and less frequent Glutathione-S-transferase and Oxidases.

47 Evaluation of a paint with microencapsulated insecticides for the control of vectors and arachnids

Jorge F. Mendez-Galvan, jorge.f.mendez@gmail.com, Martin Gaspariano, Maria E. Barrera, Yelsi Hernández, Alicia Melo, Ciro Lopez, Jose Santos and Pilar Mateo

Vectors and arachnids nest in houses and improving the house can help control them. For this reason, we evaluated a paint with microencapsulated insecticides (Chlorpyrifos 1.5%, Diazinon 1.5% and Pyriproxifen 0.063%). We measured the effect on *Triatoma palidipennis*, the scorpion *Centuroides limpidus* and larvae in houses in a rural community of 84 houses from June 2007 to December 2008. Two localities were selected as controls: one with paint without insecticides and the other with nothing. We evaluated the house infestations with 2 biological susceptibility tests on painted walls. After 18 mo of follow up, the houses painted with paint with insecticides remained uninfested and the community expressed its appreciation for not having any scorpion bites, while the control houses remained infested and had no change in their infestation levels. The effect of the infestation was statistically significant when analyzed with ANOVA and the Student's t test.

48 Prevention and control of dengue through community participation

Flor M. Herrera, flormhq@gmail.com, Maria Martìnez, Elsa Albornoz, Luis Caguaripano, Wild Ladera, Auristela Figueroa, Isdelys Rodríguez, Nancy Moreno, Milena Mazzarri, Irma Agrela and Elina Rojas

The design of a good strategy to control and prevent dengue must include community participation. We accomplished this objective through communication strategies and social movement and by evaluating community members' knowledge, attitudes, and practices related to dengue. The methodology employed was as followed: selection of 2 communities from Aragua State: Sector 4, Caña de Azúcar, Municipio Mario Briceño Iragorry (MBI) and Parcela 28, Santa Inés, Municipio Francisco Linares Alcántara (FLA). Then, the establishment of a social network among different institutions related to the communities (community councils, community leaders, educational Institutions, universities, Alcaldías, Juntas

Parroquiales, others) and health Institutions of Estado Aragua, was performed. Surveys were conducted on knowledge, attitudes and practices in selected houses by simple random sampling (50% of houses in each community), interviews and focus groups. Besides, we looked for likely mosquito oviposition sites and their positivity and identified other risk factors for their presence (participant observation). We worked to promote dengue prevention from community participation through fundamental values related to axiology, collective, commitment, accountability, and participation. As a result of working 3 months in FLA, there was a remarkable reduction (from 25% to 0%) in mosquito sites (egg, larva and /or pupa) around the homes. Financial support: Misión Ciencias, Proyecto 2008000911-1, FONACIT-Venezuela

49 Barriers to infection and immune response in *Aedes aegypti* during oral infection with dengue

Irma F. Agrela, agrelairma@hotmail.com, María E. Angarita, María I. Da Silva, Tzy Y. Huang, Scarlet Guarecuco and Flor Herrera

Transmission of dengue virus depends on the existence of competent mosquitoes which is determined by multiple factors such as barriers to pathogen development and mosquito immune response. In order to evaluate these aspects, female *Aedes aegypti* from the Aragua state were experimentally infected with a strain of DEN-2. Then the presence of virus in different mosquito body parts was determined. The expression of the defensin gene, involved in innate immune response, in the mosquito was also determined. Results show that the studied population is more susceptible than the reference population (Rockefeller strain); therefore, barriers to infection are easily surpassed by DEN-2. Indeed, females of Aragua population have higher values of experimental parameters for determining infection rate than Rockefeller strain. The parameters are as follows: the minimum infection rate (TMI=10.2 vs 7.1), the minimum rate dissemination (TMD=11.4 vs 5.7), and transmission rate (TMT= 8.5 vs 5.7). The defensin gene was expressed in mosquitoes fed with a suspension of erythrocytes 4 times more than mosquitoes fed with a similar suspension with DEN-2 virus. These data suggest the existence of a mechanism of viral interference which may allow the persistence of the virus in its vector favoring enhanced susceptibility to DEN-2.

2nd Annual Aviation Symposium

50 The winds of change and aerial applications

Daniel Markowski, dmarkowski@vdci.net, Allen Loe and Malcom Williams

With the latest technology, overcoming many of the environmental variables that affect a successful aerial application seems assured. However, success often proves to be quite elusive as conditions routinely change during flight. Although on-board meteorology equipment has increased our awareness of these changes and allowed for increased application efficiency, with each gust of wind, application efficacy can be altered. The effects of variable winds on aerial applications will be discussed.

51 Current technologies and techniques for improving accuracy of aerial applications

Bill Reynolds, breynolds@leateam.com

The Forest Service Crammer Berry Grim (FSCBG) spray fate prediction software was developed in the early 1990s to provide the Environmental Protection Agency predicted deposition and transportation values of products applied by aerial applications in the agricultural and forestry markets. The FSCBG software model incorporates the near-wake turbulence and the Gaussian far-field model and began to be used in the aerial mosquito control market in recent years. The early optimization values produced by the FSCBG spray fate prediction software are the values currently used in some of the GPS flight guidance, recording and optimization systems today. Although these software and hardware technologies were the most accurate and scientifically advanced methods available at the time, recent advances in AGDISP and new, more accurate field techniques for measuring and validating operational spray drift, have improved efficacy and produced more consistent results.

52 Aerial contingency contracts: What is your backup plan?

Caleb T. Stitely, cstitely@dynamicaviation.com

A case study approach showing the importance of having an aerial application contingency plan in the event of a public health emergency, natural disaster, or other unforeseen event.

53 TMCA Gulf Coast Fly-in: The history and high points

Tom Janousek, tjmosq@msn.com and Jim Ryan

The Texas Mosquito Control Association has sponsored the Gulf Coast Fly-in for the past 8 years. The original location was the Chambers County Airport. The current location is the hangar for the Brazoria County Mosquito Control. The fly-in has attracted an average of 75 people and 6 mosquito spray planes on display. The fly-in has had 10-15 speakers presenting on a wide variety of aerial mosquito control topics. Highlights include the appearance of the Air Force C-130 plane used in hurricane and flood relief, updated research on aerial mosquito control, and equipment displays. Other highlights include an appearance by a recent NASA Shuttle astronaut, NASA trainers and technicians, and an aerial display by renovated Japanese Zero fighter planes.

54 The Florida Mosquito Control Aerial Short Course
Pamela Jacobson, Pamelafmcpa@aol.com and Mark Latham

The Florida Mosquito Control Association sponsors an annual Aerial Short Course and Fly-in in Fort Meyers, FL, at the headquarters of Lee County Mosquito Control District. For over a decade, aviation professionals from around the world have been gathering here each January to share ideas, research, and methodology to improve efficacy of aerial mosquito control operations.

55 The Florida Mosquito Control Pilot's Association: Beginning our fifth year
Amy Sargent, amysargent1@gmail.com and Pamela Jacobson

Formed in January of 2006, the Florida Mosquito Control Pilot's Association serves as a forum for mosquito control pilots and aviation professionals to network, share information, and work to improve the safety of mosquito control aviation operations. A review of the organization, accomplishments, and goals for the future.

Aedes Biology & Control Symposium I

56 It starts with the egg: A review of biology and non-existent control methods
Daniel Strickman, daniel.strickman@ars.usda.gov

Integrated vector management attempts to use all available methods for control in a targeted, coordinated manner to achieve the safest, most effective reduction of a pathogen-transmitting population. The appeal of targeting adults is that they represent the actual target for disease reduction and, of all the life stages, they are the fewest in numbers. Larvae and pupae are convenient stages to kill because their distribution is predictable, they are highly susceptible to some very safe chemicals, and they present a target for a period of time during which they do not present a risk to public health. The egg, however, is ignored as an object for control. The problem is that the egg has a chemically resistant covering, is invisible to conventional inspection, and is the most numerous of all the life stages. The question is whether IVM is missing development of a potentially important tool in its fight against *Aedes* vectors of viral diseases. The answer is "yes."

57 A push-pull strategy for *Aedes aegypti* control
Nicole Achee, nachee@usuhs.mil

The ability to prevent a vector from entering a home to feed (spatial repellency) or cause an escape response before biting (contact irritancy), using low levels of chemical without selection pressure for resistance (toxicity) has broad implications for disease control programs worldwide. Our team is currently identifying behavioral changes of 2 populations of adult *Aedes aegypti* in response to chemical repellents and/or irritants in order to push host-seeking mosquitoes away from a host source. Our goal is to guide the development of novel intervention strategies using non-toxic products inside homes. Although both spatial repellency and contact irritancy are vital in reducing man-vector contact, there is a growing debate about diverting host-seeking mosquitoes from a treated to an untreated host source. For this reason, a trap is also being evaluated for the purpose of identifying its role in pulling and capturing repelled/irritated mosquitoes within the peridomestic environment as well as serving as a potential dissemination tool for chemosterilants for greater vector control impact. Combined, information from these studies will be used to demonstrate the efficacy of a push-pull strategy to reduce indoor densities of host-seeking *Ae. aegypti* and model the impact on disease transmission.

58 Bacteria are ecosystem engineers in the container habitats of *Aedes* (*Stegomyia*) mosquitoes
Loganathan Ponnusamy, Ning Xu, Sitoshi Nojima, Luma Abu Ayyash, Dawn Wesson, Coby Schal and Charles Apperson

Bacteria perform biological functions in water-filled, human-made containers that are critical to the life cycle of *Aedes* (*Stegomyia*) mosquitoes. Mosquito eggs are stimulated to hatch by the metabolic activity of bacteria. Bacteria are an integral component of the diet of larvae mosquitoes. Bacterial catabolism of organic detritus produces volatile and nonvolatile organic compounds that guide gravid mosquitoes to containers and stimulate them to lay eggs. Mediation of mosquito ovipositon behavior by bacterially-derived semiochemicals is a novel and promising area of research. Our present efforts to develop a "lure and kill" strategy by combining bio-active bacteria with a lethal oviposition trap will be described.

59 Spinosad-based larvicides: A new tool for mosquito management
Grayson Brown, gcbrown147@gmail.com

A new larvicide first became available in 2009. Named Natular™, it is a bacterial fermentation product which has a unique mode of action. Relative to traditional larvicides, this new one has a number of advantages and disadvantages that mosquito managers must understand. This presentation explores the results of independent tests of these new products in a variety of real world environments (abandoned swimming pools, municipal catch basins, catchment areas, salt marshes, mangrove swamps, containers, etc.), and describes the larvicide's performance. Considerations for usage and public relations are also discussed.

Trustee/Commissioner Session

60 Less dollars but same numbers of skeeters: Coping with collapsed budgets in Delaware
William H. Meredith, william.meredith@state.de.us

Like many states, Delaware's state budget is severely strained, and this fiscal year we faced one of the largest shortfalls in the country (>20%). Balancing the budget as required by law necessitated many program cuts. For the Delaware Mosquito Control Section that does all mosquito control work in Delaware, there was a 19% reduction in our annual spray budget

with possibly another 9% cut for next year, along with other sharp reductions in operational resources. As a result of personnel attrition over the past 24 mo and not being able to fill vacancies, our complement of full-time employees is down by 30%. Nonetheless, the public's expectations and demands for mosquito relief and health protection remain unabated. In needing to "work smarter while doing more with less," the Section is exploring or implementing more cross-training and multi-tasking; priority restructuring; programmatic reorganization; geographic consolidation; resource reallocation; etc. But the bottom line is, you can do only so much via "better efficiencies." Given the magnitude of cuts, a true and noticeable drop in what we can provide to the public is unavoidable. Within a political setting, questions arise for how much we might be able to share with the public, elected or appointed officials, or the media for how we're trying to cope. There will be "winners" and "losers" among the public regarding our future performance and delivery capabilities -- how "acceptable" might this be to the "losers"?

61 Mosquito control while facing declining revenues: A west coast perspective
David Brown, dabrown@fightthebite.net

Downturns in the economy have had an effect on public health programs throughout the country. California has not been alone in facing revenue deficits that have had a direct effect on local programs. This paper will discuss all of the effects on local mosquito control programs associated with the decline of revenues.

62 Dengue in the Americas and its possible indigenous transmission in the southeastern U.S.
Gary Clark, gary.clark@ars.usda.gov

Dengue is the most important mosquito-borne viral disease of humans and commonly occurs in many tropical countries around the world. The principal vector is *Aedes aegypti* which is produced in a variety of water holding containers occurring in the domestic environment. In the last 30 years, there has been a remarkable increase in dengue incidence in the Americas which poses a threat of dengue transmission in the continental US. While several factors and conditions favor the occurrence of dengue transmission in the US, conversely, other factors mitigate this occurrence. Since 1945, local dengue transmission in the continental US has only sporadically been detected in south Texas where a total of 63 locally acquired infections were detected through 2005. This presentation reviews some of the factors that influence the presence of this disease and analyzes the likelihood of indigenous dengue occurring in the southeastern US.

63 Mosquito control response to dengue fever outbreak in Key West, FL and approach to vector control in the future
Andrea Leal, aleal@keysmosquito.org

Beginning in August of 2009, locally acquired dengue fever cases began occurring in Key West, FL, USA. Operational response to this outbreak included both focus on adult and larval vector control in Key West. Both aerial and ground adulticiding were utilized in adult control, while door-to-door environmental assessments were conducted throughout Key West and neighboring islands in order to eliminate and/or treat larval habitats. In addition to vector control, the Florida Keys Mosquito Control District, along with the Monroe County Health Department, had numerous press releases, radio, and television spots to inform the residents on how to avoid being bitten by mosquitoes as well as to aid in the elimination of standing water around their homes. Location indexes revealed an average of 17% infestation rate during the first door-to-door sweep. The District is working with health officials and residents to reduce this rate in order to avoid future outbreaks as well as prevent dengue fever from becoming endemic in the Florida Keys.

64 Globalization of Chikungunya virus: Threat to the U.S.
Kenneth J. Linthicum, kenneth.linthicum@ars.usda.gov, J. P. Chretien and A. Anyamba

In August, 2004, Kenyan health authorities and partners identified chikungunya virus as the cause of a febrile epidemic in a coastal island city. The virus is transmitted by *Aedes* mosquitoes in tropical Africa and Asia; the fever is rarely fatal but can incapacitate for weeks. Control was delayed, in part, because chikungunya fever clinically resembles endemic diseases, such as malaria and dengue. The epidemic spread to Indian Ocean islands and India, where it continues, and more than 1 million cases are suspected. As infected travelers returned from epidemic areas to temperate regions, concern developed that local mosquitoes could sustain disease transmission. *Aedes aegypti*, the likely vector in Kenya, occurs throughout the tropics and subtropics. *Aedes albopictus* was implicated in the subsequent outbreak on Reunion Island that affected 265,000 people. Aided by tire shipments, the native Asian mosquito inhabits Pacific islands, parts of Africa and Latin America, 14 European countries, and 28 US States. In June 2007, an outbreak of chikungunya fever occurred in Italy, the first reported in a temperate country. The chain of chikungunya fever outbreaks from Kenya to Italy reflects a convergence of factors. Among them are rapid international transport, previous introduction of exotic mosquito species, inadequate mosquito control, and climatic conditions. We discuss the potential threat that chikungunya virus poses to the U.S.

65 A review of eastern equine encephalitis (EEE) in the U.S. during 2009
John-Paul Mutebi, grv0@cdc.gov

In 2009, state and regional health departments reported to the Centers for Disease Control and Prevention (CDC) 569 eastern equine encephalitis virus (EEE) positive mosquito pools in 10 states VA, ME, NH, CT, NY, NJ, MA, FL, and LA. This represented a 685% increase from 2008 and a 341% increase from the average of the previous 3 years, 2006, 2007, and 2008. Some 307 veterinary cases, horses, alpacas, emus, etc., were reported in 14 states ME, NH, NY, NJ, MD, VA, NC, SC, GA, FL, MS, LA, AL, and TX, an increase of 161% from 2008, and 306 positive sentinel chicken flocks were reported in 3 states VA, NC ,and FL, an increase of 197% from 2008. EEE viral RNA was detected in 14 dead birds in 6 states MI,

ME, NY, VA, FL, and NH, an increase of 470% from 2008. Four human cases were reported to the CDC from NH, NY, LA, and SC, which is close to the average number of 5 cases reported annually since reporting was initiated in 1964 and no increase from 2008. These reports show a sharp increase in EEE virus circulation nation-wide in 2009.

66 Impact of insecticide resistance on mosquito control
Janet McAllister, jvm6@cdc.gov

Insecticide resistance can arise from misuse or overuse of mosquito control products. It may also arise from use of insecticides in other sectors such as home owners or agriculture. Two possible strategies for resistance mitigation include increasing the dosage used and/or changing chemicals. Both of these strategies can have substantial effect on a district's budget, underscoring the importance of incorporating surveillance for resistance into a program. Current knowledge of efficacy of mosquito population control and interruption of disease transmission will be presented as a framework for the cost of insecticide resistance on mosquito control.

67 Overview of legislative and regulatory issues facing the AMCA
Karl Malamud-Roam, kmr@aesop.rutgers.edu

Over the past few years, the AMCA's Legislative and Regulatory Committee has been extremely active working on several issues of vital importance to our membership. This presentation will provide an overview of these topics which include federal funding for West Nile virus control, Endangered Species Act considerations, pesticide registration issues, the process of developing a nationwide mosquito management plan for national wildlife refuges, and the implications of the Clean Water Act/NPDES permit process for the application of pesticides to "waters of the U.S." An announcement of the 2010 Washington Day will be part of this presentation urging participation by trustees and their staff.

68 History of why a NPDES permit process for mosquito control appears imminent
Doug Carlson, doug.carlson@irmosquito2.org

This presentation will provide an overview of the nearly decade-long history of why the mosquito control community is facing the likelihood that a National Pollution Discharge Elimination System (NPDES) permit will be necessary for the application of larvicides and adulticides to "waters of the U.S." in April 2011.

69 Current status of the NPDES permit process and the AMCA's Integrated Mosquito Management document
Joseph Conlon, conlonamcata@gmail.com

The current status of the NPDES permit process will be presented including the EPA's methodology for developing it, largely in conjunction with state participation. A discussion of the Integrated Mosquito Management document which was developed by the AMCA and submitted to the EPA in December 2009 will follow. The AMCA anticipates that this document will be helpful to the EPA as they develop the NPDES permit for mosquito control.

20th Annual Latin American Symposium II

70 Effect of physics variables on vertical transmission of dengue virus in *Aedes* mosquitoes from Socunusco, in the State of Chiapas, Mexico
Rogelio Danis, rdanis@insp.mx, Claudia I. Albores, Iliana R. Malo, Jose Ramos, Armando Ulloa and Martha Tlatelpa

Aedes mosquitoes transmit transovarially all dengue virus (DENV); in laboratory conditions, the extent of vertical transmission appears to depend on ambient humidity and temperature. In this study we determined the effect of relative humidity and room temperature on the rate of DENV vertical transmission in successive generations of *Aedes agypti* and *Aedes albopictus* mosquitoes originated from eggs and larvae collected in Tapachula city, in the state of Chiapas, Mexico. Eggs and larvae were reared to adults under temperature conditions that ranged from 25.35-28.33°C and relative humidity that ranged from 47.45-78.44% (SD 2.34-1.52). The presence of DENV in *Aedes* mosquitoes was evidenced by RT-PCR of total RNA extracted from mosquito heads. Several generations of mosquitoes were analyzed in this way. Humidity influenced vertical transmission of DENV-1, DENV-2 and DENV-3 in *Ae. Aegypti,* while, DEN-1 and DEN-3 are for *Ae. albopictus* on F0 generation. After this, only DENV-1 were detected on F1 from *Ae. aegypti*; room temperature seems not to have an influence on transovarial transmission. The effect of relative humidity on the vertical transmission rate on *Aedes* mosquitoes collected in Tapachula city evidenced that physical variables have an effect in the reduction of transovarial transmission in successive generations.

71 Recombinants in dengue virus, serotype-2 isolates from patients from Oaxaca, Mexico
Gerardo Perez-Ramirez, geraperami@gmail.com, Minerva Camacho-Nuez, Alvaro Diaz, Alejandro Cisneros and Maria de L. Munoz

Dengue is a serious cause of mortality and morbidity in the world including Mexico, where the infection is endemic. One of the states with the highest rate of dengue cases is Oaxaca. The cause of dengue is a positive-sense RNA virus, which evolves rapidly increasing its variability due to the absence of a repair mechanism that leads approximately one mutational event per genome replication, resulting in enhancement of viral adaptation and escape from host immune responses. Besides, recombination may play a role in driving the evolution of dengue virus (DENV), which may potentially affect virulence and cause host tropism changes. Recombination in DENV has not been described in Mexican strains, neither has the relevance in virus evolution been described. To study whether there are isolates from Oaxaca having recombination, we obtained the sequence of 6 different isolates of DENV-2 from the outbreak 2005-6, 1 clone of the C(91)-prM-E-NS1(2400) structural

genes, and 10 clones of the E gene from 1 isolate. Evidence of recombination was found by using different methods along with 2 software programs: RDP3 and GARD. This is the first report of recombination in DENV-2 in Mexico. Genomic recombinations may play a significant role in the DENV evolution and must be considered as a potentially important mechanism generating genetic variation in this virus with serious implications for the vaccines and drugs formulation as occurs for other viruses like poliovirus, influenza, and HIV.

72 U.S. Environmental Protection Agency's perspectives on efficacy testing for skin applied repellents and repellent/insecticide treated textiles

Kevin J. Sweeney, sweeney.kevin@epa.gov

This presentation will begin by providing an overview of U.S. EPA testing guidance for insect repellents. This overview will describe the types and breadth of efficacy testing while briefly describing some generic repellent registration requirements. Next, U.S. EPA skin-applied laboratory- and field-testing guidance will be discussed and compared to the WHOPES guideline. A discussion on testing for repellent/insecticide treated textiles, such as bednets, clothing, upholstery, curtains, and wall coverings will follow. Comparisons will be made to WHOPES guidance and testing requirements from Canada, the U.S. Military, the European Union, and at least 1 Latin American nation. Current questions and challenges to conducting human subject testing will be included.

73 U.S. Environmental Protection Agency's perspectives on household and space spray insecticide efficacy testing

Kevin J. Sweeney, sweeney.kevin@epa.gov

Household insecticides and space sprays will be explained in U.S. EPA terms and briefly contrasted to WHOPES guidelines. Specifically, the discussion will focus on approaches EPA uses to evaluate aerosols (flying insect killers-FIKs), residual liquids including crawling insect killers (CIKs), spatial repellents, and ground applied mosquito space sprays. The presentation will also make comparisons with recently developed testing guidance from the European Union and existing requirements from a few Latin American nations. Some vision/outlook on novel approaches to dengue vector control will be provided.

74 Population dynamics of *Culex quinquefasciatus* in Bogotá, Colombia

Marco Rojas, Ginna Hernandez, Ligia Moncada, Martha L. Quinones and Libardo Renteria

Culex quinquefasciatus became a nuisance for almost 3 million people living in the south of Bogotá. A study was carried out from December 2006 to December 2007, with the purpose of describing the principal oviposition sites and its population dynamics. Excavation pits flooded with contaminated water, small streams, and temporal breeding places were examined. Mosquitoes were collected using a Shannon modified and CDC traps. The most important places found were excavations pits left from construction material factories in the area. These pits were an average of 10 ha in size. The Tunjelito river connects with the pits, filling them with highly polluted water. The density of larvae and pupae of *Cx. quinquefasciatus* was in general influenced by the rain. The biting activity of *Cx. quinquefasciatus* had 2 clear peaks at 1800-1900 h and at 0200-0300 am. During the first peak, nulliparous and multiparous females were found in similar proportion, but in the second peak mainly multiparous females were found. The highest density was observed after the first rainy season of the year. Although this mosquito species is not transmitting any disease in Bogota, the nuisance has became a public health problem for the community affected because of the mosquito density and bite allergies found in the community, particularly among children.

75 Malaria entomological inoculation rates in three regions in Colombia

Martha L. Quinones, mlquinonesp@unal.edu.co, Manuela Herrera, Lorena Orjuela and Martha L. Ahumada

In Latin America few attempts have been made to have an approximation of the intensity of transmission using the EIR. A study was carried out in Colombia in 3 different regions between 2007 and 2009 to estimate the EIR. Mosquitoes were collected in a northern part of Colombia, State of Guajira, in the eastern plains, State of Meta and in the south, State of Putumayo. The majority of the specimens were analyzed by ELISA for infectivity. In Guajira, a malaria outbreak took place during 2008 and a total of 1,408 mosquitoes were collected. *Anopheles albimanus* and *Anopheles aquasalis* were found on the coast, while *Anopheles darlingi* was found as the most abundant species inland. *Anopheles darlingi* was found positive for *Plasmodium vivax* and the EIR calculated was 35 infective bites/person/year. In Meta 3,666 mosquitoes were collected with *An. darlingi* also being the most abundant species and additionally found positive for *Plasmodium falciparum*. The EIR calculated in this region was 2.71 infective bites/person/year. In southern Colombia, a total of 5,886 mosquitoes were collected. *Anopheles darlingi* was found only in the border with the Amazon state. *Anopheles benarochi B* was the most abundant species and found positive for *P. vivax*. The EIR was 98.2 infective bites/person/year. The new species in southern Colombia is maintaining transmission with intensity higher than *An. darlingi*.

76 First record of urban malaria in Puerto Gaitán, Meta, Colombia

Helena L. Brochero, embrochero@unal.edu.co, Luz Stella Buitrago A, Armando Escobar, Nelson Peña and Jan E. Conn

Puerto Gaitán is located at northeastern Meta Department. The internal armed conflict, in addition to false expectations generated by oil exploitation in Puerto Gaitán, has increased the number of displaced persons. As a consequence, during the last year, this municipality an urban area, reported *Plasmodium falciparum, Plasmodium vivax,* and mixed malaria cases. Adult mosquitoes were collected using human landing catches indoors/outside dwellings between 1800-0600 h for 50 min/h for 2 consecutive nights/month, for 9 mo. The oviposition sites were inspected and the malaria cases/month were analyzed.

Anopheles darlingi was the most abundant species collected, followed by *Anopheles braziliensis*, *Anopheles rangeli*, *Anopheles marajoara,* and *Anopheles peryassui*. *Anopheles darlingi* specimens were caught throughout the night with 2 peaks of biting activity: indoors (1800-1900 h/2300-2400 h)/outdoors (2300-2400 h/0200-0300 h). The main anopheline oviposition sites were Manacacias River overflow and artificial fish ponds. There was no correlation between adult and larval density. We found immature forms from *An. rangeli* and *An. oswaldoi* but adults of these species were not recorded. Malaria control strategies should be focused on adequate diagnostic and immediate treatment for all people, complemented by long-lasting insecticidal nets. In addition, use of personal protection measures to prevent human-vector contact during the first *An. darlingi* peak activity should be promoted. For oviposition sites, keeping the edges of the fish ponds free of vegetation and increasing production of fish that prey on the anopheline immature forms should be promoted.

77 Evaluation of Mosquito Magnet® to collect malaria vectors in southern Venezuela

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In entomological studies on malaria transmission and evaluation of vector control programs, it is necessary to estimate the human biting rate, i.e., the number of female mosquitoes per person per night. There are ethical and practical reasons for wishing to eliminate or minimize the use of human landing catches. To evaluate the efficiency of the Mosquito Magnet trap (American Biophysics Corporation) in relation to human landing catches to collect anophelines, a longitudinal study was conducted between June 2008 and January 2009 in Jabillal, a location along the Caura River, Municipality of Sucre, Bolívar State, in southern Venezuela. The village has 37 houses and 101 inhabitants; malaria is mainly caused by *Plasmodium vivax* with an API of 633.7 per 1,000 population. Two Mosquito Magnet traps were placed 200 m apart, while 2 human baits were located about 150 m from one of the Mosquito Magnet traps. Collections were conducted from 1730 until 2130 h, 3 nights per mo every 2 mo. A total of 1,297 anophelines belonging to 6 species were collected on human landing catches, while the 2 traps caught a total 1,147 anophelines representing 8 species. *Anopheles darlingi*, *Anopheles nuneztovari,* and *Anopheles marajoara* were the most common species collected. The analysis of data showed that the number of mosquitoes of each species collected depended on the method (Chi-square=78.304, $p< 0.05$). To estimate the relative efficiency of the Mosquito Magnet trap to catch the most common species compared to human landing catches, the ODDs ratios were estimated. Mosquito Magnet is a good collection method to substitute for human landing catches in collecting *An. darlingi* (OR= 0.884, 95% CL: 0.814-0.884) and *An. nuneztovari* (OR= 1.344, 95% CL: 1.203-1.501), while it underrepresented the catch for *An. marajoara* (OR= 5.146, 95% CL: 2.564-10.329).

78 Density variation and peridomiciliary hourly biting activity of *Anopheles albimanus* Wiedeman, 1820, (Diptera: Culicidae) obtained with two chemical attractants in Mosquito Magnet® traps at the Pacific littoral of Nariño (Colombia)

Ranulfo Gonzalez, ranulfog@gmail.com, José A. Perea Ramírez and Cristhian Salas Quinchucua

In a field study at the location of La Ensenada (Colombian Pacific littoral), a comparison of the density and peridomiciliary biting activity of *Anopheles albimanus* lured with 2 commercial baits (MM-Octenol + CO2 and MM-Lurex3TM + CO2) in Mosquito Magnet Liberty traps (MM) and Human Bait - Shannon (HB-S) was performed. Captures were carried out for 6 days between 1800 and 0600 h. From a total of 10,210 captured specimens, 57.16% were collected in MM-Octenol, followed by MM-Lurex (24.18%) and HB-S (18.56%). The MM-Octenol traps demonstrated more capture efficiency (972.7 mosquitoes per night) than the other 2 attractants ($P<0.01$). MM-Lurex and HB-S didn't show any significant differences ($P>0.05$). The hourly MM-Octenol collection showed peaks of biting activity in most of the studied nights, somewhat similar to those obtained with human bait, as described in the literature. Yet this similarity is not present in the HB-S of this study. On average, with the 3 attractants, 54.6% to 58.9% of the hematophage activity was focused at the night period (2100-0300 h). The use of the MM-Octenol traps is highly advisable as a sampling and measuring method for biting activity of *An. albimanus*.

Systematics/Genetics

79 *Culex pipiens* complex hybridization in the eastern United States revisited by single nucleotide polymorphism (SNP) in the intergenic spacer of ribosomal DNA (rDNA)

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The *Culex pipiens* complex represents one of the most enigmatic phenomenons in mosquito taxonomy. In North America, 3 taxa are recognized as *Cx. pipiens* form pipiens, *Cx. pipiens* form molestus and *Cx. pipiens quinquefasciatus* that are morphologically indistinguishable but exhibit substantial behavioral and physiological characteristics. Since the introduction of West Nile virus (WNV) into the United States in 1999, much interest has been focused on hybridization in the complex because members in the complex are important WNV vectors and hybridization may have important implications in WNV transmission. In order to find additional markers that can provide better resolution and at the same time are easy to use, SNPs in the IGS of rDNA were evaluated to detect hybrids along the eastern coastal U.S. Results indicated that SNP markers detected a gradient distribution of hybrids along the eastern coastal U.S. Results also showed that SNP markers detected more hybrids than *Ace*-2 marker did and were also comparably easy and simple to use.

Abstracts

80 Mosquitoes of Big Bend National Park, Texas
Harry M. Savage, hms1@cdc.gov, Kristine Bennett and Martin Williams

Big Bend National Park encompasses more that 800,000 acres in southwest Texas. The 118-mi-long southern boundary of the park is the Rio Grande River which separates the USA and Mexico. The course of the Rio Grande changes abruptly from a southeasterly direction to a northeasterly direction which forms the big bend in the river and led to the regional and park names. The park offers the opportunity to collect and study mosquito species from both the southwestern US and Mexico. Few mosquito collections have been made in the park, and many species distributions assumed to include the park are based on nearby records from areas outside the park in Brewster Co. and other counties of southern Texas. In August 2003, we collected larvae or eggs and individually reared specimens to the adult stage at 15 sites within the park. We present the collection and identification information from our collections and distribution data for 26 species of mosquitoes believed to be present in the park.

81 The biology and identification of *Culex* (*Melanoconion*) species of the Florida Everglades
Martin Williams, zoq9@cdc.gov and Harry M. Savage

Species within the subgenus *Culex* (*Melanoconion*) are important for their role in the epizootic transmission of arboviruses, including Everglades, West Nile, and eastern equine encephalitis viruses in Florida. Seven of the 10 species that can be found in the United States occur in Everglades National Park, more than in any other region of North America. Everglades National park is a unique study location because it contains several distinct types of habitat, including hardwood hammock, freshwater marl prairie, pinelands, and mangroves. Morphological identification of these species is difficult, and we have developed both morphological keys and molecular assays to identify these species. The ecological literature, including data on larval habitats and bionomics, for these species is limited. Habitat and distribution data from 4 separate collecting trips to Everglades National Park made during 4 different months are presented and discussed.

82 The use of Barcode region for the identification of species belonging to Albitarsis group (Linthicum, 1988)
Fredy Ruiz, ruizj@si.edu, Yvonne-Marie Linton, Jan E. Conn, Helena L. Brochero and Richard Wilkerson

The Albitarsis Complex is formed by 6 species: *Anopheles albitarsis s.s*., *Anopheles albitarsis* F, *Anophelels deaneorum*, *Anopheles janconnae*, *Anopheles marajoara,* and *Anopheles oryzalimnetes*. This complex has great importance in malaria transmission; *An. marajoara* and *An. janconnae* have been incriminated as vectors in Brazil, displacing *An. darlingi* in some areas (Conn *et al*., 2002). Their role as malaria vectors in other countries is unknown because of taxonomic ambiguities. The barcode region (COI, 710 bp) was postulated by Hebert *et al*. (2003) as a DNA sequence based method for the accurate identification of species, even in cryptic species complexes. Only 2 studies have been reported using this region for mosquito identification: Cywinska *et al*. (2006) and Kumar *et al*. (2007) for Canadian and Indian mosquitoes, respectively. In the present research, 479 mosquitoes were sequenced from Argentina, Brazil, Colombia, Paraguay, Trinidad and Tobago, and Venezuela resulting in 281 haplotypes, forming 6 phylogenetic groups (taxa): *An. albitarsis s.s.*, *An. deaneorum*, *An. marajoara*, and *An. oryzalimnetes*. The remaining 2 groups may belong to *An. janconnae* and *An. albitarsis* F; however, their identification is not clear, possibly because of their recent divergence (Kumar *et al*. 2007). Preliminary results confirm that this methodology as a useful tool for molecular identification of species belonging to the *An. albitarsis* complex.

83 The *Culicidae* of the Florida Keys: Nearctic-Neotropical transition
Lawrence J. Hribar, lhribar@keysmosquito.org

The first published records of mosquitoes from the Florida Keys were those of Johnson in 1913, who reported 7 species. Since then, over 40 species have been added to the faunal list. Most species and locality records were reported after a survey undertaken in the 1940s. However, new species records have been reported as recently as 2004. The fauna consists of 3 groups of species: 1, cosmopolitan and Nearctic-Neotropical; 2, Nearctic; 3, Neotropical. The Florida Keys appear to be a transition zone with some species attaining the northernmost point of their distribution within the island chain and other species reaching their southernmost limit.

84 A new subgenus of *Aedes*, and a redescription of the holotype female of *Aedes fryeri* (Theobald) (Diptera: Culicidae)
Yiau-Min Huang, huangy@si.edu, Wayne N. Mathis and Richard Wilkerson

A new subgenus of *Aedes meigen* is characterized and diagnosed. *Aedes fryeri* (Theobald) is removed from the subgenus Levua Stone and Bohart and placed in a new monotypic subgenus based on a critical examination of specimens, including the type species, by original designation, *Aedes* (Levua) *suvae* Stone and Bohart, 1944, from Suva, Fiji. The type female and the male genitalia of *Ae. fryeri* are redescribed and illustrated. Its affinity to other subgenera of the genus *Aedes* is discussed. Information on type data, distribution, bionomics, and medical importance, and a taxonomic discussion of this species is presented. Some morphological characteristics of adults of the subgenera Ochlerotatus Lynch Arribalzaga and Levua of *Aedes* are tabulated.

85 Invasive taxonomists and systematic species: Challenges and opportunities from biological control
Daniel Strickman, daniel.strickman@ars.usda.gov

Systematics and taxonomy of mosquitoes is fragmented by multiple approaches, multiple participants, and multiple motivations. This fragmentation is a direct result of the great interest in mosquitoes and therefore represents a rich source of discussion as well as a rich source of frustration. The field of classical biological control provides a more focused example of how systematics and taxonomy can be essential to accomplishment of very practical results. In classical biological

control, scientists whose only motivation is pest control routinely grapple with the full range of systematic problems, from species identification to implied evolutionary origins. This community has been a great customer and advocate for collections-based research, with lessons for the community of mosquito taxonomists.

86 *Anopheles hyrcanus* group (Culicidae, Diptera): Taxonomic status, habitats, distribution records, and medical importance worldwide

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Anopheles hyrcanus group comprises several species which are vectors of malaria and other mosquito-borne diseases in the Oriental and Palearctic regions. The group includes 30 known species world-wide, or about 42% of the species that comprised the Myzorhynchus Series of genus *Anopheles* Meigen subgenus Anopheles Meigen. Twenty eight of these species are found in the Oriental and Eastern Palearctic Regions and 3 in the Western Palearctic Region. In Asian countries (e.g. Korea, China and Japan), the known or potential vectors of human malaria include *Anopheles sinensis* Wiedemann, *Anopheles kleini* Rueda, *Anopheles pullus* M. Yamada, *Anopheles lesteri* Baisas, and *Anopheles belenrae* Rueda. Members of the Hyrcanus Group oviposit in various habitats, such as rice paddies, irrigation ditches, drainage ditches, ground pools, swamps, stream margins, inlets and pools, uncultivated fields, and artificial containers. Surveys from various Asian countries showed that *An. sinensis* is the most dominant species from rice paddies, irrigation ditches and other habitats. The taxonomic status, distribution records, and medical importance of several species in selected countries are noted and discussed.

87 Knowing the enemy: Inferences from mosquito barcoding

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The global need to accurately identify vectors of mosquito-borne diseases needs little introduction. The Mosquito Barcoding Initiative (MBI) aims to produce identification tags for 80% of all the currently recognised world Culicidae. Here we present the data from more than 2,000 DNA barcodes from species from a wide range of genera, but with a keen focus on the genus *Anopheles*, some of which transmit malaria. Can barcoding help identify species we know? Can it help us uncover new taxa? Herein we report that DNA barcoding successfully delineates the vast majority of species tested thus far, and our unique approach has resulted in the discovery of a new genus, and 22 new taxa discovered in the genus *Anopheles* alone, with a high proportion of these detected in the subgenera *Nyssorhynchus* and *Kertezia*. Species complexes are common in mosquitoes, but we herein show that barcoding rapidly exposes novel taxa. Sceptics of barcoding advocate utility of multiple markers to determine species delineation. Comparison of barcode datasets with those of the nuclear marker ITS2 have confirmed these as mitochondrial lineages as distinct and novel taxa but have also highlighted several cases of mitochondrial introgression in members of the Pyretophorus Series. Preferential amplification of vertebrate hosts using the universal barcode primers of Folmar et al. (1994) also occurs.

Aedes Biology & Control Symposium II

88 USDA research on new strategies for controlling *Aedes aegypti*

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USDA researchers are currently studying new methods to control *Aedes aegypti*. One involves molecular pesticides which target critical genes/proteins (such as inhibitors of apoptosis proteins, IAPs) in mosquitoes using RNA interference (RNAi). RNAi constructs are evaluated in vivo in adult mosquitoes by injection and topical application. A second approach utilizes the sterile insect technique (SIT) with genetically-modified *Ae. aegypti* and involves male mosquitoes carrying a dominant lethal (RIDL®) gene that was developed by Oxitec, Ltd. RIDL® mosquitoes are hatched in the laboratory and provided with tetracycline. The progeny of RIDL® males inherit a copy of the RIDL® gene. In the absence of tetracycline in their larval diet, immature mosquitoes of both sexes that carry the RIDL® gene die. Mating competiveness of RIDL® males is being evaluated in outdoor cages with males from a recently colonized strain of *Ae. aegypti*. The third approach focuses on prevention of oviposition by female *Ae. aegypti*. With Vestergaard-Frandsen, deltamethrin-treated PermaNet® Container Covers (jar lids) are being evaluated with different configurations of 55-gallon drums with and without covers. Exclusion efficacy was measured with ovitraps and oviposition substrates placed on the inner wall of the drums. The presence of the treated Container Covers significantly reduced female oviposition. These approaches may result in better vector control and prevention of dengue virus transmission.

89 Control of a mosquito vector important to lymphatic filariasis

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Lymphatic filariasis (LF) is the leading cause of disability in South Pacific regions, where >96% of the population are at risk. As part of the current global campaign, Mass drug administration (MDA) has reduced LF prevalence, but vector biology can complicate the MDA strategy. Obligate vector mosquitoes provide additional targets to break LF transmission, but existing methods are largely ineffective for controlling the primary vector throughout much of the South Pacific: *Aedes polynesiensis*. We demonstrate that interspecific hybridization and introgression results in an *Ae. polynesiensis* strain ('CP' strain) that is stably infected with endosymbiotic *Wolbachia* bacteria from *Aedes riversi*. The CP strain is bi-directionally incompatible with naturally infected mosquitoes, resulting in female sterility. CP males are equally competitive, resulting in

population elimination when CP males are introduced into wild type *Ae. polynesiensis* lab populations. The results support the continued development of a vector elimination strategy to supplement ongoing MDA efforts.

90 Field testing *Aedes albopictus* sterile males performances

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Awareness about the unsatisfactory results in terms of efficacy and sustainable reduction of *Aedes albopictus* population densities obtained by conventional control methods stressed the need to develop new powerful strategies. For this reason we are re-visiting the sterile insect technique (SIT) approach. In our feasibility experimental program, aged male pupae are exposed to gamma rays in order to obtain a high sterility level in the adult males. The capacity of the sterile males to induce sterility in the natural population relies on some key parameters (field longevity, active dispersal capacity, mating behavior and competitiveness, sterility persistence) which are in course of evaluation. From mark-recapture studies planned to investigate male dispersal capacity and survival in northern Italy urban areas, we were able to estimate that during harsh summer months longevity of the males may be a limiting factor for cost/effective SIT application. We therefore started to evaluate possible methods to increase field survival of the released males. A semi-field model to conduct evaluations of the mating competitiveness of sterile males in relation to mass rearing methods and radiation doses was set up to obtain indications of limited values. Sterile male pupae releases were regularly performed during the development season in villages for consecutive years and impact on local population fertility levels and densities were evaluated by collecting and lab processing of wild female-laid eggs.

91 A non-typical egg laying site and larval habitat for *Aedes taeniorhynchus*

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Aedes taeniorhynchus larvae were collected from a brackish water cistern regularly over 2 years. An investigation of the source of the larvae did not reveal any obvious surface water flow into the cistern. We discovered calcium carbonate tubes along the inside walls of the cistern. The tubes were removed and allowed to dry for one month. The substrate was then flooded with water; larvae of *Ae. taeniorhynchus* were present within 2 d. After a second flooding, additional larvae hatched and egg shells were recovered. The tubes were identified as belonging to the polychaete family Serpulidae. This is the first report of *Ae. taeniorhynchus* using polychaetes as an egg laying substrate.

20th Annual Latin American Symposium III: Student Competition

94 *Culex* and *Coquillettidia* as vectors of West Nile virus in the South American continent

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Abstract Objective. To detect the presence of West Nile virus (WNV) in mosquitoes in the northeastern region of Venezuela Material and methods. Research was conducted in the Laguna de los Patos, Cumana, Sucre State and localities of Cicapro (fundo "El Pinal") and Lake Unare, Anzoátegui State, the presence of RNA-VON, mosquitoes caught in light traps + CO_2 by RT-PC, during the period July 2007 to February 2009. Results. We found a positive mosquito pool for the species *Coquillettidia* (Rhynchotaenia) *venezuelensis* (Theobald, 1912) and another pool belonging to *Culex declarator* (Dyar & Knab, 1906). The minimum infection rate (MIR) for general copies that year was 0.06 and the MIF for species would be 0.16 for *Cq. venezuelensis* and 15.8 for *Cx. declarator* for that year. The VON is active in Venezuela and joined other emerging vector-borne diseases which pose a challenge to research and prevention programs.

95 Multiple resistance to insecticides in *Culex quinquefasciatus* from Venezuela regions vulnerable to the entry of West Nile virus

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Culex quinquefasciatus is the principal vector of West Nile fever. In Venezuela it has not been monitored by health authorities Therefore, information on susceptibility to insecticides in strains of this species in the country is scarce. Diagnostic doses were established for 4 insecticides using *Cx. quinquefasciatus* strain Reference USA, through the bottle method of the Centers for Disease Control and Prevention. These detoxification mechanisms were evaluated by determining the enzymatic activity of alpha and beta esterases, Glutathione s transferase, oxidases and inhibited acetylcholinesterase. In strains of the Falcon, Aragua and Anzoategui, we found multiple resistances to insecticides deltamethrin, lambda-cyhalothrin, malathion and propoxur. Were observed high levels of alpha esterases in strains Falcon and Mariño and beta esterases in strain Falcon, we detected high levels of glutathione s-transferase in 1 of the 3 strains tested, none of the tested strains presented high levels of oxidases, and all modified acetylcholinesterase was detected. The results found limited use of insecticides for rapid and effective control of *Cx. quinquefasciatus* in the rural communities studied. Therefore suggested to seek alternative non-chemical control

96 Analysis of genetic variation of *Culex pipiens* complex in Mexico City using Ace 2 gene and prediction of the transmission of West Nile virus

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West Nile virus (WNV) was initially isolated in America from species of *Culex* mosquitoes and birds in New York City. Subsequently, the virus spread in the USA and many human cases were reported. *Culex* mosquitoes are considered the most important vectors for WNV. The intensity of WNV transmission varies enormously across both space and time, as well as

among host species. The causes of this variability are unknown, which makes effective control difficult. In Mexico, this virus was initially detected in equines and birds in Monterrey, Tamaulipas, Coahuila and Yucatan. Nowadays, West Nile infection is a health problem in the north and south of the country. Consequently, the aim of this research was to investigate the *Culex* species distribution in Mexico City in order to know the potential of an epidemic of WNV in Mexico. A total of 105 sites were sampled during 2004 for mosquito larva and adult stages. *Culex quiquefaciatus* was the dominant sub-specie collected. The importance of this species prompted us to evaluate the oviposition sites of *Culex* species in Mexico. This research is also focus in the development of microchips to detect genetic markers useful to differentiate members of the *Culex* complex, the hybrids and other species using Ace 2 gene. Then, we determined the genetic variations related to the phenotype in the mosquitoes and the theoretical susceptibility to WNV infection considering the bird migration flyways. The presence of hybrid mosquitoes was confirmed in Mexico City by molecular methods.

97 Status of insecticide resistance in natural population from *Aedes aegypti* and CAP surveys of dengue vector in Casanare, Colombia

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Casanare is located at the Llanos Orientales region. There is an endemic dengue transmission. Seven field populations of *Aedes aegypti* were tested using CDC 1998 bioassay for pyrethroids insecticides (lambdacyhalothrin, deltamethrin, cyfluthrin, permethrin); organophosphates insecticies (malathion, fenitrothion), and, organochlorine DDT insecticide. Temephos insecticide was tested only in larvae using WHO 1981 bioassay. Study sites were selected based upon mosquito infestation index, dengue transmission, and strong vector control activities. The localities were: Yopal (3), Aguazul (2) and Villanueva (2). We carried out 409 house surveys to ask about insecticide control activities and knowledge about the vector, undertaken by the community. The people said they often use household insecticides. All populations tested showed physiological resistance to DDT insecticide, and lambdacyhalothrin, and permethrin insecticides. All populations were susceptible to all organophosphate insecticides tested. Although pyrethroids have been recently used for dengue vector control, the insecticide resistance was associated with household and agricultural insecticides applied in these localities. These data provide the initial baselines for insecticide susceptibility profiles for *Ae. aegypti* in Casanare department.

98 Low transmission of malaria in the Ecuadorian Amazon basin: One step closer to eradication

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Introduction: The Amazon basin of Ecuador is a hypoendemic area of malaria, where low numbers of cases grouped in sporadic outbreaks make it difficult to measure the transmission of the disease. Materials and methods: 839 filter paper blood samples in 9 villages were tested through indirect ELISA with 4 antigens (*Plasmodium falciparum* MSP-119/AMA1, *P. vivax* MSP119/PvAMA1). Adult specimens surveyed by CDC light/UV traps as well as larvae sampled in flooded areas were identified using taxonomic keys and PCR-RFLP of the ITS2 gene. Results: Seroprevalence in each community showed areas with high (Santa Rosa PfMSP119: 11%; PvMSP119: 20%; PfAMA119: 17,3%; PvAMA1: 18,2%); medium (Eno: PfMSP119 and PfAMA1: 0%; PfAMA1: 3,5%; PvAMA1: 1,7%) and low seropositivity (Cofan Dureno 0% for all antigens). The entomological study analyzing 192 larvae and adult specimens indicated an inverse relationship between levels of seropositivity and abundance of *Anopheles* (Abundance Parameter λ, Santa Rosa=2,4; Eno=5 and Cofan Dureno=9,6; $p<0.005$). 52% of the specimens identified were *Anopheles rangeli*; 16% *Anopheles triannulatus*; 9,9% *Anopheles benarrochi* and 2,1% *Anopheles oswaldoi*. Discussion: Serological markers proved to be a useful tool to assess malaria transmission in hypoendemic areas. Low density of mosquitoes and unstable transmission of malaria suggest an interesting perspective for elimination and eradication of the disease. This is the first report of anopheline species at a molecular level in the region.

99 Status of insecticide resistance in *Anopheles aquasalis* Curry 1932 (Diptera: Culicidae) two endemic regions of malaria in Venezuela

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Anopheles aquasalis is the main vector of malaria in coastal regions of Venezuela. It was characterized organic synthetics insecticides resistance in adult mosquitoes in the states of Sucre and Delta Amacuro, evaluating the expression of resistance to the insecticide fenitrothion and lambdacyalotrhina, used for control, using the bottle method of the Centers for Disease Control and Prevention. We also identified metabolic resistance mechanisms, mentioned strains when they were compared with a reference strain of Brazil, for testing in microplates and polyacrylamide gel electrophoresis. The results indicated that Delta Amacuro is resistant to both insecticides while Sucre was susceptible to lambda, but resistant to fenitrothion. Both strains showed synergism with piperonyl butoxide suggesting resistance mechanisms based on enzymes. We identified insensitive acetylcholinesterase and alpha and beta esterases, the MFO were elevated in Sucre (0.5), while GST was not detected. The knowledge gained is a valuable contribution, which contributes to the improvement of strategies within a program of malaria vector control at the regional level.

Celebrating 30 Years of Microbial Larvicides- Part I

100 Discovery, patenting, and development of microbial larvicides

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Spore-forming bacteria with pathogenicity for insects were discovered in the early 1900s and *Bacillus thuringiensis* was commercialized in the 1930s for controlling larval lepidopteran crop pests. Searches for pathogens of mosquito larvae

yielded *B. sphaericus* (*Bs*) and others, with growing market share for some *Bs* products nowadays. The uniquely potent isolate of *B. thuringiensis* serovariety *israelensis* (*Bti*) found in Negev by Goldberg, Goldberg & Margalit, 1977, proved to be a revolutionary larvicide for mosquitoes, midges, and black flies. Larvicidal activity is caused by gut histolysis by protease activation of bacterial parasporal protoxins, mostly delta-endotoxin. *Bti* and *Bs* are safe to handle, with few side-effects on non-target organisms, and bulk production is economical. The concept of bacterial larviciding for mosquito control was patented by the US Navy in the public interest (US patent 4,166,112) based on *Bti*. Several companies quickly developed and marketed various *Bti* formulations (powder, flowable, granular, dunks, and briquettes), products of choice for ecologically benign larvicidal control of mosquitoes and *Simulium*. *Bs* outperforms *Bti* in polluted water and may recycle in larval cadavers. By their efficacy and relative specificity, these microbial pesticides are indispensable components of integrated mosquito management programs.

101 The control of black flies with *Bti*
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In the early 1980s, the newly discovered potential of *Bacillus thuringiensis israelensis* (*Bti*) for controlling black fly larvae threw a whole set of challenges at biologists and at the industry. While the safety and selectivity of *Bti* was gradually established, the availability of *Bti* for operations became possible through intense international research and development efforts. For commercial formulations, the objectives were to assess and increase potency, to devise adequate and stable physical properties, to achieve consistency and stability of lots, and to lower the costs. For operations, it was necessary to develop new application systems and techniques and to determine performance factors of *Bti* in running waters, which led to the modelling and optimization of control campaigns. Much of the early work was related to the World Health Organization Onchocerciasis Control Programme in West Africa, where *Bti* played a major role in the larvicide rotation strategy designed to counter *Simulium damnosum s.l.* resistance to chemical insecticides and to alleviate environmental impacts. Major programs based on black fly control with *Bti* have now emerged worldwide. The challenge for the future is to maintain the health and environmental benefits resulting from *Bti* use, and to promote the acceptability and performance of *Bti*-based black fly control programs.

102 The role of *Bacillus thuringiensis israelensis* and *Bacillus sphaericus* in European mosquito control programs
Norbert Becker, norbertfbecker@web.de, and Katarzyna Rydzanicz

At present almost 100 mosquito species have been described for Europe. Most commonly occurring as nuisance species are the so-called floodwater mosquitoes, such as *Aedes vexans* and *Ochlerotatus sticticus* in river valleys, the snow-melt mosquitoes, e.g. *Ochlerotatus cantans, Ochlerotatus communis, Ochlerotatus punctor*, and *Ochlerotatus hexodontus* in swampy woodlands and tundra areas, and the halophilous species *Ochlerotatus caspius* and *Ochlerotatus detritus*, which are found particularly along the coasts and in rice fields of southern Europe. *Culex pipiens pipiens* biotype *molestus*, as well as the neozoan *Aedes albopictus* can also make themselves noticed in temperate zones as a nuisance. The latter and other species can occasionally transmit pathogens to humans including West Nile and chikungunya viruses. As a reaction to mosquito annoyance, natural disasters and health threats, mosquito control programs have been founded in almost all European countries, beginning in the late 1950s and continuing in recent years. The overall goal of most programs is to control mosquitoes while conserving biodiversity. This goal can be achieved when microbial control agents are utilized in suitable formulations in the context of integrated programs.

103 Microbial larvicides for malaria control in Africa
Steve Lindsay, Steve.Lindsay@lshtm.ac.uk and Ulrike Fillinger

For the first time in a generation, malaria is on the decline in many parts of Africa. Yet this momentum may be interrupted if resistance to the pyrethroids used on insecticide-treated nets becomes widespread. It is therefore important to develop new strategies for vector control that will complement existing intervention tools. Here we report on the findings from a series of large trials of microbial larvicides carried out in Kenya, Tanzania ,and The Gambia. The results from these studies provide compelling evidence that larval control can play an important role in vector control and malaria elimination in areas where the oviposition sites are not too large, are well defined and accessible.

AMCA Annual Washington Conference: Training & Orientation Session

104 Introduction
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The Washington conference provides AMCA members and supporters the opportunity to convene in Washington, DC, and personally meet with elected representatives and regulatory officials to have AMCA voices heard and gain support for mosquito control initiatives that enable us to protect public health. Several important issues face mosquito control districts throughout the United States that will immediately affect mosquito control operations. AMCA identifies the critical legislation, and provides strategies for successful personal meetings with legislative representatives for best outcomes for public health programs. This session will include tips for interacting with elected legislators (House and Senate) and regulatory officials, along with developing and improving the effectiveness of position papers. We will also discuss the evening reception that is planned on Capitol Hill to further interact with these officials and staff in a social environment.

20th Annual Latin American Symposium IV

92 Sentinel surveillance of mosquitoes (Culicidae) using larvitraps in the department of Atlántico (Colombia) 2004-2008
Ronald Y. Maestre Serrano, rmaestre22@yahoo.com and Sergio J. Goenaga-Olaya

The Department of Atlántico presents risk factors for the transmission of vector-borne diseases. The objective was to report the Culicidae species recorded using an entomological system of surveillance based on larvitraps located in urban and periurban areas in the department of Atlántico, Colombia, between 2004 and 2008. We obtained weekly information of the entomological material collected in 14 larvitraps located in the international airport (2004-2008) and in 5 larvitraps placed in the transport terminal (2007-2008) in the municipality of Soledad and in 10 larvitraps settled in the army battalion (2005-2008) in the municipality of Malambo. We collected 83,369 mosquito larvae (Culicidae): 37,370 (45%) from the international airport, 35,376 (42%) from the transport terminal, and 10,623 (13%) from the army battalion. *Aedes aegypti* was the most abundant species (89.21%), followed by *Culex nigripalpus* (3.45%), *Culex quinquefasciatus* (2.46%), *Haemagogus equinus* (2.25%), *Culex coronator* (1.19%), *Uranotaenia lowii* (0.91%), *Culex stigmatosoma* (0.52%), and *Aedes taeniorhynchus*, *Anopheles albimanus*, *Toxorhynchites* spp with 0.01 % respectively. The presence of vector species was confirmed in urban and periurban areas of the department of Atlántico; it is necessary to maintain a permanent entomological surveillance system, in order to take prevention and control measures in time.

93 Temporal variations of *Anopheles aquasalis* Curry (Diptera: Culicidae) larval densities and some other aquatic insects associated with their habitat in the peninsula of Paria, Sucre State, Venezuela
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Anopheles aquasalis Curry has been considered as the main vector of human malaria in northern Venezuela. This longitudinal study was carried out in the coastal areas of the Paria Peninsula, Sucre state. The oviposition habitats of *An. aquasalis* larvae were identified and classified into 2 larval habitat categories: 1- brackish mangrove, and 2- freshwater herbaceous swamp. Field surveys of mosquito larvae and aquatic insects were carried out in the same sites over a 1-yr period, between January 1999 and December 1999. At each site, 30 samples for *Anopheles* larvae and aquatic insects were made monthly. Simultaneously with mosquito larvae sampling, 7 selected variables of water were measured. Relationships among chemical factors of water and the abundance of *An. aquasalis* larvae and aquatic insects were investigated using the multivariate canonical correspondence analysis and the standard nonparametric Spearman correlations. The abundance of *An. aquasalis* larvae in both seasons, were positively and significantly correlated with water salinity, pH and conductivity, and negatively and significantly associated with dissolved oxygen in the dry season. Our results of Spearman correlations in the mangrove showed a significant positive association between *An. aquasalis* larvae abundance and Scirtidae family abundance and a significant negative correlation between *An. aquasalis* larvae abundance and monthly precipitation. On the other hand, in the mangrove the Spearman correlation analysis showed a significant negative correlation between Gerridae family abundance and monthly precipitation. In the herbaceous swamp, there were not significant associations between *An. aquasalis* larvae abundance and abundance of other aquatic insects associated to habitat.

105 Presence of *Anopheles* (*Kerteszia*) *pholidotus* in a malaria focus in Colombia
Jesus Escovar, jeescobarc@unal.edu.co, Ranulfo Gonzalez, Martha L. Quinones, Richard Wilkerson and Bruce Harrison

In the Colombian malaria focus at Cunday-Villarrica in Tolima, *Anopheles* (*Kerteszia*) *lepidotus* was incriminated as the main vector in 1984 because of their almost exclusive presence in most of the localities with malaria transmission. Since then, this species has been included, along with 6 other species, as one of the malaria vectors in Colombia. Between February and August 2009, collections were carried out in the same localities as the 1984 study as part of a study to determine biological aspects of the anopheline species of subgenus *Kerteszia* in Colombia. Approximately 800 adult females of putative *An. lepidotus* designation were collected landing on humans and 37 series of larvae from bromeliads were reared. Male genitalia were mounted and compared with the morphological keys and descriptions available for *Kerteszia* species. The morphological characteristics of all male genitalia corresponded with the descriptions and keys for *Anopheles pholidotus* (Zavortink 1973). It is suggested that the incriminated malaria vector species in Tolima in 1984 corresponds to *An. pholidotus* and not *An. lepidotus*. However, confirmation of the taxonomic determination using molecular markers is necessary.

106 *Withdrawn*

107 Droplet size vs efficacy adulticides in control opperations of *Anopheles aquasalis* from Sucre, Venezuela
Darjaniva Molina de Fernandez, darja2410@gmail.com, Victor Sanchez, William Anaya, Antonio Guerra, Yarys Estrada and Carmen Escobar

The most important consideration in using aerosol generators for control of *Anopheles aquasalis* from Cagigal municipality Sucre state is the calibration and accuracy of the droplet size. Adulticiding efficacy depends on complex interactions between a number of variables that are essential to an effective operation. Droplet size has a strong influence on the effectiveness of the formulation in achieving its intended purpose.

108 *Anopheles* (*Nyssorhynchus*) *strodei*, a species complex in the subgenus nyssorhynchus of *Anopheles*
Maria A. Sallum, masallum@usp.br, Peter G. Foster, Cecilia S. Santos, Maysa T. Motoki, Daniel C. Flores and Eduardo S. Bergo

Nyssorhynchus is one of the most studied subgenus of the Neotropical *Anopheles*; however, some species still are poorly known. *Anopheles strodei* includes 5 species in the synonymy, *Anopheles ramosi*, *Anopheles arthuri*, *Anopheles artigasi,*

and *Anopheles albertoi*, described from Brazil, and *Anopheles lloydi*, from Panama. Morphological characteristics of the eggs, adult male and female, and sequence data of the mitochondrial COI, nuclear white gene, and ITS2 ribosomal DNA from individuals collected in several localities situated in the states of Espírito Santo, Minas Gerais, São Paulo, Paraná and Rondônia, including the type localities of *An. strodei* and also its synonymies corroborate that there are at least 4 valid species under the name *An. strodei* in Brazil, and thus some of its junior synonymies are valid species.

109 Distribution of *Anopheles darlingi* lineages in Colombia

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Anopheles darlingi is the main malaria vector in Latin America. It has been proposed that this species consists of 2 lineages. The northern lineage was found in populations from Central America and in 1 population from the north-west of Colombia (Nechi - Antioquia). The southern lineage was found in Amazonia (Brazil, Peru, French Guiana). The purpose of this study was to determine which lineages are present along the distribution range of *An. darlingi* in Colombia. Mosquitoes were collected in the northern part of Colombia in La Guajira, the eastern plains in the state of Meta, and in the south in the Amazonian state of Putumayo. A total of 49 sequences were obtained for the single copy nuclear DNA *white* gene and 48 for a fragment of the mtDNA COI gene. A statistical parsimony network demonstrates that both lineages are present in Colombia. Both data sets suggest that individuals from La Guajira belong to a group that corresponds to the Northern lineage, and the Putumayo and Meta populations, correspond to the Southern lineage. We hypothesize that the Andes Mountains played an important role in the differentiation of these lineages.

110 Comparison of genetic diversity among different Latin America *Aedes aegypti* populations

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Dengue is one of the most important viral diseases in Venezuela transmitted by arthropod vectors. The genetic diversity of the vector determines its susceptibility to viral infection, and that is why it is necessary to be aware of the introduction of possible new strains in a country. Therefore, we decided to study the genetic diversity of *Aedes aegypti* from different countries of Latin America to compare it with the one from Venezuela. For rapid characterization, variation in a 387-bp region of the Nicotinamide Adenine Dinucleotide Dehydrogenase subunit 4 mitochondrial gene (ND4) was determined by SSCP analysis. Preliminary analyses of mosquitoes collected (~50/country) from Argentina, Brasil, Colombia, Mexico, Puerto Rico, and Perú indicate the presence of 1 or 2 haplotypes per country`s sample. Some haplotypes have similar sizes range between 1.000 and 1.500 bp; however, sequencing of DNA amplicons is needed to identify haplotypes. Argentina, Mexico and Perú only have one haplotype; Colombia, Brasil, and Puerto Rico have 2. The frequencies of the principal haplotypes are: 96.2% (Colombia), 81.1% (Brasil), and 58.2% (Puerto Rico). These results indicate that *Ae. aegypti* populations from these countries have a low level of genetic diversity, 3 of them being monomorphic. This suggests that the mosquitoes in all countries are under strong selective pressure.

111 Blood-feeding insects from a high altitude region in Colombia

Ingrid Lotta, Nubia Matta, Ligia Moncada, Maria Cristina Carrasquilla, Gustavo Spinelli and Luis Hernandez

Information about the biodiversity of hematophagous insects from high altitudes is very scarce. This fauna is characterized by its high endemism. The objective of this study was to report Ceratopogonidae and Simuliidae species using different trapping methods in Chingaza National Natural Park, Colombia. This park has 76.000 ha and is the source of several rivers. Most of the area is located above 3,000 masl. The temperature fluctuates between 2°C and 14°C during the year. The following traps were used to capture insects: CDC light trap, CDC modified trap (light and CO2), Shannon modified trap, Malaise trap, swab net, and human and animal protected bait. These traps were located close to the streams. Immature stages of Simuliidae were collected on stones and overflowing vegetation in streams. A total of 582 *Culicoides*, *Culicoides suarezi* and *Culicoides* sp. nov, and 1 *Simulium furcillatum* were trapped. Most of the *Culicoides* (524 specimens) and the black flies were collected with human protected bait. Immature stages, larvae and pupae, of Simuliidae (>1000 specimens) were captured on stones and overflowing vegetation in streams. These results showed that *C. suarezi* and *C. sp.* nov from Chingaza Natural National Park have anthropophilic habits.

112 Mosquito vectors of human diseases related to phytotelmata dwelling-places in Colombia

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Phytotelmata dwelling-places are important breeding places of mosquito vectors. Nevertheless, the study of these dwelling-places in Colombia has been limited. The purpose of this study was identifying the mosquitoes existing in *Guadua* and *Bromelia*, and to characterize the importance of these places. The study areas were located in Antioquia, Caldas and Chocó. Larvae were collected from the phytotelmata dwelling-places and adult mosquitoes with protected human bait. Series of mosquitoes were examined. Exuviaes, larvae, and adult mosquitoes were molecularly and/or morphologically identified. The results have shown the presence of *Anopheles eiseni*, *Culex antunesi*, *Culex secundus*; *Orthopodomyia albicosta*; *Limatus durhamiii*, *Trichoprosopon digitatum*, *Trichoprosopon* sp., *Sabethes undosus*, *Wyeomyia oblita*, and *Toxorhynchites* sp. in Guadua, while in bromeliads we found *Phoniomyia longirostris*, *Ochlerotatus* sp., *Ochlerotatus* sp., *Culex* sp., *Wyeomyia* sp., *Sabethes* sp., *Anopheles neivai*, *Trichoprosopon* spp. and *Anopheles* sp.. The specific confirmation is being made by the CDC in Atlanta. These findings contribute to the ecological and medical acknowledge of the mosquito fauna in Colombia. Besides, this is part of an international initiative for the assignment of a genetic barcode for mosquitoes, lead by the London Natural History Museum, with the participation of Antioquia University and National University.

Celebrating 30 Years of Microbial Larvicides - Part II

113 Residual activity of large doses of VectoBac® WDG and VBC-60066 against *Aedes albopictus* larvae
Gregory M. Williams, gwilliams@hudsonregionalhealth.org, Ary Farajollahi, Banu Kesavaraju and Randy Gaugler

Two formulations of *Bacillus thuringiensis* subsp. *israelensis* (VectoBac® WDG and VBC-60066) were tested at large doses under laboratory and field conditions against *Aedes albopictus* larvae. In the laboratory, dry VectoBac® WDG or VBC-60066 were added to plastic cups containing 250 mL water, oak leaves, and bacterial inoculums at a rate of 8, 16, 32 mg/L and 40, 80, 160 mg/L respectively. Ten 2nd instar larvae were added to each cup. Mortality was checked, larvae were replaced, and water was replenished every 4 d. Field trials were conducted in an urban area of Mercer Co., NJ. In the field, 16 mg/L of VectoBac® WDG or 80 mg/L of VBC-60066 were added to 11 L buckets with 8 L water, oak leaves, and bacterial inoculums. After a 2-wk acclimation, buckets were sampled every 4 d for the presence of larvae. Results were analyzed using a repeated measures analysis. Field treatments provided nearly 100% control for 2 mo with both products. Laboratory treatments provided 100% control in excess of 4 mo with both products.

114 Evaluation of spray technologies for application of *Bacillus thuringiensis israelensis* (*Bti*) for the control of container inhabiting mosquitoes
James C. Dunford, dunford@ufl.edu, Peter J. Obenauer, Ary Farajollahi, Gregory M. Williams, Sean Healy and George Wojcik

Container inhabiting mosquitoes have become an increasing concern for public health and mosquito control agencies worldwide. *Aedes aegypti* and *Aedes albopictus* are species of particular concern because of their capacity to transmit severe arboviral diseases such as dengue fever and chickungunya. The geographic distribution of container species is expanding and is often associated with difficult to access and manage containers adjacent to human habitations. Spray application of *Bti* to target containers in outdoor settings has been demonstrated in recent years to provide effective suppression of container species. It has become an established method of control for dengue vectors in parts of southeast Asia. In this paper, we will review results of U.S. evaluations of spray applications of VectoBac® WG using backpack equipment and present results of exploratory work with various equipment including small deployable units and truck mounted sprayers.

115 Efficacy of VectoMax CG for mosquito control in wild rice in Lake County, California
Jamesina J. Scott, jjscott@mchsi.com, David L. Woodward, Stacy Bearden and Peter DeChant

Cultivated rice fields produce extraordinary numbers of mosquitoes, and larval control is even more difficult in cultivated wild rice because its taller, denser canopy limits the amount of larvicide reaching the water. For more than 20 years, the Lake County Vector Control District (LCVCD) has achieved moderate levels of control in about 900 acres of cultivated wild rice through aerial applications of VectoBac® G (8 lb/ acre) at 8- to 12-d intervals at an annual cost of approximately $100,000 per year in aircraft and materials. A key drawback to this approach is that VectoBac® G provides only 2-3 days of larval control, and application intervals of 8- to 12-d provide discontinuous larval control; however, more frequent applications are beyond the LCVCD's financial means. In 2009, Valent BioSciences collaborated with LCVCD to evaluate VectoMax CG for mosquito control in cultivated wild rice. VectoMax CG was applied to approximately half of the wild rice acreage and provided continuous control of *Culex tarsalis* larvae for 21 d. Adult mosquito counts were also reduced compared to previous years. In addition to providing improved control of the primary vector of WNV, the LCVCD anticipates that incorporating VectoMax CG into its wild rice mosquito control program will reduce the total annual treatment cost by 10% to 20% through the reduced number of aerial applications.

116 Trials and tribulations of the *Bti* business
Robert I. Rose, rirose1@juno.com

The *Bti* business cannot be compared to a microbrewery, because costs are riskier and impediments as frequent as crossties on a railroad. *Bacillus thuringiensis* is akin to *B. anthracis*, coming on the same page in Bergey's Manual of Determinative Bacteriology. Both are durable-spore formers. Finding a fermentation facility for economically competitive manufacture is difficult in the USA, as is finding a spray-drying facility to render a primary powder-AI, because of the potential for other product contamination by this spore-former. *Bti* is no silver bullet, being effective in the field only for limited circumstances. It is but one tool in the toolbox for integrated mosquito management (IMM) and integrated vector management (IVM). EPA registration is a $300,000, 2-yr endeavor and state registrations have annual fees. Formulations for specific uses must be developed and proved effective, each requiring separate registration. Market introduction and acceptance often requires first-hand field-trial experience by the buyer. Public sector competitive bids drive prices down to the barest margins that have caused several companies to sell their business interests due to unprofitability, with just 2 remaining companies now producing and marketing microbial larvicides in the USA. Asian countries have local manufacturers for their regional market, but Africa, Europe, and Latin America depend on bulk supplies from the USA with considerable shipping costs.

Adult Control I

117 Influence of structure geometry, mesh type, and orientation on airspeed penetration through bioassay cages
Bradley K. Fritz, brad.fritz@ars.usda.gov, W. Clint Hoffmann and Jane Bonds

Caged insect bioassays are essential tools in evaluation application treatment efficacies. They allow comparative assessments of efficacy from different systems. Present cages are composed of a large number of geometries and mesh types. Typical geometries included flat disk and cylindrical cages with meshes ranging from nylon weaves to fiberglass, aluminum, and copper screens. Recent studies compare biological responses from differing cages, but few look at structure

characteristics and their influence on airspeed and spray characteristics penetrating the cage. Thirteen cages were tested in a low-speed wind tunnel under multiple airspeeds and orientations relative to the mean airstream. Airspeeds outside and inside the cages were measured with a pair of high precision anemometers. Tunnel airspeeds examined included 0.5, 1, 2, and 4 m/s while cage orientations relative to the mean flow direction included 0°, 10°, 22.5°, and 45°. Overall, the internal cage airspeeds were 30 to 90% of the mean tunnel airspeed with greater reductions at the lower airspeeds and greater orientation angle. Orientation angle generally had less overall influence at higher airspeeds but tended to reduce mean airspeeds inside the cages, but in some cases did result in the same or increased airspeeds. The results of this work, coupled with the spray penetration studies, provide users with a better understanding of the operational influences of these bioassay cages on field efficacy results.

118 Influence of geometry, mesh, and orientation on droplet size and spray penetration through bioassay cages
Bradley K. Fritz, brad.fritz@ars.usda.gov, W. Clint Hoffmann and Jane Bonds

Evaluation of the efficacy of vector control applications commonly use caged insect bioassays to compare multiple treatment efficacies. Typical geometries include flat disks and cylinders with meshes ranging from nylon weaves to fiberglass, aluminum, and copper screens. Recent studies compare biological responses from differing cage types, but few look at structure characteristics and their influence on the spray characteristics penetrating the cage. Thirteen cages were tested in a low speed wind tunnel under multiple airspeeds and cage orientations. A spray cloud generated upwind delivered a consistent spray with a VMD of 17 µm. The different meshes were tested for the droplet size penetration. Droplet size was measured inside and outside of the meshed area. Additionally, 3 bioassay cages were evaluated for spray volume penetration inside the cages under multiple air speeds and cage orientations. Generally, the larger diameter meshes had a greater effect on spray penetration with reduced droplet sizes and spray volume. The cylindrical shaped cages typically had less effect on droplet size and spray volume penetration into the cage under multiple orientations as compared to the flat disk shaped cages. The results of this work, coupled with the airspeed penetration studies, provide users with a better understanding of the operational influences of these bioassay cages on field efficacy results.

119 Aerial application of AquaHalt™ in Grant County, WA: A pilot's perspective
Dan Couture, dcouture@co.grant.wa.us

This paper will discuss the preparation required for conducting aerial applications of a water-based adulticide, AquaHalt™, to control adult mosquitoes. Focus will be on the calibration and characterization of rotary nozzles in addition to the logistical challenges of where to conduct aerial applications. Recent changes in the mosquito district's staffing with the addition of a vector ecologist provides the necessary surveillance to conduct targeted applications with greater emphasis placed on the integrated mosquito management (IMM) approach to mosquito control.

120 Preparing for an aerial efficacy evaluation of AquaHalt™ in Grant County, WA - 2009
Ann T. Moser, amoser@co.grant.wa.us

This paper will focus on an aerial ULV field trial validating the efficacy of AquaHalt™ in Grant County, WA. The trial was conducted in collaboration with Benton County MCD, WA. AquaHalt™ is used by Grant County operationally as a preferred adulticide and this trial was performed both to document the efficacy of AquaHalt™, as well as to share aspects of an aerial evaluation with staff from both Benton and Grant counties. Efficacy evaluations provide critical information related to control decisions and resistance management. AquaHalt™ provided excellent results with an average of 99.8% mortality versus *Aedes vexans* and *Culex pipiens*.

121 I'm the pilot, I didn't make the @#$%^& plane, or, An aerial spray trial of DUET™
Sammie L. Dickson, sdickson@slc-mosquito.com and Fran Krenick

A field trial of aerially applied DUET™ was evaluated. DUET™ is advertised as a dual-action mosquito adulticide that combines the efficacy of Anvil (sumithrin) with the exceptional knockdown of prallethrin. The goals of the trial were to evaluate the ability to get the product to the target site (mortality in caged mosquitoes) and to evaluate effectiveness in reducing mosquito population (pre- & post- trapping). The trial was conducted against field caught *Culex tarsalis* and *Ochlerotatus dorsalis*. The caged mosquito mortality aproached 100% confirming that the product did successfully reach the target area. Pre- and post- trapping resulted in an 88.3% reduction in *Ochlerotatus dorsalis* and a 42.8% reduction in the background *Cx. tarsalis* population. The low reduction in *Cx. tarsalis* is believed to be the result of the pilot releasing the product 15-20 minutes earlier than instructed.

122 Efficacy of aerial mosquito adulticiding with unsynergised pyrethroids and their effects on honey bees and other insects in northern Greece
Alexandra Chaskopoulou, andahask@ufl.edu, Andreas Thrasivoulou, Javid Kashefi, Mark Latham and Philip Koehler

The efficacy of 2 unsynergised pyrethroid formulations (2% deltamethrin & 10% d-phenothrin) and their effects to honeybees, *Apis mellifera*, green lace wing larvae, *Chrysoperla carnae*, and adult lady beetles, *Cryptolaemus montrouzieri*, were assessed using ultra low volume (ULV) aerial adulticiding against mosquitoes in northern Greece. A helicopter with GPS navigation, real-time weather recording, and a fate spray model was utilized. The mean mortality observed in caged mosquitoes was ~84% and ~82% for deltamethrin and d-phenothrin, respectively. Wild mosquito populations monitored by baited light traps decreased up to ~90% for both products tested. In the 2-mo period during which 6 aerial trials were conducted, 10 bee colonies exposed to the insecticidal applications performed as well as the control colonies and increased

in weight (25-30%), in adult bee population (14-18%), and in brood population (15-19%). Each treated colony continued to collect pollen (~80% was rice pollen) and produced honey (~5-7 kg/hive) at the same rate as the controls kept in untreated areas. There was no significant bee mortality observed following each application. Also, no bees were observed showing signs of sublethal exposure to insecticides (black shiny bees) at any time during the study period. For both green lace wing larvae and lady beetle adults exposed to the insecticides, mean mortalities were <3% and not significantly different from the control mortalities.

123 Caged-mosquito trials of aerially applied Zenivex (etofenprox)
Jeffrey C. Stivers, Jeff@collier-mosquito.org

Zenivex (etofenprox) trials using wild-caught, caged mosquitoes were conducted in Naples, FL. Three trials were completed at the maximum label rate (0.007 lb AI/acre) and 3 trials at the mid rate of 0.0035 lb AI/acre. Applications were conducted along a major roadway with open borders to maximize the level of control achieved. All applications were made from a Shorts SC-7 Skyvan aircraft fitted with 2 Micronair rotary atomizers. This configuration produced droplets with a DV 0.5 of 39 microns. All but 1 trial provided better than 80% mortality within the target zone. Further operational field trials of Zenivex are scheduled for 2010.

124 Zenivex aerial field trial
Gary Hatch, hatchgary@qwest.net, Bill Reynolds, Ed Bredemeyer and Gale Jirik

A field trial using Zenivex was conducted by the Mosquito Abatement District-Davis personnel and assisted by Bill Reynolds with Leading Edge Associates, Ed Bredemeyer with Central Life Sciences, and Gale Jirik with Adapco. The spray trial was conducted over a 5,000 acre plot in the West Layton Marsh of Davis County, UT. The application rate was 1 oz per acre with a dosage .0035 lb per acre. The Zenivex was diluted 1:1 with BVA oil.

125 Aerial application of Dibrom against caged wild-caught *Culex nigripalpus* mosquitoes in Manatee County, Florida
Mark Latham, manateemcd@aol.com and Gail Stout

Culex nigripalpus Theobald is the predominant mosquito species caught in CO_2-baited light traps throughout much of west central Florida. Trap catches in excess of 5,000 per trap per night are not uncommon. It is also believed to be the primary vector of St. Louis encephalitis virus and West Nile virus in this region. Anecdotal reports indicated inconsistent control of this species through aerial applications of a number of products including Dibrom. The intent of this series of trials was to demonstrate that Dibrom would provide good control against exposed mosquitoes and that inconsistent results in operational applications were more a function of this mosquito species' cryptic behavior and population dynamics than a failure of the products used. Close to 100% control of caged wild-caught *Cx. nigripalpus* mosquitoes was achieved in replicated trials at both the maximum and minimum (half-of-maximum) labeled rates of Dibrom.

Mosquitoes and Wetland Concerns Symposium: Issues and Approaches

126 Building effective communication with wetland scientists through sound biology
Nancy Read, nancread@mmcd.org

The fields of water resources, wetland science, and stormwater management are increasing in importance as the world's supply of water is challenged and communities prepare to adapt to climate changes. By reaching out to professional organizations in these fields, mosquito control professionals can help ensure that mosquito-related issues are represented accurately. For example, in 2004 the Society of Wetland Scientists established a WNV working group; having seen reports on "healthy wetlands" and mosquitoes, they hoped to combat increasing public concerns about wetlands as a disease source. A number of mosquito control professionals soon got involved; I gave a talk on mosquito biology at the SWS conference that year, showing how wetland modifications or restorations could reduce or increase mosquito populations and disease concerns, and Bill Meredith, Bill Walton, Jorge Rey, Roger Wolfe, Gale Sakolsky, and Durland Fish joined online discussions on the biology and control of mosquitoes in various habitats. Peer-reviewed research articles trusted by both wetland and mosquito professionals were very useful in establishing common understanding. The final product of years of work by this combined group was recently released by SWS (http://www.sws.org/wetland_concerns/docs/SWS-MosquitoWhitePaperFinal.pdf) and is pending publication in the journal "Wetlands".

127 Society of Wetland Scientists president's perspective
Mark Felton, Mark_Felton@URSCorp.com

This presentation discusses the SWS intent in producing a paper on mosquito-related issues facing wetland scientists, the context surrounding its start, and some of the insights found through the effort.

128 Mosquito control in Florida mangals
Jorge Rey, jrey@ufl.edu

Florida's mangrove wetlands present some unique challenges for the state's mosquito controllers including high structural complexity and low tidal energy, but certain economic, social, and political factors at work elsewhere also manifest themselves here. Among these are: land ownership issues; the functional importance of these ecosystems; the fact that most of these areas are already heavily impacted and habitat loss is significant; the sometimes conflicting pressures for mosquito control and environmental protection; the high value of mangals for tourism, recreation, fisheries, and real estate; the fact that the state's population is concentrated along the coast in proximity to these areas, and many others. In many cases, close

collaboration between local and state government entities, environmental regulatory agencies, researchers, and mosquito control agencies has been necessary to properly deal with these concerns. Some of these challenges, concerns, and inter-agency collaborations will be described in more detail.

129 Open marsh water management: Environmental pros-and-cons for a saltmarsh mosquito source reduction technique

William H. Meredith, william.meredith@state.de.us

Open marsh water management (OMWM) is a saltmarsh mosquito control technique that relies on selective excavation of shallow ponds and small ditches in mosquito-producing areas of the high marsh, created to alter mosquito ovipositioning sites and to encourage the presence and activity of native larvivorous fish. OMWM is now widely employed in coastal wetlands along the Atlantic seaboard and elsewhere. However, some environmental controversy has been associated with OMWM since its inception in the 1960s. We examine the positive environmental attributes of OMWM such as greatly reduced mosquito populations and an associated elimination or reduction in the need to use larvicides, along with the restoration or enhancement of marsh habitat in dewatered, previously parallel-grid-ditched wetlands. OMWM features in the form of created or restored marsh ponds and pannes can have beneficial effects for waterfowl, wading birds and shorebirds, and for estuarine aquatic invertebrates and fishes. Possible negative environmental effects of OMWM such as excessive water table lowering or an excessive increase in local topographic relief, along with concomitant undesirable marsh vegetation change, are discussed, including ways to avoid such problems. Proper context is also provided for alleged "wetland losses" that have been unfairly tied to OMWM.

130 Wetlands management in the northeast: Constraints and successes

William Reinert, reinert_william@aclink.org, Dominic Ninivaggi, Mike Morrison, Paul Capotosto, Roger Wolfe, Victoria Thompson, Timothy Deschamps, Timothy McGlinchy, Gabrielle Sakolsky, Walter Montgomery and Emily Sullivan

Wetlands management for mosquito control is an integral part of many mosquito control programs in the northeast area of the United States. Additionally, mosquito control agencies also charged with wetland restoration will do the restoration with mosquito control as a concurrent objective. Constraints on the use of these activities, including regulations, non-mosquito control related restoration projects, and opposition by certain "environmental groups" will be discussed. Also, examples of successes of wetlands management, including restoration for invasive weed control, development of best management practices for mosquito control in freshwater wetlands, restoration of wet stormwater management facilities, and examples of several wetland management projects for mosquito control will be given.

131 Mosquito control and wetlands in the Central Valley of California

David Brown, dabrown@fightthebite.net

This paper will discuss the challenges facing the coordination of mosquito control efforts and construction and maintenance of wetlands in the Central Valley of California.

Disease/Vector Studies

132 Malaria vector studies in Korea: Distribution, habitats, and parasite rates of vector species

Leopoldo M. Rueda, ruedapol@si.edu, Cong Li, Heung-Chul Kim, Terry A. Klein, Desmond Foley and Richard Wilkerson

We collected over 7,000 adult anopheline mosquitoes by light traps and resting catches at different locations in the Republic of Korea (ROK) during 2008 to better understand malaria transmission in the field. The head and thorax of individual specimens were identified to species by PCR, and sporozoites of the malaria parasite species by single step and semi-nested multiplex-PCR. *Plasmodium vivax* sporozoite-positive specimens were identified for *Anopheles belenrae*, *Anopheles kleini*, *Anopheles pullus,* and *Anopheles sinensis*. The distribution and habitats of these species were also recorded. We discussed the potential role of these vector species in maintaining malaria in the ROK.

133 Prediction, assessment of the Rift Valley fever activity in east and southern Africa 2006 - 2008 and possible vector control strategies

Assaf Anyamba, Kenneth J. Linthicum, Jennifer Small, Seth Britch, Edwin Pak, Stephane de La Rocque, Pierre Formenty, Allan Hightower, Robert Breiman, Jean-Paul Chretien, Compton Tucker, David Schnabel, Rosemary Sang, Karl Haagsma, Mark Latham, Henry Lewandowski and Robert Swanepoel

Historical episodic outbreaks of Rift Valley fever (RVF) since the early 1950s have been associated with cyclical patterns (El Niño and La Niña) of El Niño Southern Oscillation (ENSO) phenomenon which results in elevated and widespread rainfall over the RVF endemic areas of Africa. Using satellite measurements of global and regional elevated sea surface temperatures, and subsequent elevated rainfall and satellite derived-normalized difference vegetation index data, we predicted with lead times of 2.5- 4.5 months specific areas where outbreaks of RVF in humans and animals were expected and occurred in the Horn of Africa, Sudan, and southern Africa at different time periods from September 2006 to March 2008. Predictions were confirmed by entomological field investigations of virus activity in the areas we identified and by reported cases of RVF in human and livestock populations. This represents the first series of prospective predictions of RVF outbreaks and provides a baseline for improved early warning, control, response planning, and mitigation into the future.

Abstracts

134 Impact of indoor residual house spraying on the resting densities of *Anopheles* and malaria incidence rates in selected districts of Zambia

Cecilia Shinondo, cjshinondo@yahoo.com, Melinda Ojermark, Dayton Makusa, Moonje Shimukowa, Brian Chirwa, Lucy Muziya, Patrick Chewe, Chadwick H. Sikaala and Wambinji Akapelwa

An assessment of the impact of indoor residual spraying (IRS) on malaria incidences was conducted in May 2009. Indoor resting densities of female *Anopheles* mosquitoes were determined by the pyrethrum spray sheet collection method. In the 230 households sampled in IRS districts, 8 female *Anopheles* mosquitoes were collected at a mean density of 0.035 per household, and 37 female *Anopheles* were collected in the 240 non-interventional households sampled at a mean density of 0.154 per household. The mean female *Anopheles* densities recorded both in IRS and non-IRS districts were lower than the 0.25 mean density recorded during malaria epidemics in Kenya (Lindblade, 2000). Critical levels of *Anopheles* mosquito densities for epidemic forecast in any area of Zambia are not known. In one catchment area with 75% malaria incidence rate, the mean mosquito indoor resting density was 0.595, double that recorded during epidemics in Kenya (0.25). As many *Anopheles funestus* and *Anopheles arabiensis* were equally collected indoors. The mean densities of female *Anopheles* mosquitoes were lower in IRS than in non-IRS districts. IRS reduced malaria incidence more effectively than all the other interventions combined, and the downward trend in malaria incidence rates was obvious after the introduction of IRS in 2004.

135 The Zambian experience in the use of DDT for vector control

Dayton Makusa, day_t_on@yahoo.com

Indoor residual spraying (IRS) forms part of the main malaria prevention strategy in Zambia and central to this strategy is the use of DDT. IRS activities using DDT have been carried out in Zambia since 2001. DDT has been an insecticide of choice in Zambia because of its ability to remain on the surface of highly porous sprayable surfaces unlike the other insecticides that get absorbed in the wall making the application futile. The relatively low cost and long residual effect clearly makes it a darling to vector controllers. Its low mammalian toxicity and inability to cause skin reactions as compared to other insecticides makes it more acceptable by householders and thus acceptability of the intervention. The use of DDT for IRS has been scaled up to 15 districts protecting about 3.28 million vulnerable people against malaria. This has been made possible through the support of the USAID funded HSSP and RTI programs. Malaria incidence has shown a marked decline in the areas sprayed with DDT, deaths have reduced, and malaria slide (RDT) positivity has also reduced. Challenges include environmental compliance, waste disposal and stringent international requirements for use of and the demonisation of DDT.

136 The *Aedes* lethal ovitrap: A review of the data and literature

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There has been a worldwide resurgence of dengue fever. *Aedes aegypti* larval control is very labor intensive, and adulticide application can be both difficult and of limited effectiveness. The propensity of *Ae. aegypti* gravid females to visit multiple oviposition sites has been well documented. The US Army-patented lethal ovitrap exploits the female's irrepressible egg laying urge to bring her in contact with a small but lethal insecticide dose while searching for egg laying sites. Control programs utilizing the lethal ovitrap have been shown to use a miniscule amount of insecticide and significantly reduce *Ae. aegypti* populations and dengue transmission. This presentation reviews the pertinent literature and 15 years of laboratory/field trial data demonstrating that the lethal ovitrap is an effective, safe, environmentally sound, economical, and simple means of dengue vector control.

137 Defining *Culex* feeding behavior in the Midwest

Richard Lampman, richlamp@illinois.edu, Nina Krasavin, Mike Ward and Tara Beveroth

The feeding pattern of *Culex pipiens* and *Culex restuans* were evaluated in central Illinois by comparing avian seroprevalence for West Nile virus (WNV) antibodies to host selection based on molecular bloodmeal analyses. The data demonstrates that *Culex* feed on a wide variety of bird species; however, the bulk of the meals are from a limited group of bird species (i.e., American robin, northern cardinal, mourning dove, and house sparrow). There was a distinct spatial variation in host blood source. The proportion of mammalian bloodmeals in *Culex* was higher in the area with animal stables (cows, pigs, and horses) than in specimens from the residential and woodlot sites. After 6 years of detecting WNV in *Culex* mosquitoes, no positive pools were detected in 2008; however, the flavivirus did return in 2009 at an exceedingly low level. Weather conditions appeared to play a critical role in transmission.

138 Malaria vector studies in Korea: Parity rates and abundance of vector species

Desmond H. Foley, foleydes@si.edu, Heung-Chul Kim, Terry A. Klein, Cong Li, Myung-Soon Kim, Richard C. Wilkerson and Leopoldo M. Rueda

Weekly parity rates were obtained for anopheline species collected by mosquito traps at 3 locations in the Republic of Korea during 2009. Weather, astronomical, and remote sensing data were also collected to investigate their statistical association with vector survival and abundance. The head and thorax of individual specimens were identified to species by PCR, and sporozoites of the malaria parasite species by single step and semi-nested multiplex-PCR. We discuss the results, and their implications for understanding the environmental causes of variation in malaria transmission, and the utility of trap indices for estimating disease risk.

Abstracts

139 West Nile virus activity in the Emilia-Romagna region (Italy, 2008-2009)
Romeo Bellini, rbellini@caa.it, Paolo Bonilauri, Paola Angelini, Alessandro Albieri, Rodolfo Veronesi, Mattia Calzolari, Michele Dottori, Marco Tamba, Luciano Venturi and Enrica Martini

During the late summer 2008, an epidemic of West Nile virus occurred in northeastern Italy. This was the largest epidemic ever recorded in the country. Following the first evidence in equine and birds, an entomological surveillance plan was started by using CO_2 baited traps positioned in 78 sites. In the period from September 3 - October 23, more than 20,000 mosquitoes were analyzed by RT-PCR. Two pools of *Culex pipiens* tested positive. In the 2009 summer, mosquito collections were conducted in weeks 25-42 by CO_2 traps in 92 fixed stations. More than 190,000 mosquitoes were collected, pooled, and analyzed (1,789 pools of ≤ 200 individuals/pool). *Culex pipiens* was the most abundant species (81.39%) followed by *Aedes caspius* (15.37%), *Aedes vexans* (2.41%), *Aedes albopictus* (0.64%), *Culex modestus* (0.13%), and *Anopheles maculipennis* s.l. (0.04%). Twenty-seven pools, all *Cx. pipiens*, were positive. Early positive pools were collected at the end of July. The highest MIR values (1.02-1.59) were recorded in August.

140 Benefits of long-term monitoring of diurnal resting populations as a primary surveillance tool for *Culex nigripalpus*
Donald Shroyer, d.shroyer@irmosquito2.org

Surveillance of adult populations of mosquito vectors is most commonly accomplished by use of traps that preferentially attract and capture a single sub-population, namely host-seeking females. Much of what has been learned of the adult biology of *Culex nigripalpus* in south Florida has been gained by long-term monitoring of diurnal resting populations. Analysis of age-class and gender in resting collections allows tracking of qualitative changes in the population (emergence, blood-feeding, accumulation of gravid females and oviposition events) that cannot otherwise be assessed, and that are important factors in assessing risk of arbovirus transmission. Indian River Mosquito Control District has employed regular ground aspiration of "sentinel" diurnal resting habitats of *Cx. nigripalpus* for 17 years as a primary tool in surveillance of the region's primary vector of St. Louis encephalitis and West Nile viruses. Monitoring resting populations of *Cx. nigripalpus* has been particularly valuable during conditions and seasons in which host-seeking is minimal (e.g., drought and winter), revealing substantial population activity that would not otherwise be observed.

141 Effect of environmental temperature on the ability of *Culex tarsalis* to transmit Rift Valley fever virus
Michael J. Turell, michael.turell@amedd.army.mil, Kristine Bennett and William C. Wilson

The recent outbreaks of disease caused by Rift Valley fever virus (RVFV) indicate its potential to be introduced into new areas, possibly even North America. Because environmental temperature has been shown to affect the ability of mosquitoes to transmit an arbovirus, we evaluated the effect of temperature on the ability of *Culex tarsalis* to transmit RVFV. Female *Cx. tarsalis* were allowed to feed on viremic hamsters, the engorged mosquitoes randomly placed into one of three 3.8-liter cages, and the cages maintained in incubators held at 22°, 26°, and 30° C. Samples of mosquitoes were removed from each cage on d 4, 7, 11, 14, 18, and 21 after the infectious blood meal and tested individually, legs and bodies separately, to determine infection and dissemination rates. Because virtually all *Cx. tarsalis* with a disseminated infection have previously been shown to be able to transmit RVFV by bite, we considered those individuals with a disseminated infection capable of transmitting RVFV. Both infection and dissemination rates observed in mosquitoes held at 30° C were higher than in those held at 22° C. As with West Nile virus, environmental temperature may play a significant role in the intensity of RVFV transmission, should that virus get to North America.

142 Rise of eastern equine encephalitis virus (EEEv) activity in Quebec and first confirmation of mosquito vectors in Canada
Christian Back, christian.back@gdg.ca, Christian Brousseau, Robbin Lindsay, Antonia Dibernardo and Chantal Vincent

In 2008 the Quebec Ministry of Agriculture (MAPAQ) confirmed 22 EEE cases (19 horses, 3 emus) in 4 regions of southern Quebec. This was a sharp increase of EEEv activity, compared to a total of only 1 horse case in the previous 36 yr, after the 1972 episode (30 dead horses, 5 confirmed). Similar high levels of EEEv activity in 2009 prompted the Public Health Agency of Canada (PHAC), in collaboration with MAPAQ, to launch an entomological survey in confirmed foci of EEE. GDG Environnement surveyed 3 confirmed foci (Sept. 15-Oct. 5) by intensive adult mosquito sampling with CDC light traps. Out of 1,376 females, 708 were *Culiseta melanura*. Twelve pools of *Cs. melanura* were positive for EEEv on the initial RT-PCR screening assay; however, EEEv was isolated in tissue culture from only 7 pools of *Cs. melanura*. All of these positive pools came from several sites within 1 of the 3 investigated foci. This is the first time that EEEv has been detected in mosquitoes in Canada and it strongly suggests that enzootic amplification of EEEv by local mosquitoes occurs in Quebec.

143 How sensitive is RAMP testing for WNV detection? A nation-wide analysis on the existence and variability of grey areas in RAMP testing from operational programs
Banugopan Kesavaraju, banu@slc-mosquito.com, Ary Farajollahi, Mike Hutchinson, Sonya Graves and Sammie L. Dickson

"The RAMP® West Nile Virus (WNV) Test is a highly sensitive pre-screening test used for identifying WNV in mosquitoes and corvids." (Response Biomedical web site http://www.responsebio.com). The RAMP WNV kit has provided a quick and easy test, enabling mosquito and vector control districts to make important operational decisions as soon as testing is completed, most often on the same day. Since important control decisions rely on accurate results from in-house tests such as RAMP, it is important to have confidence in the efficacy and accuracy of such tests. Even though

RAMP testing has been used successfully in many areas across the United States, there have been some recent concerns regarding a high number of false-positives from some areas. We collected data from mosquito samples that were tested initially by RAMP, and later re-tested using RT-PCR from across the country to analyze patterns. If we used 30 RAMP units as the cutoff point for considering a sample as WNV-positive, then the false-positive rate was 57% and correct-positive rate was 43%. But because of high numbers of false-positives, many control programs have increased their RAMP unit positive value to 100-300. These changes and high cut-off points have significantly reduced the number of false-positives for some operations. At the time of this abstract submission, we were still analyzing possible correlations between high cut-off values and other variables (eg. mosquito species) between counties.

Adult Control II

144 Experiences and results of initial studies of RIDL® mosquitoes in Florida

Gary Clark, gary.clark@ars.usda.gov, Frances V. Ellison, Luke Alphey, Derric Nimmo and Sandra A. Allan

In 2009, staff from the Mosquito and Fly Research Unit (MFRU), Center for Medical, Agricultural, and Veterinary Entomology in Gainesville, FL began collaborative studies involving male *Aedes aegypti* mosquitoes carrying a dominant lethal (RIDL®) gene that was developed by Oxitec, Ltd., in Oxford, England. This presentation summarizes the process that was followed to secure permission of 3 federal and 2 state agencies to import eggs of these mosquitoes into the USA. Once imported to the MFRU, eggs from RIDL®mosquitoes were hatched and the male mosquitoes that were produced were separated and used to initiate a mating competitiveness study with a laboratory strain of *Ae. aegypti* from San Juan, Puerto Rico (PR) that was in the F12 generation. In addition, the methodology and procedures followed in this study leading to the mixing of 50 RIDL® males, 50 PR males, and 50 PR females in the same cage and placed outdoors for 24 h will be presented. Preliminary results indicated that 49% of the matings with the females were by RIDL® males, 45% were by PR males, and 6% involved mixed matings. Implications of these results and future plans for working with these mosquitoes in Florida will be discussed.

145 Genetic control of *Aedes* mosquitoes

Ann Kramer, ann.kramer@oxitec.com, Derric Nimmo, Luke Alphey and Andrew McKemey

Recent advances in insect genetic engineering have opened new possibilities for the control of mosquitoes. 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. Mathematical modeling indicates SIT would be effective against *Aedes* mosquitoes. The first RIDL® strains have been successfully tested in confined conditions for mating competitiveness with wild-type mosquitoes, suppression and a range of life history and behavioural traits in a range of locations and conditions. Preparations are underway for field trials to demonstrate suppression of wild populations and preliminary data may be available at this meeting. This presentation will summarize the results of experiments to date and discuss the options for open field testing and programmatic use of such technology.

146 Area-wide surveillance and control of *Aedes albopictus*: An effort to find, catch, and tame the tiger

Isik Unlu, iunlu@mercercounty.org, Ary Farajollahi, Sean Healy, Taryn N. Crepeau, Kristen Bartlett-Healy, Eric Williges, Banugopan Kesavaraju, Daniel Strickman, Daniel L. Kline, Gary Clark, George Hamilton, Randy Gaugler and Dina Fonseca

Aedes albopictus is considered among the most invasive species in the world. Where abundant, this mosquito is responsible for most service requests to local mosquito control programs; however, the unique biology and ecology of this pest create an obstacle for standard approaches to mosquito abatement. We present data from our operational efforts using different mosquito control strategies against *Ae. albopictus* in New Jersey. Mosquito populations were monitored using BGS and oviposition traps in 3 (full IPM treatment, education, and control) selected study sites from 2 counties throughout the active mosquito season. We provide data on various efforts such as education, door-to-door control measures using larvicides/pupicides and source removal, ULV adulticide applications, and their effect on populations within our 3 study sites.

147 Commercialization of a lethal ovitrap

Samuel Hapke, shapke@springstar.net, Elizabeth Rorabaugh and Michael G. Banfield

Inconsistent efficacy and public disapproval of insecticide spraying against *Aedes* spp. have necessitated the development of control technologies that target specific ecological traits of the vectors. Lethal ovitraps (LO) attract and kill gravid female mosquitoes as they seek water containers in which to oviposit. Laboratory and field trials have demonstrated the efficacy of LO technology in controlling populations of container-ovipositing species, such as *Aedes aegypti*. Initial field tests were conducted using labor-intensive, short-lived prototypes unsuitable for widespread distribution. SpringStar Inc. is evaluating key refinements to the original design to craft a commercial version of the LO appropriate for mass production and implementation. Key upgrades will be outlined and data will be presented from experimental tests of altered LO components, including insecticide delivery chemistry, trap materials, biodegradability, and mold resistance.

148 Toxicity and excitorepellency of deltamethrin-treated nets on *Aedes aegypti* populations from French Guiana
Isabelle Dusfour, idusfour@pasteur-cayenne.fr, Pascal Gaborit, Véronique Thalmensy, Jean Issaly, Romuald Carinci and Romain Girod

For decades, spatial sprays of insecticides, larvicidal applications, and mechanical removal of oviposition sites have been used to control *Aedes aegypti*, the only dengue vector in French Guiana. In 2006, deltamethrin-treated-bednets (PermaNet®), imported for controlling malaria, were also distributed to children, pregnant women, elders, and dengue-positive persons to limit dengue transmission. Subsequently, an impregnated-curtain-based-strategy was mentioned as an option to control *Ae. aegypti*. Therefore, to obtain an estimate of bednet efficacy and to evaluate the relevance of curtain program implementation, we measured toxicant and excito-repellent activities of PermaNet® material against *Ae. aegypti*. We also measured the performance of the PermaNet 3.0® impregnated with deltamethrin 85mg/m2, 115mg/m2 and deltamethrin plus piperonyl butoxide. Four wild-caught *Ae. aegypti* populations and a susceptible one were exposed to these materials using WHO cone test protocols. Laboratory results demonstrated that PermaNet® has a poor toxicity but a low excito-repellent activity against *Ae. aegypti* populations from French Guiana which is not satisfactory for curtain deployment. However, PermaNet 3.0® caused a higher mortality but a high excito-repellent activity. This last material is more promising and needs to be further tested to assess its suitability in vector control program in French Guiana.

149 Evaluation of ultra-low-volume spray efficacy for dengue vector control in French Guiana
Isabelle Dusfour, idusfour@pasteur-cayenne.fr, Véronique Thalmensy, Pascal Gaborit and Romain Girod

Dengue fever represents one of the major public health concerns, with millions of cases and thousands of deaths every year. In French Guiana, *Aedes aegypti* is the only dengue vector and control of adults involves ultra-low-volume (ULV) spray with either fenitrothion or deltamethrin formulations. Our study aimed to evaluate the efficacy of these operations. Two steps were performed from April to June 2009. The first one determined, according to the WHO filter paper test, the level of resistance to deltamethrin and fenitrothion of 4 wild-field caught *Ae. aegypti* populations. The second step evaluated the performance of deltamethrin and fenitrothion-based-formulations against the same 4 populations by a simulated field trial. Lab results showed that all 4 populations are resistant to the 2 insecticides. The field trial confirmed these results and demonstrated that the fenitrothion-based formulation is more efficient than the deltamethrin one. In order to limit *Ae. aegypti* density during epidemics, the use of fenitrothion-based formulation was recommended. However, ULV operations must be restricted to outbreak events and in case of dengue cases during inter-epidemic period to limit insecticide resistance increase.

150 Insecticide resistance and the efficacy of ground ULV applications vs. *Culex pipiens s.l.* in Fresno County, California
Jodi J. Holeman, cmadclovis@sbcglobal.net, Niki A. Pool, Mark L. Amorino, Charles W. Smith, Steve Mulligan and Anthony J. Cornel

During July - September 2009, ground ULV applications of various, registered mosquito adulticide formulations were evaluated against wild populations of *Culex pipiens sensu lato* in Fresno County, California. Initial applications with piperonyl butoxide (PBO) synergized formulations of natural pyrethrins and selected, synthetic pyrethroids indicated that the populations had varying degrees of resistance to these products. Laboratory bottle-bioassay testing confirmed these observations. A combination of malathion (Fyfanon®) and natural pyrethrins, synergized at 10:1 with PBO (Evergreen), had significant resistance-breaking properties. Further tests with this combination showed that within urban neighborhoods, the average mortality of sentinel, wild mosquitoes was no more than 57% over a 300-ft swath (one city block distance). In rural sites within mature cornfields and fruit tree orchards, average sentinel, wild mosquito mortalities of 26% and 33% over 300-ft swaths, respectively, were achieved. This study demonstrates the existence of significant pesticide resistance in wild *Cx. pipiens s. l.* populations in Fresno County as well as the impact of barriers in urban and vegetated rural environments on drift, effective swath, and reduced efficacy of ground ULV applications. It also further illustrates the need for new adulticide formulations and product chemistries.

151 Impact of naled aerial ULV application on butterfly larvae and control efficacy against adult mosquitoes
He Zhong, he.zhong@famu.edu

Aerial applications of mosquito adulticide are widely used by mosquito control programs to reduce adult mosquito populations in targeted areas. Naled residue impact on Miami blue butterfly larvae (*Cyclargus thomasi bethunebakeri*) resting on 1 gal nickerbean host plant (*Caesalpinia bonduc*) was assessed following aerial ULV applications in both spray and drift zones. We also evaluated the control efficacy against adult female salt-marsh mosquitoes (*Aedes taeniorhynchus*). The study was conducted in North Key Largo (Monroe County, Florida) and consisted of 15 test stations with 9 in spray target zone, 3 in non-targeted drift zone, and 3 stations in control zone. Six field trials were conducted with 3 spray trials at 30.5 m (100 ft) and the other 3 trials at 45.7 m (150 ft) aircraft flight altitudes. The data showed that the naled ULV application at 54.8 ml/ha (0.75 oz/acre) had excellent mosquito control efficacy in an open area against adult female mosquitoes in the spray targeted zone. However, butterfly larvae mortality in the spray zone was also significantly increased. Larval mortality in the drift zone was not significantly different from the control zone. Naled residue data from GC revealed that the butterfly mortality may result from the exposure to the excess amount of naled residue. Further studies are needed to reduce amount of naled residue but not compromise the satisfied mosquito control efficacy.

152 Deployment of UAVs for vector control: Current status
Wesley Hoffmann, clint.hoffmann@ars.usda.gov, Bradley K. Fritz, Yanbo Huang and Yubin Lan

The ability to send an unmanned aerial vehicle (UAV) into a potentially hazardous area to complete a spray mission for controlling insect vectors of human diseases has great potential for protecting personnel. After working with current UAVs, several shortcomings of these systems have been identified which need to be addressed prior to successful deployment in the field. Most of the issues revolve around the training required to operate the UAV sytems, communications, and overall reliability of these UAVs. Some of the legal and regulatory hurdles to deploying the UAVs will also be discussed.

153 Evaluation of ULV and thermal fog mosquito control applications in temperate and desert environments
Kenneth J. Linthicum, kenneth.linthicum@ars.usda.gov, Seth Britch, Wayne Wynn, Todd Walker, Muhammad Farooq, Vincent Smith, Cathy Robinson, Branka Lothrop, Mellissa Snelling, Arturo Gutierrez, Hugh Lothrop and Jeremy Wittie

Ultra low volume (ULV) and thermal fog aerosol dispersals of pesticides have been used against mosquitoes and other insects for half a century. Although each spray technology has advantages and disadvantages, only 7 studies have been identified that directly compare their performance in the field. US military personnel currently operating in hot-arid environments are affected by perpetual nuisance and disease vector insect problems, despite adulticide operations using modern pesticide delivery equipment such as ULV. None of the identified comparative studies has looked at the relative feasibility and efficacy of ULV and thermal fog equipment against mosquitoes in hot-arid environments. In this study we examine the impact of ULV and thermal fog applications of malathion and sumithrin against caged sentinel mosquitoes in the field in a warm temperate area of Florida, followed by a similar test in a hot-dry desert area of southern California. Patterns of mortality throughout 150 m x 150 m grids of sentinel mosquitoes indicate greater efficacy from the thermal fog application in both environments under suboptimal ambient weather conditions. We discuss the implications of these findings for future military preventive medicine activities and encourage further investigations into the relative merits of the two technologies for force health protection.

154 The impact of integrated use of IRS and LLINs on malaria vectors in Luangwa, Zambia
Aklilu Seyoum, aklilus@yahoo.com, Chadwick H. Sikaala, Javan Chanda, Tanya Russel and Gerry Killeen

There is only little evidence for decision making by the national malaria control programs on the combined use of IRS and LLINs. The impact of combined use of IRS and LLINs on the malaria vectors was evaluated in 2 villages of Luangwa district in Zambia. Mosquitoes were collected for 30 nights during the dry season using human landing catches, CDC light traps, tent traps, resting boxes, and window traps, in 2 blocks covered both with IRS (KO-thrine) and LLINs (Permanet), and in another 2 blocks where LLINs alone was applied. Anopheline mosquitoes were identified to species morphologically. The mean catches of *Anopheles funestus* were 2.6 and 1.7 per trap per night in the LLINs intervention area and in blocks where both interventions were applied, respectively. The differences were statistically significant at $P < 0.05$. The mean catches of *Anopheles gambiae s.l* in blocks with LLINs alone and combined with IRS were 2.3 and 1.9, respectively. This study has shown that significantly higher reduction of the *An. funestus* in the area where IRS was applied together with LLINs. However, no added value was observed for the combined use of IRS and LLINs against *An. gambiae s.l* in the area.

155 Assessment of the mosquito situation in the capital city of Lusaka, Zambia
Cecilia Shinondo, cjshinondo@yahoo.com, Emmanuel Chanda and Fred Masaninga

The mosquito nuisance level in the capital city of Lusaka, has increased in the last 3 yr. Although there are no known culicine transmitted diseases in Lusaka, the persistently high mosquito densities undermine public confidence in the IRS program resulting in increased spraying refusal rates. Sewage maturation ponds in cities of Zambia have become festering mosquito oviposition sites because of the overgrowth by the exotic water hyacinth and increased biological oxygen deficit. This situation analysis was conducted to assess the mosquito nuisance level and risk for malaria. Indoor resting mosquito and aquatic stage densities were investigated. Scanty parallel larvae were identified, but as many as 250 - 500 culicine larvae per scoop were recorded from the maturation ponds. Adult *Anopheles* mosquito density was subpatent and none were caught indoors. Culicine mosquito indoor density ranged from 2.8 to 34 mosquitoes per room. The culicines were most

abundant outdoors in water wells, pit latrines, vegetation, and water hyacinths foliage. As many as 80% of culicine mosquitoes caught were fully engorged. Strategies taken to abate the mosquito nuisance in this setup are discussed.

More Boom for the Buck: Vector Control Improvements by the Deployed War-Fighter Protection Program (DWFP)-Part I

156 Weapons systems: DWFP overviews from the AFPMB and USDA-ARS
Douglas A. Burkett, douglas.burkett@osd.mil and Daniel Strickman

The Deployed War-Fighter Protection research program (DWFP) is an initiative to develop and validate novel methods to protect United States military deployed abroad from threats posed by disease-carrying insects. Starting in 2004 and administered by the Armed Forces Pest Management Board, the program is funded at $5M per year. The DWFP research portfolio is concentrated in 3 specific areas: novel insecticide chemistries/ formulations, application technology, and personal protective systems. Program consists of a noncompetitive funding process for USDA ARS-based research, and a competitive grants process open to non-USDA ARS scientists (PIs from academia, industry, and military entomologists). Up to $3 million per year is given to USDA ARS, specifically to National Program 104, dealing with veterinary, medical, and urban entomology. The ultimate objective is to find industry partners and get useful products into the market/military

stock system. This presentation focuses on DWFP program accomplishments for both the competitive grants and USDA ARS.

157 Small arms: Treated uniforms for personal protection
Melynda K. Perry, Melynda.Perry@us.army.mil and Ulrich R. Bernier

Permethrin-treatment of field-worn U.S. military uniforms has been standard practice since 1991. The uniform fabric composition has changed significantly from 100% cotton to 50:50 nylon:cotton battle dress uniforms (BDUs), to 50:50 nylon:cotton army combat uniforms (ACUs) with wrinkle-free finish, and more recently to fire-resistant material, such as the 65% rayon/ 25% para-aramid / 10% nylon fire-resistant aCcuniform (FRACU). In addition to fiber and finish changes, fabric constructions have changed as well. These changes result in less permethrin absorption and retention and thus negatively affect use of current field permethrin impregnation methods. The changes also negatively affect protection from insect bites. Factory permethrin-impregnation of uniforms overcomes these concerns by the 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 transitioned by completing "First Article Testing" of all vendors in 2007. The US Army will begin this process in 2010. "First Article Testing" involves permethrin content analysis by gas chromatography/mass spectrometry and bite protection evaluation by testing uniform material against mosquitoes. This talk will cover the results of this testing (permethrin content and bite protection) for uniforms (U.S. Marine Corps, U.S. Army, and U.S. Air Force) that have been evaluated over the past 5 years.

158 M-60: Equipment testing and application research for DWFP
Wesley Hoffmann, clint.hoffmann@ars.usda.gov, Bradley K. Fritz, Todd Walker and Muhammad Farooq

Over the past 4 years, NECE and ARS personnel have tested nearly every piece of spraying equipment with a national stock number. The most recent tests measured the droplet size spectra produced by several new sprayers, as well as, providing more extensive testing of previously tested equipment. The extensive testing involved operating each of the sprayers over the complete range of spray rates and pressures while measuring the droplet size spectra over this range. In addition to reporting on the equipment testing, the results from research projects related to bioassay cage evaluations will also be discussed.

159 Discovering and designing new insecticides and their development for vector control
James J. Becnel, James.Becnel@ARS.USDA.GOV

Discovery and development of insecticides for vector control is a primary focus of toxicology research at the USDA-ARS Mosquito & Fly Research Unit, Gainesville, FL. To identify new active ingredients among large numbers of candidate compounds, the primary high-throughput screening (HTS) procedure employs first instar larvae of *Aedes aegypti* for dose-response bioassays. Highly active compounds are then evaluated by topical application bioassays of adult mosquitoes. Toxicity data are subjected to structural-activity relationship (SAR) analysis to identify characteristics for efficacious toxicants. Analogs of active compounds obtained from the SAR results are then directly evaluated for adulticidal activities. Another line of research is the targeting of critical genes/proteins to develop molecular (genetic) biopesticides through RNA interference (RNAi). Critical target proteins include inhibitors of apoptosis protein (IAPs) that regulate programmed cell death. dsRNA constructs targeting critical proteins are evaluated in vivo against adult mosquitoes through topical application to determine activity. Constructs can be refined by targeting different regions of one or multiple genes to increase activity, with exciting possibilities for novel pesticide development.

Education and Public Relations

160 Development and pretesting of an educational program geared towards source reduction of Asian tiger mosquito habitat in New Jersey
Kristen Bartlett-Healy, krisb@rci.rutgers.edu, George Hamilton, Sean Healy, Ary Farajollahi, Taryn Crepeau, Isik Unlu, Randy Gaugler and Dina Fonseca

In 2008 and 2009, we began developing educational tools as part of a larger area-wide management project of the Asian tiger mosquito. Educational tools included a 5-d elementary school curriculum, a take-home ovitrap project, webpage, public service announcement, and a door-to-door distribution of 4 brochures over a 5-mo period. Education was implemented in 2 counties in 2009. In each county, education occurred in 2 plots consisting of approximately 1,000 homes. A third plot did not receive education and served as a control plot for comparison. The effect of education was evaluated by conducting monthly container surveys.

161 The SWAT Team: A partnership between the Franklin County Board of Health and VDCI
Daniel Markowski, dmarkowski@vdci.net, Mitze Kline, Charles Broschart, Elizabeth Kress and Adam Hlad

The partnership between the Franklin County Board of Health and Vector Disease Control, Inc. is designed to provide the citizens of Franklin County, Ohio, with a comprehensive program to combat mosquito-borne viruses. In addition to complete surveillance, source reduction, larviciding, and targeted adulticiding, at the core of our program is public education. Without help from an educated public, many other IMM components are performed with diminished effectiveness. To further public education, we have developed the SWAT Team educational program. This program consists of a 45-min presentation, pledge/membership cards, word searches, and a habitat seek designed to educate children about mosquitoes and mosquito-borne diseases. We have targeted second through fifth grade children. Our presentation will further detail the development, implementation, and goals of this program.

162 ***Withdrawn***

163 Door-to-door survey and community participation to implement a new county mosquito control program in Wayne County, North Carolina, USA
Alice L. Anderson, andersonal@ecu.edu and Timothy Kelley

Community involvement in mosquito management programs provides more sustainable and effective organization and service. A door-to-door survey in Wayne County, NC, carried out by student volunteers, resulted in 60 household responses. Residents had not previously experienced outreach from the county (88%), and 95% of them thought the student door-to-door survey was an effective form of outreach. One third of the residents thought mosquitoes were severe where they lived, but only 9% thought they had any containers in their yard that might harbor mosquitoes. Only 15% of the residents were concerned about mosquito-borne diseases. These responses provide evidence that outreach and education on mosquito control and diseases were necessary steps for future mosquito control community planning.

164 A regional approach to public information and education during National Mosquito Awareness Week: Part two
Roderick A. Wells, rwells@brgov.com

One of the most important components of a good mosquito control program is the public information and education program. In East Baton Rouge Parish Louisiana we've used several different types of reinforcing materials such as; rulers, mosquito swatters, balloons, pencils, and pens to drive home the fact that mosquito control has a message we want them to take home. "Mosquitoes are serious business and people should be aware of the dangers associated with them. Empty any containers holding water." The introduction of the "I'm One" program in 2008 by Central Life Sciences and AMCA hatched the idea to bring National Mosquito Awareness Week, Pilez Mosquito Week, and the "I'm One" program together. This year we combined mosquito district directors with experts from LSU Veterinary School Animal Disease Diagnostic Laboratory, Louisiana Department of Agriculture and Forestry, and the Louisiana Department of Health and Hospitals to discuss the importance of the work done by these agencies in protecting horses statewide from West Nile virus (WNV). We held a press conference to alert citizens of the dangers and harm these animals can suffer from exposure to WNV. This was part two of our public relations effort we started last year during National Mosquito Awareness Week.

165 The Lee County Aquatic Systems / Mosquito Education Outreach Program
Neil Wilkinson, nwilkins@fgcu.edu and Brian Murphy

An overview of the comprehensive public school outreach program for kindergarten, 5th grade, 7th grade, high school biology and chemistry, and university classes. Students engage in week-long series of activites that encompass all aspects of mosquito control in ways that enhance their understanding of basic science. Inquiry, labs, lectures, demonstrations, art activities, and field experiences are all utilized to localize the science content and make it relevant.

166 The Malaria Project: Kids Saving Kids - Giving meaning to service learning
Neil Wilkinson, nwilkins@fgcu.edu and Pat Hallahan

Clarke Mosquito Control and Florida Gulf Coast University teamed up to provide insecticide treated bednets to every inhabitant of Kanke, Nigeria, to prevent malaria and lymphatic filariasis. The goal was to save lives in a far off village, but along the way students learned about the complexities of public health and the personal benefits of working to solve global health challenges.

167 Southern California regional radio advertisement campaign
Crystal Brown, cbrown@glacvcd.org

In response to a dramatic increase in West Nile virus (WNV) activity in the region, Southern California vector control agencies held a region-wide joint press conference in the summer of 2008. The press conference garnered significant media interest that year, but the regional districts felt that more needed to be done to raise awareness about WNV as a major public health concern. In the weeks following the press conference, many of the vector control agencies in the region pooled together funds for radio advertisements through Metro Networks and ran a 4-wk radio buy beginning in late August of that year. The increased attention on WNV and its correlation to the housing and foreclosure crisis in 2008 resulted in additional free media coverage through local and national print, radio, and television media outlets. In an effort to mirror the success of the previous year, Southern Region vector control agencies coordinated another radio ad campaign in 2009. In addition to radio spots, the districts purchased web site banner ads to attract and reach a larger audience. Although far-reaching, the success of radio advertisement campaigns are difficult to measure and quantify. This presentation highlights key points to consider for districts contemplating the use of radio ad campaigns and points out the benefits of a collaborative regional effort.

168 Public capture and release program
Cynthia J. Mulla, cindymulla@comcast.net

Use of multiple methods of successful strategic tactics to lure, intrigue, captivate, and educate all ages of the general population regarding the serious health compromising diseases mosquitoes are capable of transmitting, the important role of mosquito control, individual prevention, protection and the practice of home front source reduction. The release of educated citizens back into the general public promotes the sharing of their knowledge with others that positive mosquito prevention and protection combined with routine weekly source reduction inspections really do work and they enhance the outdoor

enjoyment of favorite activities. A good public relations and educational awareness program benefits mosquito control facilities in many ways. A few examples are: the existence of a mosquito control program; the clarification of antiquated interpretations about mosquito control or lack of understanding about the importance of operation; the instruction and encouragement of routine source reduction reinforces the practice of positive integrated mosquito management plus assists mosquito personnel with minimizing the number of customer requests. Public educational outreach awareness programs are designed to establish the importance of worldwide mosquito control awareness and to establish good prevention and protection practices against the tiny foe known as the female mosquito. Together we can strive for the common goal of mosquito control and create a healthier and safer tomorrow.

New Product Trials

169 Laboratory and small plot tests of a new biobased larvicide
Alvin L. Young, young@aol.com, Robert W. Clegern, Andrew Malec, David Vincent, Robin Todd, Charles Cornell and Gail Stout

The need for "greener", environmentally friendly mosquito control prompted the United Soybean Board to fund the development of a soybased larvicide. Indoor replicated laboratory pan tests of 6 methyl soyate formulations against 3rd instar *Culex quinquefasciatus* showed that an optimum formulation provided 98% and 100% control at 96 h using treatment rates the equivalent of 3 and 5 gal/acre respectively. A second study compared the optimized methyl soyate formulation versus Golden Bear 1111, a widely used mineral oil-based mosquito larvicide. Replicated outdoor pool tests against 3rd and early 4th instar *Cx. quinquefasciatus* were conducted in April 2009 in Florida, using treatment rates the equvalent of 1, 3, and 5 gal/acre. At 1 gal/acre, the soybased larvicide produced 54% mortality vs. Golden Bear's 19% at 96 h. At 3 gal/acre, the soybased larvicide produced 98.8 % mortality vs. Golden Bear's 99.2 % at 96 h. At 5 gal/acre, the soybased larvicide produced 99.6% mortality vs. Golden Bear's 100% at 96 h. The soybased product was slower acting than Golden Bear, and formed a lasting surface film in these studies. A follow-on study of residual activity where additional larvae were added to the treated pools showed that the 3 and 5 gal/acre formulations of the soybased product caused 9-12% mortality after a second week, while the Golden Bear had no residual effect.

170 Five years of field evaluations of a new biobased larvicide
Alvin L. Young, young@aol.com, Robert W. Clegern and Andrew Malec

The need to control the spread of West Nile virus by *Culex tarsalis* in coalbed methane ponds in the western United States prompted the United Soybean Board to fund the development of a soybased larvicide. Field research was conducted under Experimental Use Permits issued for 3 Wyoming counties from 2004-2009. Evaluations of efficacy on 6 species of mosquitoes, including *Cx. tarsalis*, and effects on non-target species were assessed. Either ground or helicopter applications were used in treatments on methane ponds, sewage ponds, recreational and runoff lakes, and streams. The formulation of the biobased product was repeatedly modified until the final product provided rapid kill of the larvae and offered persistence for more than 4 wk. Over the 5 yr, the application rates varied from 1 to 6 gal of product/acre depending upon the vegetation density in the larval habitat. Helicopter applications as a concentrate at a rate of 3 gal/A on the edges of lakes with light to medium vegetation provided >80% control. Ground applications at 3 gal of product/acre in 100 gal of water provided up to 98% control within 24 h and persisted for more than 1 mo. Studies of non-target species confirmed minimal impact from the biobased product.

171 Evaluation of two new (S)-methoprene products for Australia
Michael Brown and Darryl McGinn

A new source of (S)-methoprene (active ingredient from Bábolna Bioenvironmental Centre Ltd, Budapest, Hungary) has been introduced to Australia and made available as 2 newly registered larvicides - Biopren 4SGR® (0.4% active) and Biopren 50 Liquid® (5% active) and distributed by Globe Australia Pty Ltd. In the period between 2006 and 2009, several Australian local and state government vector control programs undertook laboratory and field efficacy testing of these formulations to assess their suitability for use under Australian conditions against the important arbovirus vector species *Aedes* (*Ochlerotatus*) *vigilax* (Skuse) and *Culex* (*Culex*) *annulirostris* Skuse. Label application rates of 3kg/ha for Biopren 4GR® and between 220 - 290 ml/ha for Biopren 50 Liquid® were used for these assessments. Aerial application dose rates achieved were determined by analysis of material recovered by water sensitive dye paper or solid particle catch bags deployed in the treatment area. Laboratory bioassays, small plot field trials and aerial applications of Biopren 4GR® and Biopren 50 Liquid® provided inhibition of adult emergence ranging from 95% to 100% in all field trials. Following successful field efficacy trials, Biopren formulations are now being used operationally within local and state government vector control programs giving them increased choice of suppliers of this important larvicide technology within Australia.

172 A wide-area aerial application of etofenprox (Zenivex) with an Air Force C-130 in Williston, ND
Mark Breidenbaugh, mbreiden@kent.edu, Bill Reynolds and Fran Bosch

Efficacy of the recently registered mosquito adulticide, Zenivex® (etofenprox), was examined in Williston, ND, in July 2009. The city of Williston is located near the confluence of the Missouri, Yellowstone, and Little Muddy rivers and has extensive floodplains adjacent to it. This area is managed by the Army Corps of Engineers and is treated as a wildlife refuge; subsequently, large numbers of mosquitoes arise in this habitat and create a serious nuisance and potential public health problem to Williston residents. A single application of etofenprox over 24,000 acres was made using an Air Force C-130 modified for aerial spraying. Pre-spray landing counts were recorded at 100+ mosquitoes/ min and NJ light trap

collections were over 300 females in 12 h. Post-spray, caged mosquitoes exhibited a 95% mortality rate within 24 h. Additionally, 2-h post-spray landing rates dropped to 0. However, landing rates and trap counts rebounded to 75% of their original densities within 2 d following sprays, demonstrating the substantial reservoir of adult mosquitoes outside of Williston. Future strategies aimed at increasing the period of relief from mosquitoes are discussed.

173 Aerial application field trials of etofenprox against caged adult mosquitoes in Manatee County, Florida
Mark Latham, manateemcd@aol.com, Gail Stout, Doug VanGundy and Bill Reynolds

Six aerial ULV applications of Zenivex E20 (etofenprox) were conducted 9-11 June, 2009, in Manatee County, Florida. Application rates were 0.007, 0.0035, and 0.00175 lb AI/acre, delivered by Hughes 500 helicopter utilizing a high-pressure spray system operating at 500 psi with 4, PJ20 impingement nozzles (target droplet size = 30 µ volume median diameter) at 100 ft altitude. Weather conditions monitored at both the ground and the helicopter were stable with a light steady breeze. Two applications at each rate were made each night at 9 pm and 10 pm, delivering the high rate on the first night, medium rate on the second night, and the low rate on the third night. For each application run, the helicopter sprayed 4 x 1 mile swaths, 930 ft apart, for evaluation of impact on the ground-level treatment grid (600 ft x 600 ft, at the downwind edge of the spray block, with 16 sites having paired bioassay cages, filter papers, and spinning slides). Treatment bioassay results with caged *Culex quinquefasciatus* females showed consistently high mortality (100% in most cages) at all 3 application rates.

174 Container bioassay(s) with spinosad and *Aedes albopictus* under an operational setting
Scott C. Crans, scrans@aesop.rutgers.edu, Isik Unlu, Taryn N. Crepeau, Sean Healy, Ary Farajollahi, Mark P. Nelder and Banugopan Kesavaraju

Aedes albopictus has been a growing nuisance problem in New Jersey since its discovery in 1995. Managing problems associated with the spread of this invasive mosquito has proven to be both challenging and time-consuming in areas where the mosquito has become established. This talk reviews field studies performed in Mercer and Monmouth counties, New Jersey carried out to evaluate the performance of a new tool (spinosad) in the public health pesticide arsenal against the Asian tiger mosquito in container habitats.

175 A new, cost-effective, battery-powered aspirator for adult mosquito collections
Gonzalo M. Vazquez-Prokopec, gmvazqu@emory.edu, William Galvin, Rosmarie Kelly and Uriel Kitron

We report the development of a new mosquito aspirator with the same aspiration capacity (air flow) of the CDC-backpack aspirator (CDC-BP), but smaller and lighter (0.8 kg without battery), less expensive (US$45 to US$70), easier to build, and compatible with the use of telescoping extension poles to access hard-to-reach locations. The performance of this new aspirator, named "Prokopack", was compared with the CDC-BP in laboratory settings as well as in paired collections in Combined Sewer Overflow tunnels (CSO) of the city of Atlanta (USA), and indoor mosquito collections in the city of Iquitos (Peru). The difference in suction power between both aspirators (average, 0.29-0.43 m/s) was negligible. However, 2.3 times more mosquitoes were collected using the Prokopack in the upper wall (>1.5 m) and ceilings of CSO tunnels than with the CDC-BP in lower walls. Indoor collection in Iquitos yielded significantly more total mosquito numbers (including *Culex pipiens* complex, *Culex* (*melanoconion)* sp. and (*Mansonia* sp.), and *Aedes aegypti* (Lin.) in the Prokopack than in the CDC-BP. Our results demonstrate the effectiveness of the Prokopack in collecting different mosquito species in different epidemiological settings.

176 Leaf Defier®: An efficient method of mosquito control in house roof gutters
Eugene J. Gerberg, genejg2@aol.com and Tim Croll

A simple laboratory test was conducted, using 2 sections of gutter. Gutter A was fitted with the Leaf Defier® insert. Gutter B was untreated. Approximately 30 eggs of *Aedes aegypti* were sprinkled on both gutters. Water was poured on the surface of both gutters. After 14 d the gutters were examined. An end section of the Leaf Defier® insert in Gutter A was cut away to determine if any larvae or pupae were present. There were none. The water in Gutter B was examined and larvae and pupae were present. A field test was conducted somewhat similar to the laboratory test, except no eggs were placed on or in the gutters. The gutters were placed on a table outside, in a shaded area. Both gutters were exposed to rainfall. After 5 wk, Gutter A was examined and no larvae or pupae were present in the water trapped below the Leaf Defier® insert. The rainfall that accumulated in Gutter B had live larvae and pupae of *Aedes albopictus*. The use of the Leaf Defier® insert in the roof gutter prevented development of mosquitoes.

More Boom for the Buck: Vector Control Improvements by the Deployed War-Fighter Protection Program (DWFP)-Part II

177 War Ship: Navy Entomology Center of Excellence and the DWFP
George B. Schoeler, george.schoeler@med.navy.mil

The U.S. Navy Entomology Center of Excellence (NECE), Jacksonville, FL, is the Navy & Marine Corps center for operational entomology services. As part of its mission, NECE develops and evaluates novel products and application technologies to protect deployed military personnel from insects that carry diseases, a mission that aligns with the Deployed War Fighter Protection (DWFP) program. NECE's Testing and Evaluation Division is the Center's lead in coordinating and conducting DWFP projects, with capabilities to evaluate application equipment in terms of operational convenience; spray cloud characteristics; design safety, efficacy, and durability. These unique capabilities have allowed NECE to develop

collaborative relationships with other government and academic organizations to conduct various DWFP projects. Currently, NECE is collaborating with 10 governmental agencies or universities on 14 DWFP projects. NECE also evaluates pesticide dispersal equipment in workshops conducted in collaboration with the USDA Aerial Application Technology Unit. Utilizing laser technology and other droplet spectrum analysis methods, pesticide application equipment is brought to NECE by invited manufacturers to evaluate the equipment's spray cloud characteristics and sprayer efficacy. NECE's participation in the DWFP program has led to several journal articles, and new pest management products available to the deployed service member and DOD pest management professionals.

178 Ordinance: Fast-acting vapor pyrethroids for vector control
Kamlesh Chauhan, kamal.chauhan@ars.usda.gov

Fast-acting pyrethroid vapor insecticides, such as transfluthrin and metofluthrin, have been commercialized in household and leisure products for indoor and outdoor use against flying insects. Whereas metofluthrin has only recently been registered, transfluthrin has been marketed for a decade in ~50 countries worldwide. High vapor pressure is the useful physicochemical property of these and related fast-acting pyrethroids, giving spatial effectiveness, so the usual presentations are mosquito coils and vaporizers. We assessed molecular properties of such pyrethroids for bioefficacy and adaptation to slow-release formulations. An interesting property observed with these compounds was their efficacy on several pyrethroid-resistant strains of mosquito.

179 Ordinance: Molecular basis of selectivity and semi-field performance of carbamate anticholinesterases for control of the malaria mosquito, *Anopheles gambiae*
Jeff Bloomquist, jbquist@vt.edu

In the malaria mosquito, *Anopheles gambiae*, the ace-1 gene codes for acetylcholinesterase (AChE). Classical inhibitors of this enzyme (e.g., carbamates and organophosphates) display little selectivity for enzyme inhibition, typically < 4-fold. Recent experimental and molecular modeling studies identified carbamates having 100- to 1,000-fold selectivity for malaria mosquito AChE compared to human AChE. Insecticidal activity was assessed in semi-field studies in Africa. When bednets were soaked in an ethanolic solution of 3-*tert*-butylphenyl-N-methylcarbamate, control extended out over 50 days. We anticipate that field activity will be greatly prolonged using conventional formulations. These new molecules have unprecedented potential as leads to safe, effective mosquitocides in the fight against malaria.

180 Ordinance: Attractive Toxic Sugar Baits (ATSB) ─ A new approach for sand fly control
Gunter Muller, guntercmuller@hotmail.com, Vasiliy Kravchenko and Yosef Schlein

Blood-sucking female sand flies (Diptera: Psychodidae) transmit various *Leishmania* parasites (Kinetoplastida: Trypanosomatidae) that cause cutaneous and visceral leishmaniasis. Sand flies are notoriously difficult to control and measurements for personal protection are often inconvenient. Sugars of plant sources like fruit and floral nectar are the essential diet of sand flies and the search for sugar is apparently guided by attractants. We conducted experiments in the Jordan Valley in natural habitats with the sand fly *Phlebotomus papatasi*. The area is known for its high biting pressure of sand flies, indoors and outdoors, and its numerous cases of cutaneous leishmaniasis. We evaluated attractive toxic sugar baits (ATSB) as previously used for mosquito control, to attract and kill sugar questing sand flies. The baits contained a mixture of fruit and plant extracts, sugar, and BaitStab™ (Westham Ltd., Tel Aviv, Israel) a mixture of food grade slow-release substances and preservatives. Several application methods were evaluated: spraying vegetation, bait impregnated barrier fences, and bait stations. Good results were achieved with the first 2 methods, which reduced the local sand fly populations about 94% and 88% respectively compared to nearby untreated areas, while bait stations only achieved only ~60% reduction.

181 Pentagon: From pesticide discovery to registration ─ Unclogging the product development pipeline
Karl Malamud-Roam, kmr@aesop.rutgers.edu and Kevin Sweeney

The U.S. military has a policy of only using pesticides registered by the U.S. Environmental Protection Agency (EPA), both to ensure the safety of soldiers and sailors and protection of the environment. The DWFP Program has been remarkably successful in discovering potentially useful new toxicants, repellents, and other biologically active compounds. Now the program faces institutional and scientific challenges as it begins to develop useful products, while continuing to search for novel materials. Institutional challenges include identification of potential registrant partners, protection of intellectual property, and finding the financial resources required to prove that insecticides are not only effective but also safe. After selecting a set of candidate AIs, the next research steps include formulation, large-scale production, and characterization of toxicology and environmental fate. The program now must also determine which of these materials are likely to be both economically feasible and eligible for registration with the EPA. This presentation will provide an overview of new product development and the EPA registration processes. IR-4 staff will describe their role in public health pesticide development and registration, while EPA staff will address public health pesticide data requirements and efficacy testing for repellent/insecticide treated fabric, spatial repellents, and insecticides and will provide updates on more recent EPA initiatives.

Draft general NPDES permit for aquatic pesticide use: An update from EPA

182 Introduction
William H. Meredith, william.meredith@state.de.us

News from EPA regarding proposed contents of the agency's draft general NPDES permit for aquatic pesticide use, being an update of the EPA's nationwide webcast from October, 2009.

GIS/GPS and Equipment

183 The "laziness germ" in southern US: Malaria + hookworm, Rockefeller Foundation historic records on GIS
Alice L. Anderson, andersonal@ecu.edu

The Public Health Organization in North Carolina celebrates its 100th aniversary this year as a result of the collaboration of the North Carolina Board of Health and the Rockefeller Sanitary Commission initiated in 1909. This collaboration to eradicate the "laziness germ" of hookworm infection (with aenemic symptoms from malaria as well), generated the first systematic records of disease in the rural South. Data in the Rockefeller Foundation archives has been translated to incidence rate, using the 1900 census data, for southern states from Virginia to Florida and West to Arkansas. Ground penetrating radar GPS mapping shows soil condition correlation.

184 Managing mosquito control activities using a web-based data service with integrated mapping and a custom mobile data collection application
Derek Wright, dwright@myadapco.com

Many vector control agencies rely on a variety of legacy tools to manage their activities. These tools often include software programs installed from CDs, running on local computers. This works well until updates are required or your computer has problems and all your valuable data is compromised. Hosted software works a little bit differently. This paper describes the design and use of GeoPro and GeoPro Mobile Scout, a new hosted data management service for the mosquito control industry. Topics to be discussed include simplified methods for mapping data, managing surveillance activities from the field, importing treatment data, and tracking service requests. GeoPro is a geographic information system (GIS) based, knowledge-driven platform for vector control professionals. GeoPro is web-based, providing a secure repository for transferring a wide range of information over a secure connection. As a professionally hosted solution, GeoPro offers anytime access with 99.9% uptime reliability from dedicated servers.

185 ***Withdrawn***

186 Benefits of GIS in Vector-Borne Disease Surveillance
Ryan Pierson, ryan@elecdata.com

Geographic information systems (GIS) inherently contain powerful tools for collecting, storing, analyzing, and distributing data - much like any relational database management system (RDBMS). GIS, however, adds the additional capability of displaying and analyzing data spatially. Seeing data displayed in a digital map or analyzing spatial relationships are powerful tools unique to GIS. This added capability of GIS can be very powerful in detecting vector-borne disease and predicting patterns of disease. Sentinel GIS surveillance software provides GIS users a simple set of tools to collect, monitor, display, and analyze data relating to vector-borne disease. The tools allow field technicians to easily collect surveillance data and samples. The GIS database is then automatically updated with all field collected data upon the return of field technicians. Supervisors then use simple tools to analyze the collected data, generate reports, and create maps. This presentation will describe the benefits of GIS in vector-borne disease surveillance and demonstrate the Sentinel GIS surveillance software tools.

187 Sentinel GIS™ integration, management, and utility: A first-year perspective
Jared Dever, jdever@northwestmvcd.org

The Northwest Mosquito and Vector Control District continually strives to improve efficiency, accuracy, and reduce redundant record keeping and pesticide usage tracking, in an effort to better serve and protect the community. In 2009, the implementation of a vector control specific GIS software and hardware solution, B&G Sentinel GIS, has helped to transform the Districts' antiquated paper-based operation into a streamlined, centrally managed, electronic data capture and reporting system. This transformation was a gradual process executed in phases of installation, training, testing, and field-use. The multi-step introduction procedure ensured that District staff had the appropriate proficiency to guarantee a high margin of successful daily use and eventual reliance upon the system. After a single season of use, the volume, accuracy, and specificity of data available to both management staff and field personnel is well beyond what could have been generated from a paper-based system of recording and reporting. The utility of a vector control specific GIS product is exciting for any agency looking to make a quantum leap forward in effective vector control operations, while improving their accuracy, transparency, and accountability to their constituency.

188 Real-time communications in mosquito control operations
Lynn Hand, ldh147@psu.edu

Real-time communications between mobile workers and mission operations is an essential part of any mobile workforce management program, but real-time tracking of field-workers, service requests, and equipment operations offer specialized

benefits to mosquito control programs. Many GPS to GIS interfaces rely on hard-wired synching, or parking lot downloads of operational data. Real-time, 2-way flow of information to and from an enterprise-level GIS gives mosquito control operations that essential head-start on intervention in order to quickly interrupt the egg-to-disease life cycle. This presentation outlines the benefits of real-time communications between GPS and GIS systems. It will highlight the steps taken to integrate commercially available vehicle tracking hardware and sensors provided by Trimble Navigation with Electronic Data's Sentinel, a mosquito control extension for ESRI.

189 Comparison of mosquito population data from three manufacturers of New Jersey light traps
Lisa M. Reed, lreed@rci.rutgers.edu, Randy Gaugler, Mark Robson and George Hamilton

The New Jersey light trap is unique with regard to calibration of air flow within specifications, allowing comparison of mosquito populations from different areas. These traps are used by both county and state agencies to monitor mosquito populations throughout the state. Until recently, one manufacturer produced all of the light traps used by county mosquito control agencies in New Jersey. This manufacturer no longer produces traps. Light traps have become available from other manufacturers. Calibrations at Rutgers University on county traps indicate that air flow by traps made from 2 other manufacturers is lower than the original traps, suggesting that number and/or type of mosquito captured by the 3 traps could differ. We compare mosquito populations from light traps by 3 manufacturers set throughout New Jersey to determine if the traps are comparable in catch rates.

190 Evaluation of the Arro-Gun Bullet hand carry fogger for use in adult mosquito and midge control
Scott E. Monsen, smonsen@washoecounty.us and Dan Ariaz

The Arro-Gun Bullet hand carry fogger is a lightweight 4-cycle unit capable of outdoor treatments. The hand carry fogger was found to be compatible with oil or water based formulations of adulticides currently available over the counter. Droplet spectrum as measured by an AIMS droplet measuring unit was recorded to be between 1 and 60 microns. Favorable results were demonstrated in field assays using caged adult mosquitoes and midges. Quick knockdown and high mortality was observed against a variety of mosquito and midge species in domestic settings.

Pesticide Use: Optimum Amounts and Alternative for None (Symposium)

191 Introduction
Ruide Xue, rudy.xue@yahoo.com

Because of environmental concerns, pesticide use for mosquito control has been getting much more attention. The symposium's purpose is to share the research information about optimum use or reducing/limiting use of pesticides, and to promote using pesticide properly and search/select limited pesticide use or pesticide alternative methods for mosquitoes and mosquito-borne disease control. There are 7 topics dealing with optimum pesticide droplet size, determination of optimum levels, field evaluation roles, using attractive toxic baits and local barrier treatments to reduce pesticide application, control traps as pesticide alternative method, and the malaria reduction through urbanization and living condition improvement.

192 Product comparison: The lethal droplet size, discussions on toxicity
Jane A. Bonds, jasbarber@knology.net

Public health adulticide applications were associated with only 6 compounds in Florida; naled, malathion, permethrin, sumithrin, resmethrin and natural pyrethrum. Two new compounds have been now been registered; each of these compounds has been tested for efficacy and subsequently designated as effective mosquito adulticides. The literature, however, is lacking independent comparative assessments of toxicities among these new compounds and the current compounds. Information on the relative insecticidal toxicities of compounds is critical to those agencies planning and executing vector control programs. The J. Mulrennan Public Health Entomology Research and Education Center is known for this type of testing and has conducted many similar studies in the past, mainly using the Center's ambient wind tunnel. This time comparative toxicities were calculated for both intrinsic and atomized formulation. The difference in response from *Aedes taeniorhynchus* and *Culex quinquefasciatus* were calculated for malathion, naled, permethrin, DUET™ Anvil, Scourge, etofenprox, and Evergreen. The research not only provides insight into the comparative toxicities between each compound but the droplet size and number required and how this changes from one insect to another for the formulated product.

193 Determination of optimum levels of mosquito adulticides
He Zhong, he.zhong@famu.edu

The optimum levels of mosquitocide can be defined as "the lowest doses of insecticides" in the spray zone needed to obtain consistent and satisfactory control efficacy against adult mosquitoes. The optimum levels will vary among/within areas of targeted control. These levels may be affected by application (dose, droplet size, flight altitude, and swath width), weather (wind speed and direction), and geographic setting (river, trees and vegetation), as well as mosquitoes (species, behavior, tolerance, or resistance levels). The application dose is the concentration measured during calibration of a spray nozzle system. The spray cloud concentration will be influenced by other application parameters, including the droplet size, application altitude, and swath width. Wind speed and direction are important environmental factors affecting the dispersion, as well as droplet impingement on targets. The geographic setting may create a microenvironment that affects the final destination. Finally, the optimum levels should be customized for the species of interest. Given the above myriad of unalterable variables (weather, environment, and species), an application dose should be tailored to obtain the optimum

concentration at the targeted zone. The easiest way to customize the dose is through residue monitoring and mosquito bioassay to establish correlations. This correlation may be used to obtain the optimum levels of mosquito adulticide needed for satisfactory control efficacy.

194 The role of principal scientists in field pesticide evaluations
Jing Zhai, jing.zhai@eurofinsagro.com

Good laboratory practice (GLP) generally refers to a system of management controls for laboratories and test facilities to ensure the consistency and reliability of results as outlined by the EPA in 40 CFR 160, dated August 17, 1989. Good science principles require well designed study protocols and study director's single point of control. To improve data reliability, quality and traceability, and ensure complete reconstructability of studies, it is necessary to record and archive any documents pertinent to a study, such as, equipment calibration, test materials and system characterization, reliable reagents and solutions, chain of custody for test substances and all specimens. It is also required that all data must be reviewed and audited prior to submission.

195 Attractive toxic sugar baits (ATSB) in mosquito control
Gunter Muller, guntercmuller@hotmail.com, Amy Junnila and Yosef Schlein

During the last 4 yr, numerous experiments were conducted with ATSB to control mosquito populations. Results obtained in Israel, the Palestinian Territories, Mali, and Florida will be summarized and discussed.

196 Vegetation barrier treatments against adult mosquitoes and reducing adulticide application
Whitney A. Qualls, quallsamcd@bellsouth.net and Ruide Xue

Barrier applications applied to vegetation have been evaluated for 3 yr against mosquitoes in St. Johns County, FL, to determine their role in mosquito control programs and in reducing ground ULV applications. Barrier applications using the active ingredient, bifenthrin, have been evaluated in 3 different settings: 1) a small residential back-yard, 2) a residential park, and 3) a golf course community. Each application provided a reduction in mosquito populations, service requests generated, and ground ULV applications. Ultimately throughout the 3-yr evaluation, adulticide application for adult mosquitoes has been reduced by a more targeted treatment resulting in a reduction in operating costs.

197 The use of traps for mosquito control
Daniel L. Kline, dan.kline@ars.usda.gov

Mosquito control in the United States has relied largely on the use of chemical insecticides for population management. This is especially true for the control of adult mosquitoes. For the past 2 decades the use of semiochemical baited traps for mass trapping of adult mosquitoes has been investigated by our research group. The development of traps for mosquito control has not been easy. The perception exists in many mosquito control districts that mosquito populations cannot be controlled with traps. This paper will provide a brief overview of various traps that have been commercially developed for mosquito control. Most have been developed for the individual homeowner. Several pilot projects have been conducted which have attempted to utilize traps for control in specialized situations. The use of propane powered traps has resulted in mosquito control in some specialized situations. One thing is clear: "one size does not fit all," i.e. species composition is important to the success of this technique. Acceptance by the public and/or the professional mosquito control

community of new technologies, such as mass trapping will not be achieved easily because they have become accustomed to the immediate control obtained through spraying with chemical insecticides.

198 Malaria reduction through urbanization and living condition improvement
Tong-Yan Zhao and Ruide Xue

Recently, the rapid development and growth (urbanization) in Hainan Island, the people's living conditions have been greatly improved. The residential houses in countryside have been changed from old hut houses (no more) to model concrete buildings, and every family has electricity for lights and TV; a few families with window air conditioners. The living condition improvement, IPM, and anti-malaria drug usage brought a 97% malaria reduction in the last 2 decades. The Hainan CDC aims to eradicate malaria from the island within next 5 yr. However, malaria in an African country (Angola) still causes about 25% child mortality annually. The major reasons are malnutrition, poor economic and living conditions. The people in this malaria epidemic area are still living in hut houses without electricity. The people usually sit outside of hut houses because there are no lights and it is too hot inside the houses, and thus they are directly exposed to mosquitoes during the peak activity time after sunset. Malaria control could be successful through the reduction/limitation of contact between vector mosquitoes and people, and the changes/improvements of the people's living condition and their behaviors/cultures.

Larval Control I

199 The use of different types of larvicides
Steven Reidburn, vectorcntl@jamestownnd.com

To show the differences of chemical and bacterial treatments in larval control, the processes, chemical and bacterial types along with various application procedures. It will walk a novice and a professional through the steps of application and the

method for deciding which type of larvicide will be used in the application. Also, at the end we shall review the many application methods available for use by chemical applicators.

200 Effect of repeated application of microbial larvicides on malaria transmission in Cote d'Ivoire
Guibehi B. Koudou, G.B.Koudou@liv.ac.uk, Emile Tchicaya and Juerg Utzinger

The effect of repeated application of *Bacillus thuringiensis* var *israeliensis* (*Bti*) and *Bacillus sphaericus* (*Bs*) on entomological parameters and malaria transmission was investigated in central Côte d'Ivoire. First, all potential mosquito oviposition sites identified toward the end of the rainy season in a radius of 1.5-km from the village centre were characterized. Next, we applied *Bti* (0.8 mg/l) and, 3-4 days later, *Bs* (10 mg/l). The study area was monitored for oviposition sites over a 7-mo period and microbial larvicides were applied once every 3 wk. Additionally, adult mosquitoes were collected inside and outside human habitations in 4 cross-sectional surveys in 2006. Repeated application of *Bti* and *Bs* showed an effect on *Anopheles* larvae; in 3 of the last 4 surveys no *Anopheles* larvae were found, whereas before, 6.5-23.7% of the sites harbored *Anopheles* larvae. Entomological transmission parameters recorded for 2006 showed a decline in the biting rate of both *Anopheles funestus* and *Anopheles gambiae* compared to the preceding year. Moreover, the entomological inoculation rate of *An. funestus* was significantly reduced (from 328 to 142; P = 0.005), whereas that of *An. gambiae* remained stable. In conclusion, microbial larvicides might play a role in an integrated approach for malaria control.

201 Evaluation of extended release formulations of spinosad for *Anopheles* control in western Kenya
Nabie M. Bayoh, NBayoh@ke.cdc.gov, Derrick Mathias, Ned Walker, John Gimnig and William Jany

Novel formulations of spinosad developed for mosquito larval control were evaluated in simulated *Anopheles* habitats near Kisumu, Kenya. Simulated small and large pools were used to allow for replication of treatments and rates. The first study used small 46 cm x 15 cm mud-lined basins, Natular™ XRG, a 30-d granule; Natular™ 0.5% granule; Natular™ 2.lb EC, and VectoBac® WDG were applied and early 2nd instar larvae were placed in habitats at 7 day intervals. Larvae and water samples were removed after 1 wk and monitored for mortality. In the second study, 4 different larvicide formulations: Natular™ T30 a 30-d tablet; Natular™ XRG a 30-d granule; Natular™ 2.lb EC and VectoBac® WDG. 25 semi-natural habitats, 1.52 m diameter, 0.36 m deep were created. Early 3rd instar larvae were placed in covered screened bioassay cages. Mortality was taken at 7-d intervals. Wild *Anopheles* were allowed access to pools for oviposition, and populations were monitored weekly.Results showed the 30-d tablet and granule provided effective larval control for 4 wk while the 2lbEC provided less than 2 wk control and the VectoBac® WDG was effective for less than 1 wk. The performance of spinosad-based extended release formulations against the malaria vector *Anopheles gambiae* in semi-natural habitats were demonstrated, paving way for large scale field evaluations planned for 2010.

202 Evaluation of late summer treatments to suppress *Coquillettidia perturbans* emergence the following spring
Mark E. Smith, mmcd_mes@mmcd.org and Stephen A. Manweiler

The Metropolitan Mosquito Control District evaluated late summer aerial applications of VectoLex® granules (20 lb/acre) to control *Coquillettidia perturbans* the next year. Advantages of these applications include increased productivity, less stress on resources (including a longer aerial treatment window), and more flexibility concerning use of our control material budget.

203 Determining the susceptibility of *Culiseta melanura* to *Bacillus sphaericus* (Serotype H5a5b strain 2362) in a laboratory bioassay
Wayne Andrews, brismosqwa@comcast.net and Priscilla Matton

Culiseta melanura field-collected 4th instar larvae were screened against *Bacillus sphaericus* (Serotype H5a5b Strain 2362). Concentrations from 0.6 mg/L to 0.006 mg/L were used to determine *Cs. melanura's* susceptibility to this bacterium. We found that this mosquito has an LD_{50} of 0.022mg/L and an LD_{90} of 0.135mg/L. Mortality could not be determined until d 7 at an average temperature of 16.2°C. These concentrations are 10 to 100 times lower when compared to application rates for control of *Culex pipiens*, and well within the recommended application rates.

204 FourStar™ SBG (*Bti* sand granule) pre and post-hatch field trials - 2009
Robert Sjogren, rdsjogren@gmail.com and David Sjogren

FourStar™ Single Brood Granules (SBG) designed for maximum operational flexibility were presented in 2009. Second-year SBG field trials were conducted mid summer in 95°F temperatures against *Aedes melanimon* larvae in native irrigated pastures. Pre-hatch applications made up to 12 d prior to flooding, at 7.5 lb/acre, provided effective larval control. Post flood applications against 2nd through early 4th instar larvae also achieved excellent control at 5 lb/acre. Cooperator field trials of EPA registered SBG will be conducted in 2010.

205 Efficacy of backpack applications of VectoBac® WDG for *Aedes albopictus* larvae in placed containers and comparison to other control techniques
Sean Healy, healy@co.monmouth.nj.us, Ary Farajollahi, Peter Obenauer, Tony Hughes, Eric Williges, Isik Unlu, Taryn N. Crepeau, Randy Gaugler and Dina Fonseca

Six subplots containing approximately 40 parcels were selected within Trenton, NJ. Containers were placed at 20 houses within 4 of the subplots. Each container had 20 2nd/3rd instar larvae. Two of the subplots were treated by Mercer County

Mosquito Control personnel utilizing backpack sprayers containing VectoBac® WDG. Two of the subplots were treated with Altosid Pellets/Agnique Pellets/source reduction. Two of the plots served as controls. Efficacy of backpack applications was determined based on larval mortality in the treatment plots vs. the control plots. The comparison also takes into account the number of containers treated, time to treat (personnel costs), and chemical costs.

206 Laboratory evaluation of a granular garlic-based larvicide against *Culex* spp. and *Anopheles* spp.
Elizabeth Rorabaugh, bethr@springstar.net, Samuel Hapke, Christian Banfield and Michael G. Banfield

Increased restrictions on the application of chemicals to water sources, coupled with the development of vector resistance to widely-used chemical insecticides, have created a demand for bio-rational alternatives to control mosquito larvae. This study measured the toxicity of a granular larvicide, which contains oil derived from garlic (*Allium sativum*), against mosquito larvae in laboratory containers. In Washington State, USA, mortality of *Culex* spp. larvae was monitored in cups containing 250mL rainwater and active ingredient concentrations of 6ppm, 12ppm, 60ppm, 120ppm, and an untreated control, with 5 replicates per concentration. In Ghana, 4 replicates of 50 3rd instar larvae of *Anopheles* spp. and *Culex* spp. were exposed to 4 active ingredient concentrations and an untreated control. At average ambient temperatures of 21°C in Ghana, 100% larval mortality was reported after 24 h at all concentrations with no control mortality after 48 h. Lower ambient temperatures (average = 13°C) occurred in Washington State, where 94% larval mortality was reported after 48 h exposure to 120 ppm active ingredient. Treatments in Washington showed a strong residual effect with 94% mortality reported after 168 h of exposure to 6ppm active ingredient. LC_{50} values were calculated to be 72ppm and 42ppm active ingredient for 24- and 48-h exposures, respectively.

207 "Reduced risk" larvicides for integrated mosquito management
Jack Petersen, drjack3@hotmail.com

Pesticides, by their very nature, are designed to kill. However, every effort must be made to focus the desired effect on the target (mosquitoes) while minimizing risks to humans, other animals, and the environment. Several new larvicides are available that claim to do this. We are evaluating 2 larvicides, NOVALURON and Natular™. We will report on efficacy and residual action. Two study designs were employed: laboratory beaker dose response curves and outdoor cement troughs. Implications for incorporation of these products into integrated mosquito management (IMM) programs will be discussed.

Operations and Management

208 *Wing Beats*: 2010 progress report
Stephen L. Sickerman, swcmcd@mchsi.com and Jack Petersen

Wing Beats, an official quarterly publication of the American Mosquito Control Association and the Florida Mosquito Control Association, is a trade magazine that supports operational mosquito control, with a current national and international circulation of almost 4,000. Criteria for manuscript submission and availability to associations and institutions for use as a recruitment tool will be discussed.

209 Preparing an effective request for proposal and evaluating responses to find the best outsourced solution
Edward S. Horvath, eshorvath@hotmail.com and Bob Betts

A request for proposal (RFP) is a formal document from an organization that describes a need and invites vendors to submit a solution. A detailed RFP promotes competition while providing vendors with a better understanding of the district's needs. Through this process, vendors provide a wide variety of solutions and prices and compete for business. Proper RFP preparation, followed by an organized evaluation of responses ensures the district receives the best deal on services based on the district's own need.

210 An introduction to practical good laboratory practices for field research
Randy Fuller, randy.fuller@eurofinsagro.com

To ensure the quality and integrity of test data submitted to EPA in support of a pesticide product registration, many chemical companies and research facilities have adopted EPA's Good Laboratory Practice Standards (GLPS) compliance monitoring program. The author provides insights on what study directors and research scientists should know about practical GLP for mosquito control product research.

211 Mosquito control response to dengue fever outbreak in Key West, FL, USA
Andrea Leal, aleal@keysmosquito.org, Lawrence J. Hribar, Mikki Coss, Michael Spoto and Edsel Fussell

Local transmission of dengue fever (serotype-1) occurred in Key West, FL, USA, in 2009. Florida Keys Mosquito Control District's immediate response involved both larval and adult control of the vector, *Aedes aegypti*. Door-to-door environmental assessments were conducted throughout Key West and neighboring islands (Stock Island and Key Haven). The infestation rate from these environmental assessments was 17% on average. An island-wide residential education campaign also occurred, hand-in-hand with environmental assessments. Handheld ULV machines, truck-mounted ULV machines, and aerial ULV treatments were used as control measures for adult *Ae. aegypti*. Adult collections were made at multiple trapping sites using BG sentinel traps. All field collected adults were sent to the Florida Department of Health Laboratory for PCR testing. No adults tested dengue positive. Areas of emphasis for vector control during a dengue outbreak are vector habitat elimination, handheld ULV in areas of high concern, and public education.

212 MapVision implementation at Anastasia Mosquito Control District of St. Johns County, Florida 2009
Priscilla Greene, pgreene82@gmail.com

This presentation will outline the implementation of MapVision at Anastasia Mosquito Control District as follows: contract with Leading Edge Associates, LLC; meetings to determine MapVision capabilities; program development for customer-focused services and online data; program implementation for surveillance information such as LRC's, light trap and sentinel chicken sites as well as pesticide application graphics; and program testing. Highlights and and a summary will be provided.

213 The expanding distribution of *Aedes japonicus* in the Metropolitan Mosquito Control District
Kirk A. Johnson, kjohnson@mmcd.org

Aedes japonicus was first detected within the Metropolitan Mosquito Control District (MMCD) in August of 2007 near a tire recycling facility in Scott County. That infestation was apparently eradicated as no other specimens were collected near the recycling facility in 2007 or 2008. The species was collected in 2008 from several locations in Dakota County, MMCD's southeastern-most county. These along with additional findings in southeastern Minnesota and southwestern Wisconsin suggest *Ae. japonicus* arrived naturally from the southeast. During 2009, *Ae. japonicus* specimens were collected from multiple locations in each of MMCD's 7 counties. This talk will describe surveillance and control strategies implemented for the 2009 season, as well as documenting the observed distribution of *Ae. japonicus* within MMCD.

214 Urban field spray characterization and habitat penetration of DUET™ via truck-mounted ULV equipment against *Aedes albopictus*
Ary Farajollahi, farajoll@rci.rutgers.edu, Sean Healy, Isik Unlu, Eric Williges, Scott C. Crans, Banugopan Kesavaraju, Dina Fonseca and Randy Gaugler

Aedes albopictus, the Asian tiger mosquito, is a diurnal mosquito with considerable nuisance and medical importance. Control of this pest 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 2 separate truck-mounted ULV field trials using DUET™ (dyed with Uvitex) within an urban setting (120 acres consisting of 1,250 parcels) to evaluate penetration and characterization of droplets. Five randomly assigned parcels were chosen within the site, and 4 locations were chosen within each parcel (front of home, backyard, underneath backyard deck, and back nook between duplex homes). At each location, 2 ground level (1 ft) slide stations were used to collect droplets. A rotary slide impinger (Florida spinner) with 2 rods and 2 standard Teflon coated (Hock spinner) slides were used at each station. All slides were read using DropVision™ droplet measuring system under UV light and also manually under a compound microscope. We present our findings on droplet penetration, density/size, and concentration of DUET™ within these habitats after an operational spray application.

215 Optimizing human resources in an *Aedes aegypti* control programme
Alan S. Wheeler, alan.wheeler@gov.ky

Following the introduction of *Aedes aegypti* in 2002 the Cayman Islands Mosquito Research & Control Unit (MRCU) has been carrying out control operations against this species. By the end of 2005, this species had become firmly established and was present island-wide. It was apparent that with the limited number of personnel available eradication of *Ae. aegypti* was not attainable and control efforts where therefore aimed at minimizing the *Ae. aegypti* abundance in the areas of highest human population density. Analysis of larval collection data between 2005 and 2009 showed that yards in the selected treatment areas could only be surveyed and treated once every 35 days and this was having minimal impact on the abundance of *Ae. aegypti*. However the data also revealed that the distribution of larval finds was highly clustered in certain yards. It was shown that only 20% of the 7,000 yards surveyed on a routine basis where responsible for over 80% of all larval finds. It was also shown that yards shown to be a problem during the dry season where not necessarily problem yards during the rainy season and vice versa. Based on the analysis of this collection data a new strategy for *Ae. aegypti* control was devised which aimed to optimize the available manpower by concentrating control efforts to target the problem yards by surveying and treating them on a once per week basis. The results of this approach are discussed.

Larval Control II

216 Experimental use of Natular™ against WNV vectors in stormwater management structures
Kirk A. Johnson, kjohnson@mmcd.org and Stephen Manweiler

In 2008 and 2009, we tested several formulations of Natular™ against *Culex restuans* and *Culex pipiens* found in stormwater structures in the Minneapolis/St. Paul metropolitan area. Natular™ XRG was effective for 4 wk in consistently wet culverts. Natular™ T30 controlled mosquitoes in catch basins for 4 wk. Natular™ XRT was effective for the entire season in catch basins in both 2008 and 2009.

217 Larviciding with Natular™ T 30 tablets
Jonas Stewart, jstewart@co.volusia.fl.us

Natular™ T 30 tablets gave an average of 85% control at 15 sites for 7 species of mosquitoes in Volusia County, FL in 2009. Tablets were hand distributed to stormwater areas, tires, a tree hole, and sewage treatment facilites. Larviciding details at the 15 sites will be discussed.

218 Results using several formulations of the larvicide Natular™ (active ingredient spinosad) in Kentucky
Grayson Brown, gcbrown147@gmail.com and Grifith S. Lizarraga

The active ingredient of Natular™, spinosad, is a product derived from a naturally occurring soil bacterium. Spinosad represents a unique chemical class and mode of action different from all other existing larvicides. During Kentucky's 2008 and 2009 season, several evaluations were designed to measure efficacy and performance of Natular™. Results indicate efficacy against an array of mosquito species including *Aedes japonicus*, *Aedes triseriatus*, *Aedes trivittatus,* and *Anopheles quadrimaculatus*. Species susceptibility was achieved at label rates in several habitats, including abandoned swim pools.

219 Laboratory and field evaluation on new biopesticide Natular™ T-30 to control immature mosquitoes
Tianyun Steven Su, tsu@wvmvcd.org and Min-Lee Cheng

Natular™ T-30 is a tablet formulation of 8.33% spinosad, a mixture of spinosyn A & D derived from a soil-dwelling bacterium *Saccharopolyspora spinosa*. This new formulation is developed by Clarke and registered by US EPA as a mosquito larvicide. To determine lavicidal activity and field efficacy against immature mosquitoes, laboratory bioassay and field mesocosm test were conducted in 2009. Natular™ T-30 tablet was processed for laboratory bioassay following standard procedures. Field mesocosm tests were carried out during July - September using water troughs on defunct dairies. The bioassay showed that the LC_{50} & LC_{90} against laboratory colony of *Culex quiquefascistus* are 0.08 ppm and 0.228 ppm with 24 h of exposure at 25-27° C. In field mesocosm test, no significant control was noticed until d 7 post-treatment. During days 7 to 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. It seemed that the later stages of larvae and pupae were more affected, an indication of exposure-related differences in efficacy. The test was concluded when untreated control water troughs were no longer able to sustain high mosquito production. From this study, the spinosyn-based mosquito larvicidal formulation, Natular™ T-30 showed great potential for its future introduction and application in mosquito control operations. It would be more preferable if the treatment reaches lethal level sooner than 7 d post-treatment.

220 Cement tank: An artificial water container of *Aedes aegypti*
Armando Ulloa, aulloa@insp.mx, Jese D. Cruz-Magariño, Rogelio D. Lozano and Teresa Lopez-Ordoñez

An entomological survey was conducted in 200 houses in the community of Huixtla, Chiapas. The relative importance of diverse *Aedes aegypti* oviposition sites was determined and house index and container index were used as indicators of entomological risk for each class of container. A total of 13,003 artificial containers were reported, of these 77% (10,011) and 23% (2,992) were found outside and inside the houses, respectively; these data revealed the existence of 3.34 times more containers outside than inside the houses (X^2= 57.20 P = 0.0001). When the frequency per container was obtained, the cement tanks were the third (14%) and 5 (3%) containers with the most abundant larval population inside and outside the houses, respectively. However, this class of container occupied the first place of those containers with water inside (96%) and outside (91%) the houses, respectively. The tanks showed a house index of 45 and 29, inside and outside the house, whereas container index was 38 and 13 inside and outside of houses, respectively. These findings suggest that cement tanks are important breeding sites because they are preferred by mosquitoes and are abundant in Huixtla, Chiapas.

Poster Session Abstracts

Adult Control

P-01 Field tests using natural products on caged mosquitoes as potential new adulticides
Mary Adams, gxu8@cdc.gov, Mariah Scott and Janet McAllister

Nootkatone, thymoquinone and carvacrol, which are components of Alaska yellow cedar and incense cedar essential oils, have been shown to have biological activity against a variety of mosquito species. *Culex quinquefasciatus* (Say) were used in field tests to demonstrate the potential of these compounds as adulticides that could be formulated into space sprays. The cages were sprayed with unformulated solutions of 100% nootkatone, 100% carvacrol, and a mixture of 121.44 mg/ml thymoquinone dissolved in mineral oil. Light mineral oil was also sprayed as a negative control. The natural products and oil were tested by spraying 4 cages set on poles. Applications were done with a Colt® fogger using 3 different flow rates. Mortality was recorded at 15 min, 1 h, and 24 h. Only nootkatone produced 100% mortality at 1 h but recovery of mosquitoes occurred by 24 h indicating some sub-lethal dosing was occurring. The highest mortality nootkatone treated mosquitoes exhibited at 24 h was 62%. Thymoquinone produced 1% mortality at 24 h. No mortality was observed with carvacrol. Our results indicate that nootkatone shows the most potential for formulation as an alternative natural adulticide. Carvacrol showed the least promise as a potential new adulticide. Thymoquinone testing needs to be repeated with higher concentrations to better evaluate its potential.

P-02 Effects of space spray application methods (thermal fogging and ultra-low volume) on fenitrothion efficacy and development of resistance in *Culex pipiens* (L.)
Ali S. Al-sarar, Asarar@ksu.edu.sa and Abdullwahab M. Alhafez

The space spray efficacy of fenitrothion applied by using thermal fogging (TF) and ULV against *Culex pipiens* mosquitoes was investigated. However, the development of *Cx. pipiens* resistance to fenitrothion under various types of application methods has yet to be reported. Four *Cx. pipiens* colonies were utilized. From each colony adults were

sprayed with Fenitrothion 50% EC at application rate (10 L ha-1) using TF (volume median diameter Dv0.5 = 25 µm) or ULV (volume median diameter Dv0.5 = 37.5 µm). Mortality was recorded 24 h post treatment. Surviving adults were transferred to clean cages and fed on blood to lay eggs. Next generation of third-fourth-instar larvae from each colony were used in larval bioassay to determine LC_{50} and acetylcholine esterase (AChE) activity, and the rest of the larvae were allowed to complete their life cycle. ULV treatments demonstrated adulticidal activity greater than that of TF treatments. Larvae from all 6 successive generations (F0-F5) under ULV treatments were less susceptible to fenitrothion and developed resistance faster than larvae from TF treatments. AChE activity results were corresponding to LC_{50} values. Using different equipment in insecticide application may affect not only the biological efficacy but also rapidity of resistance development in mosquitoes.

P-03 Nozzle evaluations to suit wind tunnel for efficacy bio-assays of vector control pesticides
Muhammad Farooq, muhammad.farooq@med.navy.mil, Todd Walker and James C. Dunford

Investigations on the efficacy of pesticides used for vector control are in continuous demand. Wind tunnels provide a repeatable and controlled environment for studying the efficacy of pesticides using minute quantities. The pesticide testing wind tunnel utilized was designed and developed in 1976. The spray is atomized in the upwind portion of the tunnel and is transferred by horizontal air movement to the caged insects in the downwind portion of the tunnel. Cage bioassays are carried out in this wind tunnel at horizontal air speeds up to 4 mph and air pressures up to 15 psi. Droplet size characteristics for vector control products have become the prime factor in evaluating application effectiveness. This study was conducted to determine the most suitable nozzle for ULV wind tunnel spray tests. The droplet size analysis for the original nozzle and the nozzle from terminator sprayer was performed with Phase Doppler Particle Analyzer (PDPA) using water + NIS and BVA13 by controlling air pressures in to the nozzle. The tested pressures included 40, 60, 80, and 100 psi. The droplets were measured at 3 and 24 in from the nozzle exit. Each measurement was replicated 3 times. The results indicated that the original nozzle did not meet the droplet size requirements for the ULV sprays for mosquito control. The terminator nozzle was determined to be useful for this tunnel at air pressures between 60 - 100 psi.

P-04 Characterization of vector control spraying equipment
Wesley Hoffmann, clint.hoffmann@ars.usda.gov, Bradley K. Fritz, Todd Walker, Muhammad Farooq and George Schoeler

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 11 sprayers and 3 spray formulations were evaluated. The droplet size spectra were measured by a laser diffraction instrument, a hot wire system (AIMS probe), and rotating slides. Sixteen different sprayers were evaluated using both water- and oil-based solutions. 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-05 Flightmaster™: Using new aerial guidance technology to optimize adulticide performance in Beaufort, SC
Fran Krenick, fkrenick@clarke.com, M. Rosolina, B. Yoder, Greg Hunt, E. Hager, T. Davis and R. Wright

Vital technologies, including aerial GPS guidance systems such as Flightmaster™, have facilitated the accuracy, efficacy and safety of ULV aerial adulticiding applications around the world. Concepts such as "off-sets", "optimized spray clouds", "targeted sprays", "spray models" and "droplet characterization" are gaining acceptance in established aerial programs. This poster will address aspects of training that took place at Beaufort County Mosquito Control (BCMC), Beaufort, SC in 2009 associated with recently installed Flightmaster™ in their aircraft. Education and hands-on training were conducted by Dynamic Aviation Pilots. This pilot-to-pilot knowledge transfer was invaluable to the BCMC pilots and staff in aiding them to successfully integrate applications of AquaAnvil™ into their integrated mosquito management (IMM) program during the 2009 aerial adulticiding season.

P-06 Semi-field evaluations of a commercially-available metofluthrin-impregnated product on host-seeking mosquitoes in Thailand
Jason H. Richardson, jason.h.richardson@us.army.mil, Brian Evans, Prasan Kankaew, Somwang Kurusarttra and Alongkot Ponlawat

To reduce the burden of mosquito-borne disease, vector management programs must incorporate some means of minimizing contact between the host and vector. Our laboratory is currently evaluating the long-term spatial repellency of a metofluthrin- impregnated, polyethylene mesh (SumiOne®) against *Anopheles dirus* and *Aedes aegypti* using a semi-field, tunnel assay system. Metofluthrin is unique from most other pyrethroids in that it vaporizes at ambient temperature without requiring a heat source. A long-lasting, effective spatial repellent can be an expedient, sustainable, and low-risk approach to protecting vulnerable populations, including refugees and deployed soldiers, from vector-borne diseases. Ongoing evaluations and the utility of a semi-field, tunnel assay in determining the efficacy of candidate spatial repellents will be discussed.

P-07 Comparison of results from insecticide resistance tests in field assays and the CDC bottle bioassay
Mariah Scott, gni6@cdc.gov, Mark Delorey, Nathan Vessey, Pam Stark, Kyle Flatt, Rudy Bueno and Janet McAllister

Various dose-response based laboratory test methods have been used to detect insecticide resistance. To date, their results have not correlated with results from field tests evaluating the efficacy of operation control. The CDC bottle bioassay measures resistance using a different parameter, the time it takes for an insecticide to work. This test has been shown to correlate with biochemical assays designed to measure various enzyme-based resistance mechanisms. Over a 4-yr period, a series of field trials were performed on caged *Culex quinquefasciatus* Say using resmethrin, malathion, and permethrin sprayed with truck-mounted ULV equipment. Laboratory tests using the CDC bottle bioassay on mosquitoes from the same collections as those used in the field trials were also conducted. A weak correlation between the 2 tests was shown; however, there was a lot of variation in the field test results when laboratory results indicated either very low (<10%) or very high (>80%) levels of resistance. The estimate of resistance was higher in the laboratory tests than the field tests in all cases except in 2005 when very low levels (<10%) of resistance were detected in laboratory assays while up to 60% survival was observed in field tests. Environmental factors and different application rates are playing a role in the field data variation.

Biology/Behavior

P-08 Testing the Resource Ratio Hypothesis in competition between *Aedes albopictus* and *Culex pipiens*
Katie S. Costanzo, kscosta@gmail.com and Barry Alto

Aedes albopictus is a successful invasive mosquito species that has been recently introduced in the United States. Its introduction has been associated with declines in the abundance of other North American mosquitoes and competitive displacement has been proposed to explain these patterns. Here we test the Resource Ratio Hypothesis in the competitive interactions of *Ae. albopictus* and *Culex pipiens* and aim to determine if various relative ratios of 2 resources may alter or alleviate larval competition. The experiment was executed in 250-ml cups with 3 species treatments of larval densities (*Ae. albopictus*: *Cx. pipiens*) 40:0, 20:20, 0:40 crossed with 5 resource treatments consisting of different relative mixtures of American elm leaves (*Ulmus americana*): foxtail grass (*Setaria faberi*) of 100% elm, 75% elm, 50% elm, 25% elm, and 0% elm. Larvae were reared under these conditions and emerged adult males were sacrificed, while female adults were housed in paper cages with access to water until death. We quantified survivorship, development time, adult longevity and size. This study will provide further insight into what mechanisms promote or impede an invader's success, while additionally determining if conditions experienced during the larval stages continue to the adult stage.

P-09 2010 update: Temporal variation in mosquito community composition in a southwest Louisiana marsh
Linda D. Canning, Benjamin M. Clark, Caroline C. Hennigan, Josiah D. Land, Harry A. Meyer, Mukesh Wagle, Terry L. Sylvester, Joseph H. Dees and William H. Dees

An on-going nocturnal periodicity study of mosquito community composition continues in the Sabine National Wildlife Refuge in southwestern Louisiana. Mosquitoes are collected during new moon phases before, during, and after sunset and sunrise, and at other intervals throughout the night using a modified Centers for Disease Control mosquito light trap with a rotating collector placed 1.5 m above ground. This trap is placed in an area with little to no competing light and where no pesticide applications are conducted. Studies were initiated in July 2006. Seventeen species have been collected. To date, *Aedes sollicitans*, *Anopheles crucians*, *Anopheles quadrimaculatus,* and *Culex salinarius* have been the most commonly collected species. Data from this study will broaden our understanding of mosquito population dynamics and mosquito-borne disease pathogen transmission in southwest Louisiana. Studies such as this are excellent for undergraduate research projects.

P-10 Oviposition preference of *Aedes aegypti*, *Aedes albopictus,* and *Culex quinquefasciatus* to five infusions
William H. Dees, wdees@mcneese.edu, Erin Vrzal, Julie McClurg and Sandra A. Allan

Laboratory studies were conducted to determine oviposition preferences of *Aedes aegypti*, *Aedes albopictus,* and *Culex quinquefasciatus* to 5 test infusions: (1) hay (H), (2) fresh grass (G), (3) hay + lactalbumin + yeast (HLY), (4) lactalbumin + yeast (LY), and (5) lactalbumin + yeast + soil (LYS). Gravid *Ae. aegypti* mosquitoes significantly preferred H and HLY infusions over the other 3 substrates ($p<0.05$). Preference ranking from most preferred to least was: HLY, H, LY, G and LYS. Tests with *Ae. albopictus* mosquitoes indicated no significant difference between the number of eggs in oviposition cups with H and G infusions ($p>0.05$). Significantly more eggs were deposited in cups with H alone than in cups containing HLY ($p<0.05$). Significantly more eggs also were deposited in cups with G rather than in cups containing LY ($p<0.05$). Preference ranking from most preferred to least was: H, G, LYS, HLY, and LY. Gravid *Culex* mosquitoes preferred oviposition cups containing HLY over the other 4 substrates. Infusions containing HLY were preferred significantly to those with H alone ($p<0.05$). Infusions containing G were preferred the least. Preference ranking from most preferred to least was: HLY, LYS, H, LY, and G. *Aedes albopictus* preferred the fresh grass infusion more than *Ae. aegypti* and *Cx. quinquefasciatus*, whereas *Ae. aegypti* and *Cx. quinquefasciatus* preferred the hay + lactalbumin + yeast infusion more than *Ae. albopictus*.

P-11 Vertical oviposition preferences in the Asian tiger mosquito *Aedes albopictus* (Skuse)
Eric Williges, williges@eden.rutgers.edu, Ary Farajollahi and Randy Gaugler

After first being detected in New Jersey in 1995, the Asian tiger mosquito, *Aedes albopictus* (Skuse), has spread rapidly across the state and is now found in all but the furthest northwest corner of New Jersey. We focus on examining the

vertical distribution of *Ae. albopictus* oviposition through field experiments conducted over the summer of 2008 and 2009 in Trenton, NJ.

Disease/Vector Studies

P-12 The establishment of West Nile virus in Washington State
Jo Marie Brauner, jo.brauner@comcast.net, Caitlin Reed, Anne Duffy and Elizabeth Dykstra

West Nile virus (WNV) was first detected in Washington in 2002 in 2 horses and 4 birds. The virus was not detected again until 2005, when low numbers of environmental positives were detected. Since then, WNV has slowly, but steadily become more established in central Washington. In 2009, Washington experienced its most active year to date. This poster examines the population dynamics of WNV vector mosquitoes and the establishment of the virus in central Washington State. It compares mosquito population distribution patterns and GPS locations of WNV detections with climatic patterns involving accumulated degree-days, precipitation, and local water-use.

P-13 Potential for mechanical and biological transmission of West Nile virus by stable flies (*Stomoxys calcitrans*)
Michael S. Doyle, mdoyle@cdc.gov, Bethany N. Swope, Jerry A. Hogsette, Harry M. Savage and Roger S. Nasci

In 2006-2007, stable flies (*Stomoxys calcitrans*) were suspected of playing an enzootic role during a significant die-off of white pelicans (*Pelecanus erythrorhynchos*) at the Medicine Lake Wildlife Refuge in northeastern Montana. Hundreds of flies observed feeding on WNV-positive moribund pelicans aroused suspicions that they could be involved in mechanical and/or biological transmission of WNV among pelicans, livestock, and potentially humans in the surrounding area. Biological transmission was assessed by infecting 166 flies intrathoracically with WNV, and harvesting flies at 2-d intervals over a 20-d period. Infectious WNV was detected in fly bodies only during the first 6 d post-infection, indicating that WNV does not replicate within fly tissues. WNV does not appear to be biologically transmissible in stable flies. Mechanical transmission was assessed by allowing 136 individual flies to feed on Q-tip®-like cotton swabs saturated with WNV-infected blood (i.e., artificial donors), then after intervals of 1 min to 24 h, allowing flies to feed again on swabs saturated with WNV-negative blood (i.e., artificial recipients). Preliminary results indicate that viable WNV virions were mechanically transmitted on stable fly bodies, mouthparts, and/or legs for up to 1 h. WNV RNA was detected on artificial recipients for up to 6 h, suggesting that under some conditions WNV may be mechanically transmissible for longer than 1 h.

P-14 A rapid identification guide to larvae of the most common North American container *Aedes* species (Diptera: Culicidae)
Ary Farajollahi, farajoll@rci.rutgers.edu and D. Price

The lack of readily accessible and current information on the identification, distribution, and biology of container-ovipositing *Aedes* mosquitoes impairs scientific approaches to the monitoring and control of disease vectors of public health importance. This is particularly true for invasive species that are rapidly expanding their geographical ranges and are not familiar to most mosquito/vector control personnel. Many of these mosquito species are diagnosed by fine morphological characters which cannot be visualized without high-magnification light microscopy. We present here a dichotomous key, complete with high-resolution full color photography, for the identification of the most common North American container mosquitoes within the genus *Aedes*.

P-15 Rapid detection of flaviviruses in arbovirus vectoring mosquitoes using quartz crystal microbalance (QCM)
Anna Gibson, anna.gibson@tiehh.ttu.edu and Steve M. Presley

Arboviruses of the genus flavivirus are positive-sense, single-strand RNA viruses, which result in significant human morbidity and mortality. A rapid, selective, and sensitive method of detecting virus infected vectors will enhance epidemiological surveillance efforts and methods to control outbreaks of disease. The quartz crystal microbalance (QCM), as a primary element of a biosensor system, utilizes capture-probe immobilization and sequence-specific nucleic acid hybridization to provide an ideal platform for rapid detection of viral RNA in infected mosquitoes.

P-16 West Nile virus activity in San Joaquin County, CA: A six-year summary 2004-2009
Shaoming Huang, shuang@sjmosquito.org, John Stroh and Eddie Lucchesi

West Nile virus (WNV) was first detected in San Joaquin County in 2004 with 3 human cases, followed by intensive amplification with 36 human and 19 horse cases in 2005. WNV activity subsided thereafter to its maintenance levels. This pattern agrees with what has been seen nationally. From May 2004 to November 2009, a total of 9404 mosquito pools of *Culex pipiens, Culex tarsalis,* and 7 other mosquito species were tested by VecTest™, RAMP® and/or RT-PCR. There were 535 positive pools (5.69%) that were all from *Cx. tarsalis* (206) and *Cx. pipiens* (329). The frequent WNV detections from late June to September when the 2 mosquito species are most abundant and most of the human cases occurred, in conjunction with demonstrated vector competence and host preferences, make *Cx. tarsalis* and *Cx. pipiens* the most likely vectors of WNV in the county. Significant correlation of WNV activity and population density was not observed because a large portion of positive mosquito pools were collected from the Delta area, consisting of agricultural lands, ecological reserves, and recreational areas. Typically, first detection of WNV activity in birds, mosquitoes ,and humans was on average 53.3, 41.4 and 17.6 d earlier than in sentinel chickens, respectively. Dead birds may become less valuable to WNV surveillance. However, detection of WNV in mosquitoes is an early and sensitive indicator of virus activity in San Joaquin County.

Abstracts

P-17 Utilizing real-time PCR to detect *Borrelia burgdorferi* infection in *Ixodes pacificus*
Kimberly A. Heilig, Kristen Holt and Valkyrie P. Kimball

Our purpose was to develop a protocol using real-time polymerase chain reaction (RT-PCR) to test field-collected *Ixodes pacificus* ticks for *Borrelia burgdorferi*, the Lyme disease bacterium, by conducting a minimum infection rate (MIR) study. An acceptable protocol should yield a MIR comparable to those previously found in northern California. 1,806 adult *Ixodes pacificus* were collected at northern California state parks over the 2008-2009 winter season by the flannel-drag method. Ticks were sorted by sex and collection location, placed in pools of 5, and stored at -80° C until testing. DNA was extracted on the Applied Biosystems 6100 Nucleic Acid PrepStation, using the NucPrep® DNA Chemistry for Tissues protocol. A positive control of heat-killed *Borrelia burgdorferi* cells was used. RT-PCR was performed on the Applied Biosystems 7500 Real-Time PCR System, using TaqMan chemistry. Pools with Ct values of 40 or below were considered to be positive. Of 357 pools tested, 26 were positive for *Borrelia burgdorferi*. Assuming 1 positive tick per positive pool, and with a total of 1,806 individual ticks tested, the MIR found in this study was 1.44%. The RT-PCR protocol developed in this study is effective in testing *Ixodes pacificus* for infection with *Borrelia burgdorferi*. The MIR found in this study is comparable to infection rates found in previous studies conducted in northern California.

P-18 Ecological changes affecting the potential for tick-borne diseases in the Republic of Korea
Terry A. Klein, terry.klein@us.army.mil, Heung-Chul Kim and Joon-Seok Chae

Over the last century the Korean landscape has changed as a result of Japanese occupation, wars, and most recently, economic recovery. At the end of the Korean War (1953), the hills and mountains were nearly treeless. A tree-planting policy was instituted in the 1960s to reestablish long-ago lavish forested mountains and hills that made up >70% of the South Korean landscape. Today, these same barren mountains and hills, now covered with 10-50 year-old forests, provide protection for wild animals dependent upon forest habitats, increasing the potential for ticks and associated zoonotic pathogens. As a result of surveillance by the US Army in collaboration with Korean counterparts, 2 new records of ticks and identification of the presence of tick-borne encephalitis, *Rickettsia*, *Ehrlichia*, *Anaplasma*, and *Bartonella* spp. and *Borellia burgdorferi*. Recent evidence showed that approximately 2% of nearly 9,000 US soldiers while deployed to Korea during 1995 seroconverted to SFG *Rickettsia*. As tick-borne diseases are not reportable diseases, the impact on civilian and military populations is unknown. Ecological conditions at US military training sites consist largely of unmanaged forests and grasslands, with personnel working and sleeping in tents that abut forested areas where animals and their ectoparasites are present. Tick-borne disease surveillance by the 65th Medical Brigade provides baseline data for ticks and tick-borne diseases affecting soldiers in Korea.

P-19 Regional variation in West Nile virus transmission in Illinois
Nina Krasavin, krasavin@illinois.edu, Richard Lampman and Barry Alto

Pools of *Culex pipiens* and *Culex restuans* from Cook County, Macon County, and Champaign County were assayed for West Nile virus (WNV) RNA by TaqMan RT-PCR. The temporal pattern of WNV positive mosquitoes from the 3 areas is shown from 2002 to 2009. Incidence of WNV-RNA differed between the sites; however, after a rebound in transmission in 2005 and 2006 there was a decline in the annual magnitude of transmission throughout the state. In addition, we compared the detection of WNV in mosquito batches by the RAMP method to the cycle thresholds of RT-PCR TaqMan.

P-20 Evaluation of four sampling techniques to detect *Aedes albopictus* (Diptera: Culicidae) in different Florida habitats
Peter J. Obenauer, obenauerp001@yahoo.com, Philip Kaufman, Daniel Kline and Sandra Allan

To compare the reliability at detecting *Aedes albopictus* from suburban and sylvatic habitats a sampling study compared a BG-Sentinel trap baited with CO_2, a gravid trap with an oak-pine infusion, a human subject, and an aspirator. We collected 73,849 mosquitoes, representing 29 species in 11 genera over a 20-wk period. The BG-Sentinel trap accounted for over 85% of all *Ae. albopictus* captured and was significantly more effective at detecting the presence of *Ae. albopictus* compared to the other 3 techniques. Landing counts provided the fewest mosquito species (n = 10), yet provided a quick and effective weekly assessment of the major biting species and were the most effective method for sampling *Ae. albopictus* within a 10-min period. Fewer *Ae. albopictus* were sampled from sylvatic habitats compared to suburban ones. Sampling criteria advantageous for surveying *Ae. albopictus* and other mosquito species are discussed.

P-21 Vector competence of *Culex restuans* Theobald in Chicago, IL
Bethany N. Swope, gmq4@cdc.gov, Michael S. Doyle and John-Paul Mutebi

West Nile virus (WNV) activity is spatially clustered within the City of Chicago. We hypothesized that variability in vector competence among WNV vectors in Chicago was one of the probable causes for this phenomenon. We evaluated the vector competence of 2 *Culex restuans* Theobald populations: one population from a high WNV activity area, Edison Park, and the other from a low WNV activity area, Illinois Medical District. Competence was assessed by feeding 10 mosquito families from each of the 2 populations WNV-infected blood via an artificial Hemotek® feeder. Wild-caught *Cx. restuans* were less receptive to the bloodmeal than a colonized *Culex quinquefasciatus* Say control group. Among bloodfed *Cx. restuans* specimens, high body infection rates (100.0% for Edison Park and 99.3% for Illinois Medical District) and high leg dissemination rates (90.71% for Edison Park and 94.04% for Illinois Medical District) were observed. The percentage of mosquitoes with positive expectorate differed slightly between the 2 populations (48.13% for EP and 36.91% for IMD), but this difference was not significantly different, suggesting that overall, vector competence for these two populations is not a factor determining the spatial distribution of WNV in Chicago.

Abstracts

Education

P-22 A West Nile virus summer internship program: Educating youth on how to fight the bite
Kristina Clarke, Kristina.Clarke@msdh.state.ms.us, Sharon Sims, Wendy Varnado and Mary Currier

Background: During the summer of 2009, the Mississippi State Department of Health (MDSH) established an internship program that was used to educate Mississippi youth on the dangers and prevention of West Nile virus (WNV) and other mosquito-borne diseases. Methods: 9 interns were utilized to educate youth across the state. The education consisted of a PowerPoint presentation and scavenger hunt which was targeted at school-aged children. Education was presented at a variety of community locations such as libraries and boys and girls clubs. A pre/post-test knowledge questionnaire was used to determine if the program was successful at teaching youth about mosquitoes and WNV prevention using a convenience sample of the children reached. Results: The internship program reached 13,054 children, 2% of Mississippi's school-based child population. 65 (79%) out of the 82 counties in Mississippi received education. 894 pre/post-test questionnaires were collected. The education program was successful in teaching children about mosquitoes and WNV prevention ($p<0.001$). Conclusion: Although the education program only reached a small percentage of the target population, the program was effective at teaching kids about mosquitoes and WNV prevention. To reach a larger percentage of the target population, future programs will possibly be offered in the spring when schools are in session.

P-23 Undergraduate research in medical entomology, McNeese State University, Lake Charles, LA
William H. Dees, wdees@mcneese.edu and Linda D. Canning

This presentation discusses research projects in medical entomology involving undergraduate students in the Department of Biology and Health Sciences at McNeese State University, Lake Charles, LA. The field of medical entomology provides students the opportunity to work on important organisms from both an ecological and public health perspective. Studies using mosquitoes help students understand basic biological and ecological concepts, while at the same time broadening students' understanding of pathogen transmission and disease ecology. This presentation provides examples of several inexpensive laboratory and field techniques/experiments used by students engaged in undergraduate research in medical entomology.

P-24 From typewriters to Twitter: The evolution of public health education in San Diego County
Arleen Lim, arleen.lim@sdcounty.ca.gov, Kristen Meckel-Parker, Jill Dumbauld, Pamela Gilb, Steven Durham, Kerry McNeill and Michael Dorsey

Mosquito control has been a public service in San Diego County since the 1930s. Initially, the program was geared toward eliminating mosquito populations. Over time, the San Diego Vector Control Program (SDCVCP) has evolved into a much more encompassing program to include public education alongside mosquito population control and vector-borne disease surveillance. It is a critical component of SDCVCP to provide San Diego County residents with empowering tools for active involvement in prevention, protection, and reporting. The current target audiences for public outreach incorporate at-risk and under-serviced populations such as children, seniors, immuno-compromised individuals, horse owners, non-English speakers, and rural community residents. Several methods of media are utilized, including newsletters, newspapers, health and wellness fairs, presentations, educational materials, websites, and public service announcements via radio, television, and the internet. In the past 5 years, social networking has become an integral part of our culture. Millions of users log in to sites like Facebook and Twitter to connect with friends, join causes and groups, post links and get real-time current events. Additional social media tools include blogs, email and mobile updates, podcasts, RSS feeds and widgets. With the goal of reaching out to under-served target populations, especially teens, it is the intention to focus SDCVCP future directives to incorporate social networking.

P-25 West Nile virus support group Mississippi
Sharon Sims, Sharon.Sims@msdh.state.ms.us and Mary Currier

Background: In 2002 the Mississippi State Department of Health (MSDH) identified the need for a West Nile virus (WNV) support group in response to phone calls taken on the WNV hotline. Recently diagnosed patients and family members were looking for somewhere to obtain more information regarding WNV and its complications. Methods: A letter and a questionnaire were mailed to all 2002 WNV patients. Respondents were asked to send the questionnaire back in the provided self addressed, stamped envelope. Results: There were 193 letters mailed; 50 (26%) were returned, of those: 6 (12%) were marked "Not Interested" and 44 (88%) were marked "Interested". A second letter informing interested respondents of the meeting location (Jackson, MS) was then sent. Of the 44 interested respondents, 32 attended the initial meeting. Conclusion: Meeting attendance has continued to be successful and an additional meeting was offered in the Hattiesburg area in 2007. Meetings are alternated on a monthly basis between the 2 locations. Speakers from the medical community present information on how to deal with WNV related symptoms. From these meetings, MSDH identified support group members to be involved with its "I'm One" campaign, featuring them on brochures that are taken to local health events and conferences promoting WNV awareness.

Equipment

P-26 A simple, low-cost mosquito rearing chamber
William H. Dees, wdees@mcneese.edu and Aaron Figueroa

A low-cost mosquito rearing chamber for laboratory and field investigations is described. The rearing chamber is made from recycled plastics from common household products. The cost for the rearing chamber is negligible. A demonstration of this device will be presented.

P-27 Determination of collection efficiency of active and passive airborne samplers
Muhammad Farooq, muhammad.farooq@med.navy.mil, Bradley K. Fritz, Wesley Hoffmann and Todd Walker

The effectiveness of ULV sprays for vector control depends upon dispersion and mixing of spray in to the air column. To assess spray dispersion, the measurement of spray material passing through a space (spray flux) is required. New samplers for the measurement of flux and droplet size characteristics are being employed. However, the collection efficiency of these samplers is not known. This study was designed to analyze spray collection characteristics and to determine collection efficiency of various active and passive samplers. The collection efficiency of 5 samplers was determined by measuring the deposition on a test sampler and standard sampler at the same time under controlled conditions in the low speed wind tunnel. Three wind speeds and 2 sprays having different droplet size characteristics were employed in this study and each test was replicated 3 times. Two similar standard samples were placed on either side of the test sampler in the wind tunnel. Droplet size measurements were made with Sympatec Hellos laser just prior to the standard samplers. These measurements were used to calculate the collection efficiency (CE) of these samplers. The deposition on standard samplers and their CE was used to reverse calculate the spray flux through the wind tunnel cross section. This calculated flux and measured deposition on the test samplers was used to determine collection efficiency of the test samplers.

GIS/GPS

P-28 Using GIS and spatial analysis for West Nile virus surveillance and management in New York City
Waheed Bajwa, wbajwa@health.nyc.gov, Marcia O'Connor, Liyang Zhou and Zahir Shah

With the discovery of West Nile virus (WNV) in 1999, the need for geographic information system (GIS) and spatial analysis became necessary for its systematic surveillance and site-specific management in New York City. For the precision integrated vector management, GIS was incorporated for geocoding of standing water and dead bird reports from the public; locating larval and adult mosquito surveillance sites; guiding aerial larviciding and adulticiding treatment; buffering wetlands; presenting maps for press releases and treatment zones; and acquiring global position system (GPS) data for mosquito control operation. Spatial analysis has since been used to study the temporal and spatial population dynamic of mosquito species, the correlation among habitats (natural/green areas, cemeteries and marshes), and the effectiveness of spray operations and its relation to human cases. In this poster, spatial analysis (universal kriging) was used to show the temporal and spatial population dynamic of *Aedes albopictus*. The population of this species has increased significantly in the past several years with the highest population densities (seasonal average of approximately 20 adults/trap-night on light traps) found in the southern part of the city. With the use of GIS maps and spatial analysis data, we were able to manage and analyze the data collected for better decision making and control tactics.

P-29 New oviposition habitat for an exotic species: *Ochlerotatus japonicus* breeding in storm drains near bluffs
Eric J. Dotseth, dotseth1@yahoo.com and Dave Geske

In an effort to manage the invasive Asian rock pool mosquito, *Ochlerotatus japonicus japonicus* (Theobald), in La Crosse, WI, new potential oviposition sites, such as storm drains, were examined. Seven of the 85 storm drains held *O. j. japonicus* larvae. All storm drain sites were below woodland bluffs. However, not all subterranean catch basins close to these bluffs held *O. j. japonicus* larvae. There was a significant, positive relationship between *O. j. japonicus* larval activity and proximity to these bluffs ($X^2 = 19.15394$, df=1, $p<0.001$). Adult mosquito habitat, water drainage ability, and storm drain design are discussed.

Larval Control

P-30 Larvicidal activity of neolignan from a Brazilian plant against *Aedes aegypti*
Marise M. Cabral, mmaleck@oi.com.br, Juliana O. Narciso, José Maria Barbosa-Filho, Anthony E. Gumarães and Marise M. Cabral

Dengue is a disease caused by an arborivus transmitted by *Aedes aegypti* (Culicidae). Since no effective vaccine is available, the strategy for disease prevention has been addressed by vector control using natural insectides from plants. The aim of this study was to evaluate the larvicidal activity of neolignan burchellin isolated from *Ocotea cymbarum* (Lauraceae).The botanical material was collected in Belem, identified at Hamburg University/DE, and the neolignan was purified as previously described (Barbosa-Filho et al. 1989). *Aedes aegypti* eggs were obtained from the "Lab. Transmissores de Hematozoários"/IOC and have been maintained in the "Lab. Diptera"/IOC. The burchellin solution was applied on Petri dish with dechlorinated water (5mL) at final concentrations of 0.001 - 30 µg/mL. The L3 larvae (n=10) of *Ae. aegypti* in triplicate, with 3 repetitions, were evaluated for burchellin effect and the controls groups included untreated solution. The mosquitoes were maintained at 27°C and 70% RH and the toxicity and development of *Ae. aegypti* were evaluated during 15 days. *Aedes aegypti* treated with burchellin solutions showed viabilility of 87% (0.5 µg/mL) and only 30% (0.5 µg/mL) of emergence have been observed. The burchellin treatment showed 100% larvae toxicity at 30 µg/mL and a LC_{50} of 0.4 µg/mL. The activity of the neolignans from *Ocotea* species suggests their potential in developing new useful types of mosquito's control.

P-31 Assessment of methoprene in marine waters after catch basin treatment with Altosid® XR briquets
D. Alan Warren, Aaron Peck and Gregg J. Hunt

In 2007, Beaufort Co. Mosquito Control (BCMC) in South Carolina initiated a pro-active plan to control *Culex quinquefasciatus* by treating up to 19,000 stormwater catch basins using Altosid® XR briquets. In response, the public became concerned that methoprene, the active ingredient, would flow into marine receiving waters and adversely impact shrimp, oysters, crabs, and other non-target organisms. BCMC assessed the concentration of methoprene in marine waters following catch basin treatment to determine if this strategy would have unintended consequences. Briquets were applied to 230 catch basins in a ~200-acre urban area to represent a worse-case scenario. Pre- and post-treatment water samples were collected during 5 mo at 13 sites near stormwater outfalls and tested for methoprene using gas chromatography. Methoprene was found in only 4 of 65 post-treatment samples at a maximum concentration of 285 ppt. The scientific literature indicated shrimp was among the most sensitive species to methoprene with the lowest adverse level at 2,000 ppt for sublethal effects on growth and reproduction. Therefore, the catch basin treatment with Altosid® XR briquets did not result in methoprene concentrations sufficient to adversely impact non-target species. Also, the accumulation of methoprene over time to toxic concentrations is unlikely as it degrades rapidly in the environment. The public health benefits of catch basin treatment seemingly outweigh any risk to non-target marine species.

P-32 Determining the susceptibility of *Culiseta melanura* to a biorational mixture of *Bacillus sphaericus* (Serotype H5a5b Strain 2362) and *Bacillus thuringiensis* var. *israelensis* (Strain AM65-52) in a laboratory bioassay
Priscilla Matton, brismosqpc@comcast.net and Wayne Andrews

Culiseta melanura field-collected 3rd and 4th instar larvae were screened using a biorational mixture of *Bacillus sphaericus* (Serotype H5a5b Strain 2362) and *Bacillus thuringiensis* var. *israelensis* (Strain AM65-52). Concentrations from 0.25 mg/L to 0.025 mg/L were used to determine *Cs. melanura's* susceptibility to these bacteria. Results were collected over an 8-d period.

P-33 Larvicidal and phytochemical studies of *Acillia fragrantissima* and *Nerium oleander* on vector competence of *Culex pipiens*
Belal A. Soliman, ba.soliman@yahoo.com and Shouk A. Rehan

Mosquito larvicidal effect of some plant extracts on *Culex pipiens* larvae in Egypt were evaluated. Eleven plant extracts showed toxicity with different grades. Petroleum ether extracts of both *Achillea (Ac.) fragrantissima* and *Nerium (N.) oleander* were the most toxic plant extracts with LC_{50} values 45.23 and 95.7 ppm respectively. Obtained results revealed that larvae were more susceptible to petroleum ether extract as a whole than their fractions. Phytochemical screening of *Ac. fragrantissima* and *N. oleander* using gas liquid chromatography was carried out to identify their hydrocarbons, sterols and/or triterpenes as well as fatty acid content. *Culex pipiens* larvae were susceptible to insecticide (cyphenothrin) and IGR (chlorfluazuron). The addition of small concentration (LC_{10}) of cyphenothrin to different concentration of *Ac. fragrantissima* increased its efficacy compared to the insecticide alone. Mosquito larvae were exposed to sublethal concentration (LC_{40}) of both *Ac. fragrantissima*, cyphenothrin and their mixture and *N. oleander*. *Achillea fragrantissima*, cyphenothrin and their mixture gave more effect than *N. oleander* on fecundity, egg hatching, pupation, and sex ratio. Treatment of *Cx. pipiens* larvae with LC_{40} of *Ac. fragrantissima*, cyphenothrin and their mixture affected vector competence to *Wuchereria bancrofti*.

New Product Trials

P-34 Efficacy of picaridin-containing insect repellent spray products against West Nile virus vector mosquitoes
Chris Bartlett, chris.bartlett@avon.com, Nick Spero, Vincent Polywoda, Andrew Pechko, Ramez Labib, Enrico Gilberti and Stephen Gettings

The function of insect repellents is to protect consumers from insect bites including mosquitoes that may transmit the West Nile virus (WNV). It is well documented that *Culex* sp. are known as primary vectors of WNV in the wild. The efficacy of 2 insect repellent spray products (EPA Reg. No. 806-29, and 806-31), each containing 10% picaridin, were evaluated in a laboratory cage study against *Culex quinquefasciatus*. The goal of the study was to identify the complete protection time (CPT) of each product. The repellents were applied to the forearms of 12 human subjects at a dose of 1.67 mg of product/cm^2. Each treated forearm was then exposed to laboratory-reared mosquitoes housed in a cage for 5 min every 30 min for 10 h. The data was analyzed with SPSS statistical software using the Kaplin-Meyer product-limit technique. Based on this laboratory cage study, the mean complete protection times for the pump and aerosol products were found to be 9.4 and 9.7 h respectively. The results of the study confirmed these products repel mosquitoes that may transmit WNV.

P-35 Mosquito spatial repellent efficacy assay (laboratory) of the 'Bug Bam! Insect Repelling Grid'
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Bug Bam! Insect Repellent Grids substantially and consistently reduced the rate at which captive, aggressive yellow fever mosquitoes (*Aedes aegypti*) landed on the otherwise unprotected arm of the test subject. Mosquito landing pressure in the testing environment was higher than that which consumers would be likely to encounter under typical conditions of use. The results obtained are excellent for an area repellent, in which reductions greater than 50% are regarded as substantial. Repellency approaching 90% is more typical of topical repellents, and near the Grid, repellency was that great for the product at 100 h after being removed from the packaging. Spatial effects were also pronounced, with strong repellency

being consistent within a 10-ft radius of the grid but dropping substantially beyond that distance within the test enclosure. In summary, Bug Bam! Insect Repelling Grids were effective in repelling mosquitoes at a rate of 70-90% within an area of 300 square ft for a duration of 100 h after opening. That performance is likely to substantially exceed that of area repellents such as citronella candles and is likely attributable to the higher concentration of active ingredient, which includes Geranium oil, in a time-released matrix.

P-36 A longitudinal comparison of long-lasting insecticidal nets

John Gimnig, hzg1@cdc.gov, George B. OIang, Francis Atieli, Stephen C. Smith, John Vulule and Nabie Bayoh

Long-lasting insecticidal nets (LLINs) are factory-treated nets designed to retain insecticidal activity and physical integrity for at least 3 years under field conditions. However, most products have only been evaluated in laboratory or experimental hut studies. We report the results from a comparison of 5 LLINs or candidate LLINs with a conventionally treated net after more than 2 years of use in western Kenya. Sixty nets of each type (5 LLINs and 1 conventionally treated net) were randomly distributed to households in Kisian village in western Kenya in July of 2007. Nets were evaluated at approximately 4-mo intervals and cone bioassays were performed on all nets. If the bioassay mortality on a net was <50%, the bioassay was repeated. If mortality was again <50%, the net was considered to have 'failed' and it was replaced with a new net. Through August 2009, 120/360 nets had 2 consecutive bioassays with mortality <50%. Over 80% (49/60) of the conventionally-treated nets had failed. Among the 5 LLIN products, less than 40% had failed through 2 years. Of the 5 LLIN products, the instantaneous risk of failure was >80% lower than that of a conventionally treated net, and all 5 LLIN products are effective longer than a conventionally treated net. We continue to monitor these nets at regular intervals and plan to follow any surviving nets for at least 4 years.

Operations

P-37 Evaluation and efficacy of ULV and thermal fog applications of *Bti* on container ovipositing mosquitoes

James C. Dunford, james.dunford@med.navy.mil, Craig A. Stoops, Peter J. Obenauer, Todd W. Walker, Muhammad Farooq and Adam C. Strong

Hand-held ULV and thermal fog sprayers were evaluated using 2 different formulations of *Bti*, VectoBac® 12 AS and VectoBac® WG. Cups and/or bowls were used to position *Aedes albopictus* (Skuse) larvae in field plots located in northeastern Florida with sparse, moderately dense, to dense vegetation. Droplet size, deposition, and mortality data are discussed for each evaluation with the goal of standardizing equipment testing of hand-held applications of suitable *Bti* formulations for military use.

P-38 Nature vs. nurture: A San Diego County perspective

Arleen Lim, arleen.lim@sdcounty.ca.gov, Christopher Conlan, Gregory Slawson, Brent Nelson, Kerry McNeill and Michael Dorsey

Over the past 10 years West Nile virus (WNV) has spread across the United States (US) and became endemic in most states in the country. During its progression, the original NY99 strain was supplanted in 2002 by a more virulent strain, WN02. The virus finally reached San Diego County (SDCo) and the rest of California in 2003. With the introduction of WNV into the US, national, state and local agencies integrated mosquito-borne disease surveillance and mosquito abatement programs. Many of the programs had already been in place, but efforts were greatly increased with the threat of WNV. In SDCo, the Vector Control Program includes: sentinel chickens, dead bird surveillance, mosquito pool surveillance, ground and aerial larvicide application, adult mosquito spraying, habitat remediation, mosquito fish distribution, and public education. The products of this extensive vector control program for SDCo were most notably observed in 2009. In the previous year, SDCo suffered from a regional WNV epidemic that affected all of southern California, while prevalence subsided in the rest of the country. However, in 2009, the incidence of WNV in SDCo also dropped precipitously. The question then arose: Was the drastic decrease a result of the natural evolution of the virus (nature) or a result of the massive defense efforts put forth by SDCo Vector Control (nurture)? The answer is not clear-cut and is most likely nature and nurture working together.

P-39 Comparative species and numbers captured by B&G Sentinel, NZI, Mosquito Magnet X and Stinger MK-100 mosquito traps configurations

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Six traps configured with and without various attractants (CO_2, Nosquito, Octenol and BG Lure) were evaluated in a latin-square study to compare species and numbers caught. The BG Sentinel with CO_2 and BG Lure, and the MMX with CO_2 and octenol caught significantly more mosquitoes on average (4.0 and 5.5X, respectively) than the other trap configurations. There was no significant difference in numbers captured between these 2 traps. The BG Sentinel with BG Lure and no CO_2 managed to collect significantly more mosquitoes than the 3 remaining trap configurations. There was no significant difference between the NZI with CO_2 and octenol and the Stinger MK-100 with Nosquito Lure. The NZI with octenol and no CO_2 caught significantly fewer mosquitoes than any of the other traps.

Latin American Poster Submissions

P-40 Evaluation of the susceptibility status to public health used insecticides of *Anopheles darlingi* in Puerto Carreño, Colombia

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In the department of Vichada in Colombia, which is in the border with the state of Amazonas in Venezuela, malaria is the vector-borne disease with highest incidence. One of the municipalities with more cases is Puerto Carreno, a semi-urban settlement where malaria and dengue transmission take place. Insecticides malathion, fenitrothion and lambdacyhalothrine have been used in this area since 2003, and no previous test on the susceptibility status of the malaria vector *Anopheles darlingi* had been done. CDC bottle assay was used to determine the susceptibility status to malathion, fenitrothion, deltamethrin, propoxur, and lambdacyalothrine. The diagnostic doses used were those determined for *An. darlingi* susceptibility surveillance in Colombia: malathion 50µg/bottle 30min; fenitrothion 50µg/bottle 45min; deltamethrin 12.5µg/bottle 30min, propoxur 20µg/bottle 15min, and lambdacyhalothrine 12.5µg/bottle 30min. *Anopheles darlingi* in this region showed susceptibility to all insecticides tested. However, given the constant use of insecticides for the Colombian and Venezuela health authorities in this region, is necessary to continue the surveillance.

P-41 Resistance profile to pyrethroids in *Aedes aegypti* from east coast of Mexico

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Pyrethroid resistance of 7 field strains of *Aedes aegypti* (L.) adult females from Veracruz, Mexico, to d-phenothrin, permethrin, deltamethrin, lambda-cyalothrin, bifenthrin, cypermethrin, alpha-cypermethrin and z-cypermethrin was investigated and compared with a susceptible strain (New Orleans) by using the bottle bioassay. Knockdown resistance after 1 h exposure (RRKD-50) and resistance after 24 h (RRLD-50) of recovery were calculated. Cluster analysis of the KD50s for each of the 8 compounds indicated that the knockdown resistance profiles were very similar between d-phenotrin and alpha-cypermethrin, permethrin and cypermethrin, and deltamethrin and lambda cyalothrin and z-cypermethrin. Resistance profile for bifenthrin was not correlated with any of the other 7 compounds. Regression analysis of RRLD-50 and RRKD-50 indicated that more than 8 times the amount of lambda-cyalothrin is required to cause lethality vs knockdown, 2.68 more for z-cypermethrin, 2.63X for deltamethrin, 2.40X for alpha-cypermethrin, 1.91X for permethrin, 1.89X for cypermethrin, 1.66X for biphentrin, and 0.875 X for d-phenothrin.

P-42 Altosid XRG against *Aedes aegypti* (L.) in laboratory and outdoor conditions

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Effectiveness and residual effect tests of a granular formulation of an insect growth regulator against laboratory-reared larvae of colonized mosquitoes, *Aedes aegypti*, were conducted in laboratory and outdoors. For the laboratory phase we used 12 stainless steel containers with a capacity of 5.8 L, for 6 tests and 6 controls (prepared with water). For the field phase we used 9 plastic bins with a capacity of 100 L, 3 of which were used for the product, 3 for controls (water only) and 3 experimental controls with temephos (commercial product formulation granules). The XRG test dose was 1.5 grams product in 100L of water. Three days after container treatment, 3rd instar larvae were added. We used 25 larvae per replicate both in treatment and controls. The larvae were fed balanced fish food (Aqua Crece®) every 2 d during the bioassays. Mortality was recorded daily and pupae were removed to observe the emergence of adults. We recorded temperature and pH of the containers daily. Altosid XRG showed satisfactory efficiency in the laboratory up to 33 d and diminishing effectiveness after 44 d. The high level of eutrophication in the test trays can be a condition limiting the effectiveness of the product. For field tests the product showed satisfactory efficiency after 50 d.

P-43 Detection of the mutation Kdr through PCR analysis in *Culex quinquefasciatus* (Say) from northeastern 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 it 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 the northeast. In this study we found out the Kdr mutation (leucine to phenylalanine at position 1,014) was present in some samples, using polymerase chain reaction (PCR), a molecular tool based on test genomic DNA of each mosquito sample. Nowadays, the major emphasis in resistance research is in the early detection of the molecular mechanisms of resistance for rational resistance management, with a view to controlling the development and spread of resistant vector populations through better design of insecticide use.

P-44 West Nile virus surveillance in horses and mosquitoes in Nuevo Leon, Mexico

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West Nile encephalitis was initially isolated in the New World from mosquitoes and birds in the New York City in 1999. West Nile virus (WNV) is an arbovirus from the Flaviviridae family which can cause inapparent infection or febrile disease, encephalitis and death in birds, humans, and horses. Birds are main reservoirs and mosquitoes especially *Culex* species are the main vector. Nuevo Leon state is located in the northeast of Mexico and is an area where many United States of North America migratory birds arrive carrying diseases like the WNV to affect horses. We collected 203 horse

serum samples during 2006-2007 and 7,365 mosquitoes representing 15 species in 2007. Seroprevalences for WNV in horses sampled in 2006 and 2007 were 26% and 45%, respectively. *Culex* mosquitoes were screened for WNV RT-PCR and other genera (*Mansonia, Anopheles, Aedes, Psorophora,* and *Uranotaenia*) were screened for flaviviruses by RT-PCR. Two pools consisting of *Culex* spp. mosquitoes contained WNV RNA. Molecular species identification revealed that neither pool included *Cx. quinquefasciatus* complex mosquitoes. No evidence of flaviviruses was found in the other mosquito genera examined. These data provide evidence that WNV is currently circulating in northern Mexico and that non-*Cx. quinquefasciatus* spp. mosquitoes may be participating in the WNV transmission cycle in this region.

P-45 Use of *Metarhizium anisopliae* for control of *Aedes aegypti* adults

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In this work we studied the effect of application of conidia produced by the IB-Ma-2 *Metarhizium anisopliae* strain obtained in solid medium against *Aedes aegypti* mosquitoes. Groups of 25 newly hatched mosquitoes were placed in individual cages and fed with cotton embedded in a 5% honey solution prepared with distilled water, and then were sprayed with a conidial suspension containing 3.94 x 10^6 conidia/cm^2, determined through viable plate count. Four replicates and an untreated control (sprayed only with distilled water) were maintained during 9 d at 28 ± 3°C. The first bioassay showed 30% and 70% mortality at 1 and 4 d posttreatment respectively, whereas at 9 d posttreatment the accumulated mortality was 75%. The second bioassay showed 80% and 97% mortality at 3 and 9 d posttreatment respectively, whereas the mortality of untreated control was less. The majority of mosquitoes treated showed fungal growth on the surface of their bodies after variable time posttreatment.

P-46 Propagation of *Metarhizium anisopliae* and *Beauveria bassiana* in liquid media for control of *Aedes aegypti* larvae

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The fungal entomopathogens *Metarhizium anisopliae* and *Beauveria bassiana* have been seldom studied as biocontrol agents of mosquitoes; thus, most of the studies have been performed with conidia produced in solid media. In previous work, we selected one strain of *M. anisopliae* (IB-Ma-2) and other *B. bassiana* strain (IB-Bb-2) which resulted in higher mortalities for *Ae. aegypti* larvae, so, in this work we propagated both strains in 3 liquid media using inexpensive ingredients, and compared with a standard medium (casaminoacids, soybean fluor, and ground sunflower seed) under agitation at 25 ± 1° C and 300 rpm, in order to obtain high concentration of blastospores. The experiments were repeated 3 times. The IB-Ma-2 strain showed average of 6.36, 2.58 and 4.6 X 10^6 blastospores/ml in the media composed by casaminoacids, soybean fluor and sunflower seed, respectively after 72 h fermentation, whereas the IB-Bb-2 showed average of 9.3, 3.5 and 0.052 X 10^8 blastospores/ml for the media composed by casaminoacis, soybean flour and sunflower seed respectively, without significant differences between the media used.

P-47 Molecular identification of phytotelmata mosquito associated species using DNA Barcoding

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Although the identification of mosquitoes is a priority because of its importance in public health, it is not an easy task because of the available tools and morphological characters, the use of DNA, a modern and necessary alternative to make such identification complete. This is especially true in the case of complex or cryptic species, which are frequently found among mosquitoes. In this study we explored the utility of the COI fragment to differentiate mosquitoes species previously collected in phytotelmata dwelling-places such as *Guadua* and *Bromelia*. Analyzing the included specimens in terms of genetic distances, we determined the utility of the COI fragment proposed as a genetic code to separate species. The values of the genetic distances oscillated between 0.16 and 0.21 for genus, between 0.013 and 0.044 for species and between 0 and 0.008 among the same species. This is a pilot study about the use of the sequence proposed as barcode for mosquitoes, which provides helpful elements for the use of this marker in the taxonomy and systematics of mosquitoes in Colombia, in the present and the future.

P-48 Evaluation of *Bacillus thuringiensis* variety *israelensis* (Bactivec®) on *Culex* spp. and strains of *Aedes aegypti* of Mexico in laboratory conditions

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Bacillus thuringiensis variety *israelensis* (*Bti*) has been used since 1980s in programs for controlling mosquitos. Bactivec® is a commercial formulation based on *Bti* (600 ITU/mg) developed by LABIOFAM group. The dam Manuel Ávila Camacho "Valsequillo" located between 18°52'48.5" - 18°57'9" N and 98°06'29.8" - 98°15'26" W is a permanent mosquito-breeding area with abundant larval and adult mosquito populations. Toxicity studies were conducted for early 4^{th} instar (L4) of *Culex stigmatosoma*, *Culex salinarius,* and 3 strains of *Aedes aegypti* (Puebla, Oaxaca and Rockefeller) in 250ml containers. Each one was treated with 2.5µl of *Bti* and 5 larvae of the same species. Mortality rate was recorded after 24 h. Acute toxicity tests were conducted for associated fauna at the dam (*Notonecta sp., Belostoma sp.,* and *Poecilia reticulata*). Mortality rate was recorded 72 h after. The laboratory bioassay data were analyzed using ANOVA test ($P<0.5$) and Tukey post hoc test. The results obtained showed that the mean mortality achieved was 100% for Rockefeller and Oaxaca strain, 88% for *Culex* species, and 86% for Puebla strain. ANOVA test showed statistically significant difference between the efficacy of *Bti* in *Culex* spp. and Rockefeller and Oaxaca strain. 100% of all specimens survived to

the acute toxicity test. This trial shows that the Bactivec® formulation has a positive larvicide effect in mosquitoes species of Puebla and Oaxaca regions with safety to the associated fauna, and it can be a useful tool for *Ae. aegypti, Cx. stigmatosoma* and *Cx. salinarius* control.

P-49 Bactivec® (*Bacillus thuringiensis* H-14) evaluation for larvae control of *Culex salinarius* and *Culex stigmatosoma* (Diptera: Culicidae) in a dam

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This study was developed for testing and knowing the efficiency of Bactivec® (*Bacillus thuringiensis* var. *israelensis*) as a biolarvicide for *Culex salinarius* and *Culex stigmatosoma* populations, species that are found at the Manuel Ávila Camacho dam, in Puebla, México. This dam features a high contaminant index and great amount of aquatic vegetation (*Eichhornia crassipes*). Those characteristics produce a high number of mosquitoes, which represent a risk of damage for the surrounding human populations, and their blood meal seeking may be very annoying. The study was been made from October to December, months where high mosquito larvae abundance has been reported. The study was held in 2 stages. For the first stage, larvae were kept inside recipients of 100mL and a previously reported Bactivec® dose for this volume was added. At the second stage, larvae of both species were kept inside manufactured nets of 400mL volume, which were placed at the dam, and a Bactivec® dose was added. A survival analysis was made for each stage with the statistic software R. It was shown that Bactivec® produced a high mortality rate for the Culicidae populations, proving its effectiveness as a biolarvicide for these species.

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Rorabaugh, Elizabeth	SpringStar Inc., Woodinville, Washington, United States	147, 206
Rose, Robert	Biotechnology Development & Regulatory Consultant, Frederick, Maryland, United States	116
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Ruckert, Ed	McDermott Will & Emery LLP, Washington, District of Columbia, United States	15, 28
Rueda, Leopoldo	Walter Reed Biosystematics Unit, WRAIR/SI, Suitland, Maryland, United States	86, 132, 138
Ruiz, Fredy	Walter Reed Biosystematics Unit, Smithsonian Institute, Suitland, Maryland, United States	82, 87
Ruiz, Johanny	Universidad de Carabobo, Maracay, Aragua, Venezuela	94, 110
Russell, Tanya	Ifakara Health Institute, Dar es slaam, United Republic of Tanzania	22, 154
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Salas Quinchucua, Cristhian	Universidad del Valle, Cali, Valle, Colombia	78
Salazar, Marlene	Instituto de Altos Estudios en Salud Dr. Arnoldo Gabaldón, Maracay, Aragua, Venezuela	95
Sallum, Maria	Faculdade de Saude Publica, Universidade de Sao Paulo, Sao Paulo, Sao Paulo, Brazil	108
Sanchez, Rosa	Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza, Nuevo León, Mexico	P-44
Sánchez, Víctor	Servicio Autonomo Instituto de Altos Estudios en Salud Publica Dr. Arnoldo Gabaldon, Ministerio del Poder Popular para la Salud y Proteccion Social, Maracay, Aragua, Venezuela	77, 99, 107
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Sanchez-Rodriguez, O.	University of Nuevo Leon, San Nicolas de los Garza, Nuevo Leon, Mexico	42
Sandoval-Coronado, Carlos F.	Universidad Autonoma de Nuevo Leon, San Nicolas de los Garza, Nuevo Leon, Mexico	P-46
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Santiago, Carmen	Facultad de Ciencias Quimicas Universidad Autonoma de Chiapas, Tapachula, Chiapas, Mexico	25
Santos, Cecilia	Faculdade de Saude Publica, Universidade de Sao Paulo, Sao Paulo, Brazil	108
Santos, Jose	Hospital Infantil de Mexico Federico Gomez, Mexico City, D.F., Mexico	47
Sanzone, Joseph	AMCA Washington Conference Program Chair, Eden Prairie, Minnesota, United States	104

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Savage, Harry	Centers for Disease Control, Fort Collins, Colorado, United States	80, 81, P-13
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Schnabel, David	USAMRU-Kenya, Nairobi, Kenya	133
Schoeler, George	US Navy - Navy Entomological Center of Excellence, Jacksonville, Florida, United States	177, P-04
Scott, Jamesina	Lake County Vector Control District, Lakeport, California, United States	115
Scott, Mariah	Centers for Disease Control, Division of Vector-Borne Infectious Diseases, Ft. Collins, Colorado, United States	P-01, P-07
Seyoum, Aklilu	Liverpool School of Tropical Medicine, Vector Group, Liverpool, United Kingdom	22, 154
Shah, Zahir	Department of Health and Mental Hygiene, New York City, New York, United States	P-28
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Shinondo, Cecilia	Department of Biomedical Sciences, School of Medicine, University of Zambia, Lusaka, Zambia	134, 155
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Sickerman, Stephen	South Walton County MCD, Santa Rosa Beach, Florida, United States	208
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Sikaala, Chadwick	National Malaria Control Center, Ministry of Health, Lusaka, Zambia	22, 134, 154
Siller, Quetzaly	Facultad de Ciencias Biologicas UANL, San Nicolas de los Garza, Nuevo Leon, Mexico	P-42
Silva, Brenda	Facultad de Ciencias Biologicas, UANL, San Nicolas de los Garza, Nuevo Leon, Mexico	46, P-41, P-42
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Sims, Sharon	Mississippi State Dept. of Health, Jackson, Mississippi, United States	P-22, P-25
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Sjogren, Robert	FourStar Microbial Products, Sag Harbor, New York, United States	204
Slawson, Gregory	County of San Diego, San Diego, California, United States	P-38
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Smith, Mark	Metropolitan Mosquito Control District, Saint Paul, Minnesota, United States	202
Smith, Stephen	Centers for Disease Control and Prevention, Atlanta, Georgia, United States	P-36
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Tlatelpa, Martha	Instituto Nacional de Salud Pública, Tapachula, Chiapas, Mexico	70
Todd, Robin	ICR, Inc., Baltimore, Maryland, United States	169
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AMCA AWARDS

HONORARY MEMBERS

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

HAROLD FARNSWORTH GRAY MEMORIAL CITATION
MERITORIOUS SERVICE TO MOSQUITO CONTROL AWARD

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

1964 Fred C. Bishopp (DC)

DR. THOMAS J. HEADLEE MEMORIAL AWARD

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

1968 George H. Bradley (USDA/USPHS)

MEDAL OF HONOR

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

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

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)

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)

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	

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

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.	2003	Sarah Yaremych	U. Illinois
1990	Andrea Brown	Peru State Coll.		Laura Goddard*	U. California
1991	John Paul Mutebi	Notre Dame U.		Jason L. Rasgon*	U. California, Davis
1992	Rosmarie Kelly	U. Massachusetts	2004	Gregory M. Williams	U. Delaware
1993	Merry L. Holliday-Hanson	U. California, Davis		Stephen Aspen*	Colorado State U.
1994	John E. Gimnig	U. California, Davis		Christian Kaufmann*	U. Zurich
	Alice Shaeffer*	U. Mainz, Germany	2005	Wesley Rubio	San Diego State U.
1995	Glen Scoles	Notre Dame U.		Whitney Qualls*	Auburn University
	Jittawadee Rochaeroen*	U. California, Riverside		Rebecca Trout*	University of Kentucky
1996	Esther Chow Schaeffer	U. Maryland	2006	Robert D. Anderson	University of Winnipeg
1997	Lynn Cooper	U. Maryland		Linda O'Connor**	University of Delaware
1998	C. Roxanne Rutledge	Louisiana State U.		Joshua R. Ogawa*	Oregon State University
	Emmalee Kennedy*	U. Illinois		Matthew Eaton*	Concordia College
	Timothy Schaub*	U. Illinois		Linda M. Styer*	U. California, Davis
1999	Laura Harrington	U. Massachusetts	2007	Jennifer Armistead	University of Florida
	Adam S. Jones*	U. Massachusetts		Robert D. Anderson*	University of Delaware
	Hillary Reno*	U. Illinois		Thomas M. Mascari*	Louisiana State U.
2000	Jason L. Rasgon	U. California, Davis		Kristen Bartlett*	Rutgers University
	Hope Q. Liu*	Virginia Polytechnic Inst.	2008	Jerome Schleier	Montana State University
2001	No competition			Christopher Barker*	U. California, Davis
2002	Laura B. Goddard	U. California, Davis		Lisa Reimer*	U. California, Davis
	Sharon L. Minnick*	U. California, Davis	2009	Alexandra Chaskopoulou	University of Florida
	Margaret Sherriffs*	Yale U.		Stephanie Larick*	University of Florida

* - 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 F. 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		
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

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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			

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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


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