AMCA

90th ANNUAL MEETING

DALLAS TX

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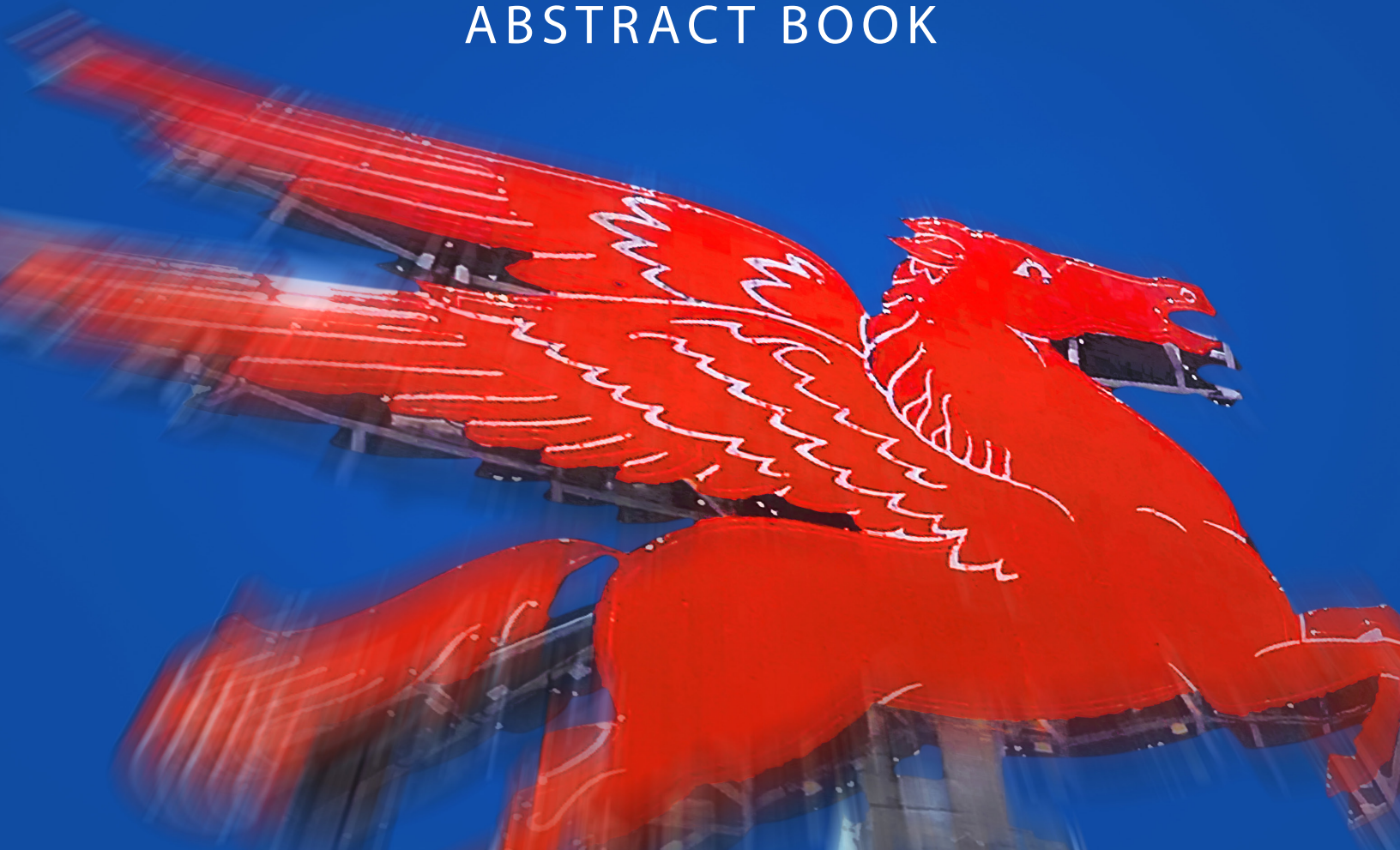
ABSTRACT BOOK



Plenary Session

PL-1 **In Memoriam of Mir S. Mulla, Ph.D. (February 15, 1925 – January 29, 2023): Man of the Achieving Family, Mentor, Scientist, Comminuty Activist, Friend, Colleague and More**

Tianyun Su, M.Sc., MD, PhD, stevensu1995@gmail.com

Dr. Mir Subhan Mulla, man of the achieveing family, mentor, scientist, comminuty activist, friend, colleague and more, passed away peacefully at his home in Riverside, California on January 29, 2023, at age 97. He was laid to rest on February 4, 2023, at Crestlawn Memorial Park in Riverside, California. Mir is preceded in death by Lelia Mulla, his wife for 64 years, 4 children of David, Shireen, Dean and Janet, 5 grandchildren, 3 great grandchildren, and many brothers and sisters. Mir was born on February 15, 1925, as chosen by himself as his birthday, in the village of Zangawat, Panjwayi District, Kandahar Province, Afghanistan to a family of 12 brothers and 4 sisters. Mir received a scholarship in 1948 to Cornell University where he obtained his undergraduate degree in entomology and parasitology in 3.5 years. He received his doctorate at UC Berkeley in 1956, then joined the UC Riverside faculty in the same year and retired in 2006. During his graduate studies at UC Berkeley, he met Lelia (Lee) Patterson at the International House. They married in August 1954 and moved to Riverside upon his employment with UC Riverside. This couple later helped Mir's brothers and sisters immigrate to the U.S. and settle in state of California.

As one of the founding faculty at UC Riverside Entomology, Dr. Mulla created an undergraduate-graduate course and seminars in Medical and Veterinary Entomology with Dr. Louis Riehl. His teaching included upper division and graduate seminar courses in medical and veterinary entomology. As a teacher, Professor Mulla possessed an almost unmatched scope and magnitude of knowledge and experience in the subjects he taught. He unreservedly shared his experience with students and scholars. As a lead of the world-renowned medical entomology program for graduate students focused primarily on the biology and control of mosquitoes and blackflies at UC Riverside Entomology, he trained 27 Ph.D. students, 3 mater's students, 20 postdoctoral fellows and 30 visiting scholars from many countries during his career. Those who studied under Mir's mentorship have been serving in key positions in academia, governments, and industries domestically and internationally.

Dr. Mulla significantly contributed to the research and development in biology, ecology, and control of arthropods of public health importance, including but not limited to, mosquitoes, eye gnats, midges, blackflies, and others, in particular, for his remarkable work on biorational larvicides (microbials, insect growth regulators, botanicals, and more). In his 50-year career, more than 550 scientific papers were published in peer-reviewed scientific journals. As a pioneer researcher on pestiferous eye gnats in the Coachella Valley, California, Mir, and his colleagues initiated and conducted systematic research on attractant, traps, trapping and trapping out (removal), agricultural practices, pesticide activity and efficacy ranging from conventional and biorational options for controlling the pestiferous species. At the same time, he extended his research to vector and nuisance mosquitoes and blackflies, where his most significant accomplishments were evaluations of various techniques and tools including organochlorines, organophosphates, carbamates, insect growth regulators (juvenile hormone analogs and chitin synthesis inhibitors) and natural predators (mosquitofish and tadpole shrimp), for their activity, efficacy, and non-target safety when used in mosquito control. Since the 1970s, Mir began evaluation on biopesticides, particularly the naturally occurring Bacillus thuringiensis subsp. israelensis (Bti) and Bacillus sphaericus.

The former is now used for mosquito and blackfly control globally, and the latter for mosquito control in many countries. His research showed that Bti was effective against blackflies, implementation of his discoveries tremendously reduced the disease burden of river blindness, a filarial infection that is transmitted by blackflies in West Africa. Dr. Mulla's research also covered other dipteran flies such as non-biting midges, where a universally used pesticide efficacy calculation equation was published – Mulla's formula.

In scientific community, he served a consultant, advisor, member, or chairman on numerous national and international organizations such as US NIH, the US Agency for International Development, the UNDP, FAO and WHO. Lending his in-depth knowledge of vector biology and control, he provided advice for controlling important mosquito-borne diseases such as malaria, dengue fever, filariasis, and various viral encephalitis. Additionally, he guided Chulalongkorn University (Thailand), University of Tehran (Iran), Universidad Autónoma de Nuevo Leon (Mexico), University of the Punjab (Pakistan), and Government College University (Pakistan) in establishing their graduate student programs. As a founding scientist for the Society for Vector Ecologist (SOVE) in the US, he donated $50,000 for an annual memorial SOVE lecture in addition to his excellence of services for decades to this organization. Furthermore, Dr. Mir S. Mulla & Leila Mulla Endowed Scholarship Fund provides a merit scholarship to undergraduate and/or graduate students in College of Natural and Agricultural Sciences majoring in Entomology or Bio-Agricultural and/or Biomedical Sciences at UC Riverside.

In the non-scientific community, Mir served as a leader in the Riverside Muslim community. He and his wife Lelia founded the Islamic Society of Riverside and Orange Counties and played a key role in building the Islamic Center of Riverside, the first mosque in the Inland Empire of Southern California. His philanthropic work included supporting the local Muslim community, donating land to Riverside County Parks to preserve public access to Sugarloaf Mountain and establishing scholarships in the College of Agriculture and Natural Sciences at UC Riverside.

In recognition of Mir's excellence in teaching, mentorship, and research, he was elected as a Fellow of the American Association for the Advancement of Science (AAAS) and Fellow of the Entomological Society of America (ESA), awardee of the Distinguished Service Award (1986) and the Distinguished Achievement Award (2006), and Lifetime Achievement Award (2009) from SOVE. The 49th SOVE annual meeting was dedicated to Dr. Mir Mulla in 2018. The Indian chapter of SOVE recognized him by establishing the Mir Mulla Award in 2019. Among more honors were the highest award from the American Mosquito Control Association, the Medal of Honor (2010), and the Meritorious Recognition Award from the Science Society of Thailand (1997). The King of Thailand recognized his many years of continuous contributions in developing the academic infrastructure in Thailand for instruction, research, and control of vector-borne diseases. The Coachella Valley Mosquito and Vector Control District dedicated the new state-of-the-art Biological Control Facility to Dr. Mir S. Mulla in 2006. Upon retirement, Professor Mulla was awarded the University of California's Dickson Emeritus Professorship for 2008-2009.

Professor Dr. Mir S. Mulla will be greatly missed by his loving and devoted family, friends, students, and colleagues here in the USA and overseas as well.

Legislative and Regulatory Symposium I

1 **USEPA Updates to the Endangered Species Act Workplan and the Vulnerable Species Pilot Project**

Jan Matuszko, matuszko.jan@epa.gov

In November of 2022, the USEPA released a that explains steps EPA is and will be taking to better protect non-target species, including listed species, earlier in the process through pesticide registration review and other FIFRA actions. Following the release of the ESA workplan, the EPA released a "Vulnerable Species Pilot Project" that aimed to identify certain vulnerable listed species, identify mitigations to protect them from pesticide exposure, and then implement these mitigations across different types of pesticides. Updates to both of these initiatives, as well as other actions the EPA is taking with regard to protecting endangered species and pesticide registrations will be discussed.

2 **Refinement of AGDISP for wide-area space sprays in mosquito control**

Jane Bonds, PhD, jasbonds@gmail.com

The mechanistic model AGDISP™, developed to predict pesticide fate in the environment, is unique to aerial pesticide applications, and the EPA uses it to make regulatory decisions related to spray drift from crewed aerial applications. A primary concern is that the current input parameters for AGDISP™ are for an open field that reflects agricultural paradigms instead of mosquito control. Even though AGDISP™ is an accepted regulatory model, it has not been validated for mosquito control. Input parameters must be investigated to better reflect how and where wide-area mosquito adulticide applications are conducted. The model needs to reflect better the effect of the habitat on spray dispersal, dilution, degradation, and ultimately removal of the pesticide.

The American Mosquito Control Association has secured a grant to work toward the refinement of this model; to provide a better understanding of the distribution of residues from operationally relevant applications in heterogeneous environments to predict potential impacts on non-target organisms. Ultimately, refined models would allow for more efficacious applications while not creating excessive limitations on the chemicals available.

This presentation will provide an overview of the experimental plan. Each treatment will include an open field versus a vegetative habitat, possibly adding an intermediary suburban filtration model. The two different habitats will be treated at the lowest operational altitude, with three distinct airframes: a crewed rotary, crewed fixed wing, and Uncrewed Aerial Spray System (UASS) over a range of meteorological conditions. This is an exciting new endeavour which will mesh a multitude of studies to formally underscore the importance of space spraying in mosquito control.

3 **CDC update on the National Public Health Strategy for the Prevention and Control of Vector-Borne Diseases in Humans**

Lyle Petersen, MD, MPH, lxp2@cdc.gov

Americans are at an increasing risk of vector-borne diseases, and the United States is unprepared to respond to these threats. In response, the 2019 Kay Hagan Tick Act required the development of a national strategy to address vector-borne diseases carried by ticks and other blood-

feeding vectors. The Office of the Assistant Secretary for Health, in collaboration with the CDC, more than 15 civilian agencies, and the Department of Defense, delivered an inaugural National Strategy for Congress in December 2023. This talk will discuss the components of the national strategy with a focus on the role AMCA membership should play in implementing this public health strategy. Other topics of discussion would be the One Health Framework, the Regional Centers of Excellence funding, and the public education materials being developed by the DVBD.

Mosquito Lightning Symposium

5 **Where to publish? An entomologists journey to becoming an expert cardiologist, gerontologist, oncologist and more…**

Ary Faraji, PhD, ary@slcmad.org

As entomologists we are often bombarded by invitiations from various "scientific" journals to submit an article to these newly founded and subject-specific "peer-reviewed" publicaitons. For some perplexing reason, the journals have found us as the leading experts in fields that have nothing to do with our actual expertise. These journals may range from the Global Journal of Aging & Geriatric Research, the Annals of Forensic Science and Research, Polymer Interfacial Characteristics in Polymer Blends, IPNs, Gels, and Composites, Virology & Retrovirology Journal, Hearth and Mind, and the Cohesive Journal of Microbiology & Infectious Disease, amongst many others. However, these are primarily predatory journals that are looking for a quick profit and they can care less what field your expertise may actually stem from. So how do you know where to publish and where to submit your novel articles? This presentation will provide a brief overview of predatory journals and their schemes, and make recommendations on how to avoid such scams.

7 **The host associations of Uranotaenia sapphirina**

Lawrence Reeves, PhD, lereeves@ufl.edu

The females of most mosquito species need to feed on the blood of another animal in order to obtain proteins and nutrients necessary to complete the development of their eggs. Mosquitoes take blood from a wide range of animals, including amphibians, birds, fishes, mammals, and reptiles, and host associations vary by species. Each mosquito species takes blood from a distinct subset of the animal community within its ecosystem. Some are relative generalists that take blood meals opportunistically from most vertebrates, but most specialize, to varying extents, on particular types of hosts. For the majority of mosquito species, host associations have not been characterized, and much of what we know about mosquito host associations is gleaned from species that are known vectors of medically important pathogens. Despite attempts to determine the host associations of Uranotaenia sapphirina, the identity of the hosts of this mosquito have been something of a mystery. Uranotaenia lowii, the only other Uranotaenia species in the eastern US, feeds only from frogs, which they locate acoustically, by listening for the songs of calling male frogs, and the host associations of Uranotaenia sapphirina had been presumed to parallel those of Uranotaenia lowii. However, the bright red blood meals of Uranotaenia sapphirina cannot be identified using traditional blood meal analyses, designed to identify vertebrate hosts. Only by observing these mosquitoes in nature were we able to determine their host associations.

8 **Quick tour of Anastasia Mosquito Control District's new Vector-borne Disease Education and Research Center**

Whitney Qualls, PHD, wqualls@amcdfl.org, Richard Weaver

Get a sneak peak of Anastasia Mosquito Control District's novel Disease Vector Education and Research Center. This education center focuses on mosquitoes, but also addresses other vectors, pathogens transmitted by mosquitoes and other arthropods, public health vector control tools and technologies, and fun themes centered around entomology. The use of interactive displays, built for all ages, a classroom for lectures and laboratory demonstrations and a working insectary makes the 6,000 square foot education center fun and engaging. The construction of the project started in February 2020 just before covid lockdowns, adding to the difficulty of designing and building the center. AMCD hopes to have a grand opening in the spring of 2024.

9 **To what end?**

Brian Byrd, PhD, MSPH, bdbyrd@wcu.edu

While conducting a mosquito survey in the Sierra Nevada Mountains this past summer, I was approached at our campsite by a father and his children. He asked what I was doing with a microscope and the various tools on the picnic table. I shared that we were surveying for mosquitoes. He followed up with the question — To what end? In an unprepared response, I spouted off some generaliz ations about the need for updated records and being diligent in our search for species range expansions and invasive mosquitoes. He seemed satisfied with the answers and they left. I suspect that for most AMCA members, inquiries like this are common. I generally enjoy interacting with the public and sharing our work. However, the phrase "to what end?" left me unsettled and I stewed over it for the rest of our time in the field. This lightning talk will highlight my struggle with this question in the context of the complexities of our work (and passions).

10 **Revealing cryptic bloodmeals through metabarcoding: from triatomines to soft ticks to mosquitoes.**

Gabriel Hamer, gabe.hamer@ag.tamu.edu

Abstract: I can create an abstract as needed but am in a meeting currently and was requested to submit this asap.

11 **Back to the Future: Quantifying Wing Wear as a Method to Measure the Age Structure of Mosquito Populations**

Brian Foy, PhD, Brian.Foy@colostate.edu

Rapid, easy, and high-throughput determinations of mosquito age structure is critical for determining the risk of mosquito populations for transmitting pathogens and for the measuring the efficacy of mosquito control interventions. Qualitative assessments of wing wear was the original method for assessing mosquito age, first described more than 100 years ago. We updated and quantified this method by applying machine vision to mosquito wing pictures and demonstrate how the method could be valuable to researchers, public health agencies and mosquito control operators.

12 **Harvesting insects from naturally abundant areas for animal feed and pathogen surveillance**

Lee Cohnstaedt, lee.cohnstaedt@usda.gov

Mosquitoes are naturally abundant in many areas such as wetlands and rice fields. These mosquitoes can be harvested using the novel USDA-Biomass Harvest Trap and turned to animal feed. The USDA-BHT has the capabilities to harvest kilogram quantities of insects using a massive suction fan. The modular design allows for customization of attractants for various insect vectors or pests. The harvested insects are then disinfected and fed to animals as a protein supplement. Analysis of the insects shows they are low in fat but up to 80% protein and high in vitamins and minerals.

13 **Scatology Meets Arbovirology: Can Testing Wastewater Augment Traditional West Nile Virus Surveillance?**

Lyle Petersen, MD, MPH, lxp2@cdc.gov

Early detection of impending outbreaks, prompt vector control, and public messaging can mitigate West Nile virus (WNV) outbreaks. However, human disease case reporting is subject to surveillance delays, and mosquito, dead bird surveillance, and virus testing are resource-intensive and thus limited in geographic scope. The National Wastewater Surveillance System (NWSS) currently has more than 250,000 unique wastewater samples and receives data from more than 1,500 sites in 50 states, Puerto Rico, USVI, Guam, and 6 tribal communities, representing more than 144 million people (40% of the US population). NWSS currently tests for SARS-CoV-2 and Mpox virus, and if expanded to include WNV, it could greatly augment ongoing WNV surveillance efforts. We have developed a novel WNV subgenomic flavivirus RNA (sfRNA) digital RT-PCR assay for use in wastewater surveillance. The subgenomic target is resistant to exoribonuclease activity, potentially increasing assay sensitivity from environmental samples. In spiked wastewater samples, WNV can be detected up to 72 hours in a dose-dependent manner. We will present results from wastewater samples collected in 2023 from areas experiencing human cases and outbreaks with concurrent mosquito surveillance programs to assess the feasibility and relative utility of this approach. If successful, pilot wastewater surveillance activities will be undertaken during the 2024 transmission season.

14 **Baculoviruses: Master Manipulators of Moths**

Nathaniel Byers, PhD, nate@slcmad.org

Abstract: Baculoviruses are a family of insect-specific pathogens that manipulate their hosts in numerous interesting ways. Generally, baculoviruses prey on specific species of lepidopterans. As both the minute subcellular processes and the macroscopic physiology of the larva are altered, these viruses replicate to high titers. Conditions are optimized for spread to the next host. At the culmination of the infection, gypsy moth caterpillars climb high into the trees and dissolve into high-titered slime, raining virus down onto their brethren. Many of the genetic adaptations were genes stolen from their hosts and altered to best suit the viruses. This feat is made easier by their shared genetic material; baculoviruses are large double-stranded DNA viruses. Despite these fascinating interactions between virus and host, much of the interest in baculoviruses has been based on their utility as protein expression vectors. This talk will briefly discuss some of the intriguing adaptations of baculoviruses and the disturbing consequences for their lepidopteran victims.

15 **Malaria in Africa: A Global Call to Action**

Silas Majambere, PhD, silas.majambere@valentbiosciences.com, Beth Ranson, , , , , , , , ,

Abstract: Malaria in Africa presents a pressing global challenge that demands our immediate attention. With its prevalence, devastating health consequences, and profound economic burden, malaria affects millions in the African continent, particularly vulnerable populations, including children and pregnant women. Its impact extends beyond health, hindering education and productivity while inflicting a heavy social and psychological toll on communities. Prevention methods, such as bed nets and indoor residual spraying, exist, but are not enough. To combat this crisis, global cooperation is imperative, with organizations and initiatives actively addressing the issue. Individual and collective responsibility is crucial, as we strive to change the trajectory of this disease and create a brighter, healthier future for Africa and the world.

16 **Treating outside the box, using spatial models to define adulticide treatment surfaces**

Kevin A. Caillouet, Ph.D., kcaillouet@stpmad.org, Hieu Duong, Ph.D.

Abstract: Integrated mosquito management relies on surveillance data including species abundances and infection status from mosquito traps to define control actions. Given limitations of sample size due to the resource-intensive nature of mosquito trapping, inferences of mosquito abundance across space and time likely result in considerable error and therefore imprecise insecticide applications. St. Tammany Parish Mosquito Abatement makes daily decisions to conduct ultra-low volume adulticide applications to static “zones”, polygon areas defined by road networks. Currently, treatment decisions are driven by mosquito abundances exceeding thresholds or the presence of arbovirus-infected mosquitoes from single trap nights within each zone. Interpolated spatial models can estimate mosquito abundance across unsampled space to create a “surface” of mosquito abundance. Since these estimates are created by weighting abundance from a network of multiple sites instead of inferring from just one, theoretically they should result in more precise treatments. Treatment “need” surfaces are no longer static polygons but become “blob-like”, creating new logistic challenges. In addition to improving treatment precision to areas of need, novel outcome metrics including estimating number of mosquitoes reduced, number of people served, and treatment costs allow for improving cost efficiency.

18 **A Connecticut Yankee in a mosquito's court: mapping mosquito and arbovirus activity in Connecticut**

Joseph McMillan, PhD, josmcmil@ttu.edu

Using mosquito and arbovirus data from the Connecticut Agricultural Experiment Station’s (CAES) statewide mosquito and arbovirus surveillance program (2001 – 2020), we developed a risk projection pipeline that projects risk of detecting West Nile virus (WNV) in un-sampled spaces within the state. We used boosted regression tree (BRT) methodologies to first develop predictive algorithms of Culex pipiens collections in gravid traps based on average surveillance effort, climate and land cover variables only; these algorithms were then nested within a BRT algorithm of WNV detection probabilities. Results of the WNV prediction models were aggregated to the town level and then successfully validated against two separate data sets: 1) reported human case data (2001 – 2022) and 2) observed WNV detection rates in mosquitoes sampled in 2021 – 2022. Overall, our WNV detection predictions explained a significant amount of variance in human WNV case data and mosquito

surveillance data. The over-arching goal of this research is to develop interactive, online risk maps which can be released to the public by CAES in real-time. The predicted utility of such risk maps is that they will allow users to estimate arbovirus risk at locations not explicitly sampled by the surveillance network.

19 **Plugged-in: male Anopheles have it all figured out**

Laura C. Harrington, PhD, lch27@cornell.edu

Did you know that the male Anopheles mosquito has a special strategy to ensure paternity? After transferring sperm, he applies a "mating plug". What is this plug? How did it evolve? What would happen if we could alter his ability to make the plug? Follow me on a quick journey to understand these questions and more regarding this tiny and clever mosquito mating strategy!

20 **Antibody responses against salivary proteins of Ae. albopictus and Cx. quinquefasciatus in Northern Cardinals in Louisiana**

Berlin londono-Renteria, blondono@tulane.edu, Kevin A. Caillouet, Ph.D., Alyssa Schwinn, Sara Harris, Zoe Jacobs, Matt Duckworth, Jane de Verges, Sam Jameson, Dawn Wesson

West Nile virus (WNV) is a mosquito-borne pathogen primarily transmitted by Culex mosquitoes. Since the emergence of WNV in the US in 1999, detecting infection in birds and mosquitoes have become the primary surveillance tools used as precursors for human infection and neuroinvasive disease incidence. WNV is normally transmitted between birds and mosquitoes in the environment; and humans are considered dead end hosts. WNV is transmitted to a vertebrate host through the bite of an infected mosquito during blood feeding. In this process, mosquitoes deposit salivary proteins that elicit antibody responses; previous studies have established that the concentration of such antibodies is directly related to the intensity of exposure to mosquito bites and a good proxy to determine risk of infection in the human population. Since WNV infection in birds has also been used to determine risk of transmission in some areas, we tested the levels of IgY antibodies against whole salivary glands of Ae. albopictus and Cx. quinquefaciatus in more than 700 Northern Cardinals captured via mist nets in Louisiana between 2018 and 2019. Our preliminary data (n=169) showed a significant negative correlation between the sample collection date and the IgY antibody levels against Ae. albopictus in younger hatch year Northern Cardinals ($p=0.0375$). This correlation was not shown in older after hatch year birds. We did not find significant difference in the antibody levels between males or females from any of the locations. In general, higher levels of antibodies against Ae. albopictus were observed in comparison to Cx. quinquefasciatus. We will discuss the proteins that were identified by immunoblot as the most immunogenic in these two different sets of samples. We are working towards designing new tools to track bird exposure to infective bites to effectively measure risk of WNV transmission.

21 **The First Tick Surveillance Program in Wyoming, Oh What We Have to Learn**

Mikenna Smith, M.S., msmith@tcweed.org

In 2023, Teton County Weed & Pest District set out to initiate the first tick surveillance program in the state of Wyoming. The program we proposed to the powers that be included standardized surveillance, pathogen testing, species identification services, insecticide susceptibility status testing, and community outreach and education. Initial hurdles, lessons learned (specifically those about

“standardized surveillance” in the Wild Wild West), and results from our preliminary passive and active surveillance efforts will be discussed.

22 **Culex antillummagnorum: dogma smasher**

Donald A. Yee, donald.yee@usm.edu

We lack basic information on ecology and natural history for the overwhelming majority of the 3,719 identified species of mosquitoes, leading to reliance on a few well-studied medically important species to inform us about the habitats of all mosquitoes. This means we are likely overlooking important details about mosquito biology by ignoring other species that may have unique and unusual traits. This reliance has likely led to a dogmatic view of several important traits, including patterns in oviposition across genera. The mosquito Culex antillummagnorum (Dyar), which is widely distributed across the island of Puerto Rico, as well as across several other Caribbean islands, has larvae that can be found in a variety of man-made and natural containers. This species is placed along with five other species in the subgenus Micrades, a group which we know essentially nothing, except their distribution and larval habitats. In this talk I will detail some newly discovered aspects of their ecology that will challenge well-established beliefs about this genera.

23 **How to shed 40 pounds in one day: Converting traps to lithium batteries.**

Gregory Williams, PhD, gwilliams@hudsonregional.gov

Abstract: For years, the mosquito control community has relied upon lead-acid batteries to run our portable mosquito traps (i.e., gravid, CDC, EVS, etc.). While reliable, lead-acid batteries are expensive, large, and heavy, making transporting them in the field difficult. By contrast, modern lithium batteries are small and lightweight with an energy density over six times greater than lead-acid batteries. Unfortunately, many of our traps run on 6 volts, which lead-acid batteries can easily supply. Lithium cells typically run at 3.7 volts, too low to run a trap. Two lithium cells in series yield 7.4 volts, which can burn out trap motors. In this presentation, I will show how to convert your traps to lithium-ion battery power using readily available parts. The conversion results in an 18% reduction in cost, a 96% reduction in volume, and a 89% reduction in carried weight over lead acid batteries.

Operations I

24 **Insights from the Chicken Warden at Beach Mosquito Control District**

Emily E. Evans, MSBio, emily@pcbeachmosquito.com

Abstract: Beach Mosquito Control District has incorporated a sentinel chicken program within its integrated mosquito management arsenal since 1998. Throughout that time, many protocol adjustments have been implemented not only to create a more efficient operational cycle, but also to improve the chickens’ quality of life. This presentation will highlight my experiences of weekly serology sampling over the past two years, covering 4 essential duties: husbandry, blood collection, blood preparation and packaging, and documentation.

25 **Selecting target wild bird species for West Nile virus serosurveillance**

Elise T. Nishikawa, M.S., elise.nishikawa@phs.hctx.net, Stephanie Turnstone, Bachelors, Maximae Vigilant, PhD

Abstract: Wild birds play an important role in the natural cycle of arboviruses such as West Nile virus. Serosurveillance of wild birds can enhance early detection of arbovirus circulation and indicate the geographic extent of transmission within the host population. However, as avian species do not show equivalent response to arbovirus exposure, it is important to determine which species will provide the most utility for a serosurveillance program. An ideal target species should be abundant and widely distributed throughout the study area, have diagnostic traits that make determining age relatively simple, be likely to be exposed to arthropod vectors, and able to survive infection and mount a strong and long-lasting immune response. This presentation will discuss insights from twenty years of West Nile virus serosurveillance in Harris County and relevant life history traits of resident bird species and provide recommendations for establishing avian arbovirus serosurveillance programs.

26 **Enhancing Local Preparedness: Mobilizing Volunteer Resources Against Local Transmission of Aedes-borne Disease in Los Angeles County**

Steven F. Vetrone, MPH, svetrone@glacvcd.org

Abstract: The introduction and subsequent establishment of Aedes albopictus (S.) and Aedes aegypti (L.) in Los Angeles County have created many operational control and surveillance challenges for local vector control agencies. The rapid increase in distribution and abundance of these species have elevated the risk for autochthonous transmission of diseases such as dengue, chikungunya, and Zika, which are regularly detected as travel-associated human infections by the Los Angeles County Department of Public Health (LACDPH). Conducting targeted surveillance, control, and outreach efforts around these human cases to mitigate the risk of local transmission is highly resource-intensive, particularly when concurrently responding to two or more probable or confirmed cases. Consequently, in the event of an outbreak of Aedes-transmitted disease, vector control agencies can become easily overwhelmed. In 2016, the Greater Los Angeles County Vector Control District (GLACVCD) partnered with the Emergency Preparedness Response Division of the LACDPH to facilitate access to public health volunteer resources during an outbreak or emergency declaration. Through this partnership, GLACVCD can access support from various governmental and community partners, including the Medical Reserve Corps, local Community Emergency Response Teams, and the Public Health Emergency Volunteer Network, to assist with conducting inspections and outreach efforts. Informational training sessions and full-scale exercises are conducted annually to ensure readiness. In this presentation, the evolution and current status of this partnership will be discussed.

27 **Evaluating efficacy of pre-season larvicide treatment on WNV vectors in Cook County, IL**

Cassandra Durden, MS, bwh4@cdc.gov

Abstract: The metropolitan region surrounding Chicago, IL, has historically high incidence of West Nile virus (WNV) disease. Culex restuans and Cx. pipiens are the primary enzootic and epidemic vector species for WNV in this area, respectively. Cx. restuans are more abundant in spring and Cx. pipiens in late summer. We conducted a cluster-randomized trial to assess the efficacy of early (April) and late (June) season larvicide treatments, aiming to reduce Cx restuans and its amplification of WNV. Sumilarv® 0.5G, (Sumitomo Chemical, Tokyo, Japan) was applied to 8 treatment sites (April 4–June 4,

2023) within the operational area of North Shore Mosquito Abatement District. Mosquitoes were collected weekly from 96 CDC gravid traps and 48 CDC miniature light traps for 24 weeks after initial treatments. Adult mosquitoes were identified to species using morphological characters and screened for WNV via RT-qPCR. Ovitraps were deployed once a month to examine ratio of the two species compared with species from the CDC gravid and miniature light traps. We hypothesized early treatment sites would have a decreased abundance of Cx. restuans compared with sites in the late treatment group, and reduced infection rates. This study will help inform vector control applications and elucidate population dynamics of Cx. restuans and Cx. pipiens in the upper Midwest.

28 **Assessing Control Measures for Managing Aedes aegypti**

Gabriela Perezchica Harvey, gharvey@cvmosquito.org, Kim Y. Hung, Ph.D., Jennifer A. Henke, Gerald Chuzel, Melissa Snelling, Jacob Tarango, Gregorio Alvarado, Tammy C. Gordon, , ,

Abstract: Since its first detection of Aedes aegypti mosquitoes in 2016, the Coachella Valley Mosquito and Vector Control District (the District) has been diligently working to reduce the number of mosquitoes. Ae. aegypti mosquitoes are currently found in all cities of the Coachella Valley. One approach of mosquito management is to conduct Wide Area Larvicide Sprays (WALS), which the District conducts by aerial and by truck-mounted application equipment. These applications entail a significant amount of work by District staff each year. The treatments are evaluated with trap collections compared to other areas that are untreated. Along with trap collections, sample cups are set to determine if the product reached the target areas. Routine treatments led to a reduction in Aedes mosquitoes after the applications; however, the objective was to determine if the yearly WALS applications have made an impact on reducing Aedes aegypti and Culex quinquefasciatus over time.

29 **An optimist sees an opportunity with every difficulty: the Lee County Mosquito Control District shifts from UAS to Helicopters for LiDAR Operations.**

Aaron Lloyd, lloyd@lcmcd.org, Nick Lefkow, David F. Hoel

Abstract: Unmanned Aircraft Systems (UAS) are commonly used in mosquito control districts nationwide. There are many uses that have been implemented into an Integrated Mosquito Management program and those uses change with each organization. In 2021, the Lee County Mosquito Control District in Southwest Florida pushed the limits of UAS to include LiDAR operations. After a hard stop of UAS operations in Florida, initiated by state legislation in 2022, LCMCD shifted to manned helicopters to collect LiDAR data. With this new perspective, we found that our UAS equipped to carry the LiDAR is outmatched by the helicopter. This presentation will discuss operational use of LiDAR and how this technology is currently used at the Lee County Mosquito Control District.

30 **VectorSurv: New Developments for Data Management and Evidence-based Vector Control Decisions**

Olivia Winokur, PhD, ocwinokur@ucdavis.edu

Abstract: Authors: Olivia Winokur1, Tim Valdepena, Jody Simpson, Kurt Johnson, Shawn Ranck, Kylie Pace, Lincoln Wells, Christina De Cesaris, Aynaz Lotfata, Christopher M. Barker

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VectorSurv is used by over 220 vector control and public health agencies in 20 states and territories across the United States to manage and visualize their data, create reports, and make real-time, evidence-based decisions to prevent the spread of vector-borne diseases. We work closely with local, state, and federal agencies to identify development priorities to serve the diverse needs of agencies across the country and continue to develop new tools. In 2023, we released the VectorSurv API that allows for data integration with external software for anyone with data access, including vector control software providers, academics, and public-health agencies. VectorSurv also released a new tick module, which implemented a new user interface and offers new possibilities for analyzing and mapping data on ticks and tick-borne pathogens across the U.S. During 2023, over 80 VectorSurv agencies volunteered to contribute their open mosquito trapping and testing data to inform models for the 2023 CDC West Nile Virus Forecasting Challenge. This presentation will review recent VectorSurv developments, newly expanded offerings for user engagement and online training, and exciting new options for vector control agencies to accelerate data sharing and collaboration.

31 **From Salt Lake to Mali, an introduction of western mosquito control in Mali, Africa**

Jason Hardman, jason@slcmad.org

Abstract: The Salt Lake City Mosquito Abatement, Anastasia Mosquito Abatement, Ouelessebougou Alliance, and University of Bamako have partnered together to bring Western style mosquito control to Mali, Africa. This is an overview of how these organizations helped to form the first mosquito abatement program in Mali that utilizes Integrated Mosquito Management. The information provided will discuss funding, training, equipment, operations, and how the program is currently moving forward in Mali, as well as its future.

Student Competition I

33 **Adapting standard mosquito research methods for monitoring insecticide susceptibility and resistance in Culicoides biting midges**

Vilma Montenegro, vilma.montenegro@ufl.edu, Nathan Burkett-Cadena, Eva Buckner, PhD

Abstract: Tools for monitoring insecticide susceptibility and resistance in Culicoides no-see-ums are unavailable. We modified methods for insecticide trials using field susceptibility cages and CDC bottle bioassays that are commonly used in mosquitoes, to evaluate the susceptibility of Culicoides to permethrin (pyrethroid). Adult Culicoides were susceptible to permethrin delivered in ultra-low volume applications and CDC bottle bioassays. These methodologies will be used to monitor insecticide susceptibility and resistance in species that vector hemorrhagic disease viruses.

34 **Effects of Elevated Ambient Temperature on Response of a Mosquito Citronellal Receptor: Implications for the Efficacy of Mosquito Repellents**

Yeaeun Park, B.S. in Biology, the University of Michigan, 2019, park.3296@osu.edu, Peter M. Piermarini, Ph.D. in Zoology, University of Florida, 2002; B.S. in Biology, James Madison University, 1995

Abstract: I explored the impact of noxious heat on the chemical activation of transient receptor potential ankyrin 1 (TRPA1) in mosquitoes. TRPA1 is a receptor of noxious heat and repellents, but

whether heat modulates TRPA1 response to repellents is unknown. By using whole-cell voltage clamping of heterologously expressed Aedes aegypti TRPA1, I found that heat reduced its activation by citronellal. My findings suggest the possibility of reduced efficacy of repellents targeting TRPA1 under extreme heat events.

35 **Evaluation of silver nanoparticles as a control tool against adult mosquito vectors**

Kai Blore, kblore@amcdfl.org

Abstract: Toxicity screenings via topical application were conducted to assess the adulticide potential of silver nanoparticles (AgNPs) in conjunction with permethrin against three species of mosquitoes. Nanoparticles were biosynthesized from silver nitrate using essential oils to reduce stabilize the AgNPs molecules. Resultant AgNPs were characterized by UV-Vis, transmission electron microscope and direct light scattering analysis to determine size and morphology. Standalone toxicity of AgNPs at 24h was low but nanoparticles demonstrated positive synergism with permethrin.

Adult Control II

36 **Survey of Naled Resistance in Aedes aegypti Populations Across the Collier Mosquito Control District**

Decyo S. McDuffie, MS, dmcduffie@cmcd.org, Keira J. Lucas, PhD, Rebecca Heinig, PhD, , , , , , , ,

Abstract: Collier County is an ideal habitat for Aedes aegypti. Unfortunately, local Ae. aegypti populations are highly resistant to pyrethroids and are also showing preliminary signs of naled resistance. To further assess the extent of naled resistance, Collier Mosquito Control District is conducting a more comprehensive spatial survey of naled resistance in local Ae. aegypti populations through a series of CDC bottle bioassays. The results will help optimize Collier Mosquito Control District's integrated mosquito management program.

37 **A Comprehensive Mosquito Species Richness Study in Southern Indiana show the Establishment of Medically Important and Invasive Species**

Sajjad Khan, khansaj@iu.edu

Abstract: Utilizing BG-Pro mosquito traps with BG Lure and LED at nine locations in Bloomington Indiana we started sampling on May 23, 2023. We collected 629 mosquitoes from 9 genera and 23 species including invasive and medically important species. Our species accumulation curve confirms exhaustive sampling, accurately representing local mosquito diversity with our employed methodology. The most abundant species in our study were Ae japonicus (20%) followed by the Cx pipiens complex (17%).

38 **An assessment of adult mosquito trapping methods and molecular identification of blood meals in Cameron Park Zoo, Waco Tx.**

Dhivya Rajamanickam, PhD, dhivya_rajamanickam1@baylor.edu, Jason Pitts

Abstract: Host preferences of female mosquitoes is an essential aspect of disease transmission cycles. In this study, we collected mosquitoes over a three-month period in Cameron Park Zoo in Waco, Texas, using multiple trap types. We then identified mosquito species and blood meals using a DNA

barcoding protocol. Our results indicate broad host choice in a public setting, establishing a baseline for future studies at this site and across the state.

39 **Characterizing Wolbachia prevalence across mosquito host genomes over a latitudinal gradient**

Rebecca (Becky) E. Cloud, rcloud3@illinois.edu, Patrick Irwin, MS and PhD, Carla Cáceres, Ph.D. in Ecology and Evolutionary Biology, Cornell University

Abstract: Wolbachia can phenotypically manipulate its mosquito hosts in ways that influence vector competence. Field collected Culex restuans and Cx. pipiens complex collected from two Illinois and one Wisconsin locations were used to characterize the prevalence of Wolbachia in natural populations. The integration of host species and genotype with Wolbachia strain identity and prevalence across genomes will inform current models of West Nile virus in these endemic hosts.

40 **Incriminating vectors of deer malaria (Plasmodium odocoilei) in a Florida deer farm**

Morgan N. Rockwell, B.A., morganrockwell@ufl.edu

Abstract: Plasmodium odocoilei, is a hemoparasite that infects wild and farmed white-tailed deer (WTD) in the United States and is the causative agent for deer malaria. Co-infection with deer malaria and epizootic hemorrhagic disease virus can cause high mortality and morbidity in WTD. Determining the vector(s) of deer malaria permits development of integrated pest management strategies that can ultimately reduce WTD mortality and morbidity at Florida deer farms, where WTD are an economically important species.

Variation in pyrethroid resistance and efficacy of triple action adulticide ReMoa Tri Symposium I

42 **Considerations for Effective Aerial Adulticide Applications**

Mark D. Latham, BA and MA in Natural Sciences from the University of Cambridge, manateemcd@aol.com

Abstract: Aerial adulticiding is a method used to effectively treat large areas infested with actively flying mosquitoes, either disease vectors or pestiferous species, without the need for a tight street network. However, unlike truck adulticiding which places the spray cloud directly into the target zone, aerial adulticiding relies on a combination of factors to move the spray cloud both horizontally and vertically from application altitude, typically between 100 and 300 feet, to the target near ground level. These factors include:

< ! 1) Aircraft vortices which entrain the spray droplets and then descend between 50 and 100 feet below the aircraft flight level before their energy decays to near zero. The strength, longevity and descent distances of the vortices are primarily dependent on aircraft characteristics such as size, weight, wing loading and forward speed, with larger slow-moving aircraft producing stronger vortices.

< ! 2) Atmospheric turbulence in the form of both horizontal and vertical air movement. Atmospheric stability describes the level of turbulence present in the atmosphere, a stable

atmosphere being characterized by little to no vertical air movement, a condition common soon after sunset on clear calm evenings. By contrast, a neutral atmosphere occurs on windy overcast evenings and is characterized by moderate turbulence that causes a significant vertical mixing of the spray droplets within the air mass.

< ! 3) Droplet sedimentation energy, which although relatively low (10's of feet per minute), can be of significance in bringing droplets down under stable atmospheric conditions with little vertical air movement.

Consideration must also be given to obstructions within the target habitat, such as forest canopies, which can limit horizontal movement of the spray. This presentation describes how these factors influence spray movement under different operational settings, an understanding of which is vital in planning accurate and effective aerial adulticide applications.

43 **"ReMoa Tri Rising to New Heights with Aerial Applications"**

Leanne Lake, Leanne.Lake@valentbiosciences.com

Abstract: ReMoa Tri recently was registered for ground-based spraying for controlling permethrin resistant mosquitoes. Aerial amendment is under review by the EPA. Operational aerial equipment used for aerial adulticide applications are varied and each equipment needs to be calibrated according to the application profile and needs of individual users. Application parameters that are commonly used across the USA were applied to several aerial applications of ReMoa Tri to develop a standard operating procedure. A review of the data collected for both fixed and rotary wing equipment, using wind driven and electric rotary atomizers, and conducting applications at altitudes of 150' to 300' will be presented. Methods of the droplet characterization process, droplet drift, and droplet deposition and best practices for such aerial applications will be discussed.

44 **Operational evaluation of ReMoa Tri against pyrethroid- and naled-resistant arbovirus vector species in Collier County, Florida**

Rebecca Heinig, PhD, rheinig@cmcd.org, Katie F. Williams, NA, Casey Crockett, MSc, MPH, PhD, Rachel Bales, Decyo S. McDuffie, MS, Hunter Martin, Keira J. Lucas, PhD, , , ,

Abstract: Collier Mosquito Control District is home to over 50 species of mosquitoes, among them disease vector species Aedes aegypti and Culex quinquefasciatus. Unfortunately, local populations of both vectors have shown indications of pyrethroid and/or naled resistance, which has severely limited the District's treatment options in the event of a disease outbreak. The introduction of ReMoa Tri presented a possible alternative. Because ReMoa Tri includes abamectin, which has a different mode of action than either pyrethroids or organophosphates, it was theorized that this material might be effective even against the District's most insecticide-resistant mosquito strains.

To evaluate this new product, the District first performed a series of semi-field trials in which adults from various local mosquito strains were placed in field cages and challenged with a ground-based ULV application of either ReMoa Tri or Merus 3.0, a pyrethroid. The results indicated that the ReMoa Tri successfully controlled not only pyrethroid-resistant Cx. quinquefasciatus but also naled- and pyrethroid-resistant Ae. aegypti. Based on these results, the District has initiated operational field trials in selected

residential areas. These trials are ongoing, but preliminary data suggest that ReMoa Tri shows promise as an effective addition to the District's integrated mosquito management program.

45 **"ReMoa Tri: Mortality Response of Local Culex Mosquitoes Using Ground Ultra-Low Volume Applications in a Cage Field Trial"**

Jasmine Che, lab@mosquitocontrol.org

Abstract: As insecticide resistance in mosquitoes becomes more prevalent, it continues to have a negative impact on the operational efforts of mosquito control and threatens vector-borne disease management. ReMoa Tri, a novel triple mode of action mosquito adulticide, was developed to fight against this issue and target pyrethroid-resistant mosquitoes. The Grandview Sewage Lagoons and Byron Ponds in south central Washington have historically been considered to be hotspots for mosquito breeding and West Nile Virus. They are, therefore, some of Benton County Mosquito Controls' most problematic areas in the district. It has been suspected for some time that these populations of mosquitoes have developed insecticide resistance to some degree. A cage field trial was conducted at Benton County Mosquito Control District to evaluate the efficacy of ReMoa-Tri against these local populations of adult Culex pipiens.

Arboviral Surveillance throughout the United States Symposium

46 **An Analysis of West Nile Virus Risk Thresholds and Epizootic Transmission Dynamics in a Two-Vector System**

Mark E. Clifton, Ph.D., mclifton@nsmad.com, Haley E. Johnson, Ph.D., Ana Erkapic, Megan L. Fritz, Ph.D., Thea Bliss, Susan Paskewitz, Ph.D., Lyric Bartholomay, Ph.D., , , ,

Abstract: Mosquito control organizations (MCOs) in the United States are charged with monitoring mosquito abundance and West Nile virus prevalence, assessing the risk to humans, and then intervening with mosquito control treatments to disrupt arboviral outbreaks thereby reducing the risk of arboviral infection in human populations. The best methods for assessing risk, as commonly employed by MCOs, contain assumptions and methodological flaws which complicates the ability of MCOs to coordinate interventions with the periods of highest risk to humans. In this study, we analyzed highly detailed, near-daily, disaggregated mosquito abundance and WNv prevalence data and compared that to an operational "best practice" MCO surveillance program. The results of this analysis indicate that the: 1) sympatric mosquitoes Culex restuans [Theobald] and Culex pipiens Linnaeus exhibit very different patterns of abundance and WNv infection rate, 2) WNv activity is highly variable on a day-to-day basis, 3) Gravid and host-seeking mosquitoes do not exhibit similar patterns of WNv infection and activity, 4) Cx. pipiens, when taxonomically separated from Cx. restuans using updated morphological keys, exhibited an extraordinarily high preference for human blood meals. Each of these observations impacts how the risk to humans of arboviral infection is assessed by MCOs.

47 **Arboviral surveillance and outbreak response in California**

Christopher M. Barker, PhD, cmbarker@ucdavis.edu, Ying Fang, MS, Sandra Garcia, Tina Feiszli, MS, Hannah Romo, PhD, Vicki Kramer, Ph.D., , , , ,

Abstract: California's statewide arbovirus surveillance program operates as a "three-legged stool" involving long-standing, close partnerships among the California Department of Public Health, the member agencies of the Mosquito and Vector Control Association of California, and the University of California, Davis. The program monitors endemic zoonotic arboviruses (West Nile, St. Louis encephalitis, and western equine encephalomyelitis viruses) and anthroponotic viruses that have the potential to emerge in the state (dengue, chikungunya, and Zika viruses). This presentation will cover (1) various elements of the statewide surveillance program, (2) methods used for collecting and testing samples from mosquitoes, sentinel chickens, and dead bird carcasses, (3) coordination efforts to ensure consistency of statewide surveillance results, (4) real-time data management, analysis, and reporting via VectorSurv for public-health and vector-control decision support, and (5) the statewide response plan for risk assessment and control of arboviral outbreak threats.

48 **Mosquito Testing in Texas**

Bethany Bolling, MS, PhD, bethany.bolling@dshs.texas.gov

Abstract: The Texas Department of State Health Services (DSHS) Arbovirus-Entomology Laboratory supports local jurisdictions with mosquito surveillance activities by providing species identification, population counts, arbovirus testing, and insecticide resistance testing services. A small number of counties in Texas have the capability to identify and test mosquitoes for arboviruses internally. In addition, there are commercial entities and academic institutions that can provide mosquito identification and arbovirus testing services to local jurisdictions. All statewide arbovirus-positive mosquito pool data is reported to the DSHS Zoonosis Control Branch, where it is compiled, summarized, and reported to the CDC through ArboNET. This presentation will cover current mosquito testing protocols utilized by the DSHS Arbovirus-Entomology Laboratory and other agencies in Texas. Historical data will be presented, highlighting the most common arboviruses detected in Texas mosquitoes. West Nile virus is the most prevalent mosquito-borne arbovirus picked up in mosquito pools each year, since it was first detected in the state in 2002. Other mosquito-borne pathogens of concern include eastern equine encephalitis virus, the dengue viruses, and malaria. Future directions for mosquito testing in Texas, as well as challenges, will be discussed.

49 **Mosquito-Borne Disease Surveillance in Florida**

Andrea Morrison, PhD, Andrea.Morrison@flhealth.gov, Rebecca Zimler, PhD, Alexis LaCrue, PhD, Maribel Castaneda, Edgar Kopp, MS, Lea Heberlein, DrPH, Danielle Stanek, DVM

Abstract: Arboviruses are of particular concern in Florida due to the state's semi-tropical climate, potentially allowing for year-round activity. Surveillance in Florida is a concerted effort between the Florida Department of Health (FDOH) and local mosquito control programs. West Nile virus (WNV), Eastern equine encephalitis virus (EEEV), and St. Louis encephalitis virus are endemic in Florida. In addition to surveillance for equine and human cases, Florida also has a sentinel chicken surveillance program. Mosquito control programs in 26 counties submit blood samples from sentinel chicken flocks, which are tested for endemic arbovirus exposure. FDOH generally screens at least 45,000 chicken samples per year. From 2001–2022, 13,210 chickens tested positive, with WNV being the most frequently detected (69%), followed by EEEV (22%). Human cases are more commonly reported for WNV, with an average of 20 each year (range 0–93; median 12). Human EEE cases are much rarer, with less than 100 documented cases since 1957 (average 1.3 cases per year; range 0–5). Mosquito-borne

illness advisories and alerts are regularly issued in response to increased activity; triggers are based on human and horse cases, sentinel chicken activity, or positive mosquito pools (not a primary surveillance method).

The state's high volume of international travelers also increases risk for introduction of exotic arboviruses, such as dengue, chikungunya, and Zika viruses. Dengue is the most common, with travel-related cases reported each year since 2009 (range 19–929; median 86), and at least one locally acquired case reported in Florida almost annually (range 0–77; median 7). As humans are the virus reservoir, surveillance activities focus on identifying human cases, so that rapid mosquito control activities can occur to prevent further transmission locally. Florida's unique environment and human population dynamics require a multifaceted approach for surveillance of both endemic and exotic arboviruses.

50 **Expanding Surveillance and Laboratory Capacity in the Canyon County Mosquito Abatement District**

Heather Ward, M.S., hward@2cmad.org

Abstract: The Canyon County Mosquito Abatement District (CCMAD) was founded in 1997 with its initial mission centered around mosquito control in the vicinity of Lake Lowell and the Deer Flats National Wildlife Refuge in Western Idaho. Over the years, CCMAD's scope has significantly broadened to encompass all of Canyon County, the second largest population hub within the Boise metropolitan area. The District spans 604 square miles and encompasses diverse mosquito habitats that sustain both pestiferous and disease-vectoring mosquito populations. During the mosquito season, CCMAD conducts routine arbovirus surveillance for West Nile virus (WNV), Saint Louis encephalitis virus (SLEV), and western equine encephalitis virus (WEEV). Prior to and including 2023, CCMAD relied on the RAMP testing method for rapid, in-house WNV testing, which provided same-day results. For confirmatory testing, as well as testing for SLEV and WEEV, CCMAD collaborated with the Idaho state laboratory. In 2023, CCMAD's laboratory surveillance manager successfully presented a proposal to establish in-house RT-qPCR testing capabilities for these three arboviruses, known to be in circulation within CCMAD's region. The primary objective was to enable CCMAD to conduct accurate arbovirus surveillance, without reliance on confirmatory testing and the state laboratory, for all three viruses while maintaining a swift turnaround time that would facilitate timely decisions for the operational teams, and public health notifications. This presentation will guide you through the process of developing and presenting the proposal to CCMAD's Board of Commissioners, and ultimately gaining approval to augment CCMAD's laboratory capacity with RT-qPCR arbovirus testing.

Operations II

51 **Re-emergence of Aedes aegypti in the Florida Panhandle**

Kaylyn Pearce, BSc in Wildlife Ecology and Conservation, kaylyn@pcbeachmosquito.com

Abstract: Aedes aegypti is an invasive mosquito vector that is present within the southern and eastern United States. Historically, Ae. aegypti was replaced by Aedes albopictus in north Florida through satyrization, but has recently been found in several counties north of its recently observed range. After almost 30 years of absence in this area, multiple observations of Ae. aegypti have been made across 2 counties in the Florida panhandle in 2023. It is currently unknown if this range expansion will be

sustained or if these are isolated observations. Regardless, Ae. aegypti is a significant threat to public health and will continue to be monitored for presence/absence within this geographic area.

52 **Welcome to the Neighborhood: Expanding Mosquito Surveillance in Central Texas**

Jason Fritz, MPH, jason.fritz@wilco.org

Abstract: Williamson County and Cites Health District (WCCHD) is the only local health department in Central Texas with staff dedicated solely to vector surveillance and control. Collaborations with academic, state, and federal partners have provided invaluable trainings and resources allowing WCCHD to remain prepared for local vector-borne disease (VBD) threats.

The WCCHD Integrated Vector Management (IVM) program was awarded a Vector Control Collaborative (VCC) grant from the National Association of City and County Health Officials (NACCHO) in early 2023 to mentor the Bell County Public Health District (BCPHD), a neighboring health department, on establishing a mosquito surveillance program. This grant allowed WCCHD to train BCPHD staff on routine adult mosquito surveillance operations such as trapping and species identification, guidance on routine and response procedures, and the creation of a surveillance system to guide treatment recommendations. The BCPHD began with ten Centers for Disease Control gravid traps and due to increased West Nile virus (WNV) activity in central Texas, has increased trap operations across the county. Additionally, this collaboration has allowed for presentations with BCPHD stakeholders on the importance of sustained funding for mosquito surveillance and control. The VCC also benefitted WCCHD by providing funds for professional development and supplies to increase its operational capacity, with an expected 50% increase of trap locations in 2024.

Since mosquito surveillance began in May, a total of 51 WNV-positive mosquito samples have been collected (as of September 23, 2023) from both Bell, and Williamson counties. Human cases of WNV have also been detected in these counties. As VBDs continue to threaten Central Texas, this funding opportunity has allowed these organizations to further address the gap in public health vector surveillance and promote stronger partnerships in this region.

53 **Not your average landing rate count: Strategies for dealing with surveillance numbers than aren't actually numbers**

Rebecca Heinig, PhD, rheinig@cmcd.org, Atom Rosales, Keira J. Lucas, PhD

Abstract: Landing rate counts (LRCs), or the number of mosquitoes that land on an observer during a set time period, are a common mosquito surveillance method due to their quick turnaround time and realistic assessment of local biting pressure. At Collier Mosquito Control District (the District), LRCs had traditionally been collected for either two or five minutes depending on the time of day. When mosquito densities were high, however, it was difficult to accurately count the number of mosquitoes landing during the proscribed time period, leading to "binned" estimates of 25+, 50+ or 100+. While these estimates were sufficient to determine whether treatment was warranted, averages calculated based on the numeric values were artificially depressed. In addition, because the District evaluates treatment efficacy by comparing average LRCs before and after pesticide applications, the binned estimates tended to underestimate treatment efficacy.

The District took a two-pronged approach to addressing this issue. First, the LRC data collection protocol was revised to allow technicians to record counts over shorter time periods, increasing LRC sensitivity and facilitating detection of post-treatment mosquito population density changes that had previously been obscured by the binned estimates. Second, curves were fit to frequency distributions of the District's historical LRC records. Averages for target years and areas were then recalculated using a hybrid method in which counts of less than 25 were treated as numbers, but binned values were replaced with randomly sampled integers from the relevant section of the fitted curve. The new averages were used to adjust the District's baseline population estimates, resulting in treatment thresholds that more accurately reflected local conditions. Making these small adjustments has yielded substantial dividends, not only improving the accuracy and sensitivity of the District's operational assessment tools but also creating new opportunities to use LRC data to answer quantitative research questions.

54 **Aerial application of bacterial larvicides for control of avian malaria in Hawai'i**

Serena Zhao, serena@kauaiforestbirds.org, Cali Crampton, Hanna Mounce, Bryn Webber, Christa Seidl, Lindsey Nietmann, Joe Iburg

Abstract: Avian malaria is one of the drivers of critical declines of endangered Hawaiian honeycreepers, endemic birds that are vital to forest function in the Hawaiian islands. With increasing encroachment of the vector mosquito Culex quinquefasciatus into endangered bird habitat due to climate change, effective control of avian malaria will require significant population reduction at a landscape scale. Here, we report on implementation and efficacy of aerial application of Bacillus thuringiensis israelensis (VectoBac, Valent Biosciences) and Bacillus sphaericus (VectoLex, Valent Biosciences) in remote montane forests of Kaua'i and Maui. Use of Bti tools in conservation management is not widespread. Here, we monitor efficacy of application in two forest types at the larval and adult stage. This implementation offers considerations for vector control in other environments with challenging access and logistical processes.

55 **Climate Change and Mosquito Control: The Effect of Atmospheric River Events in California's Central Valley**

Broox Boze, PhD, bboze@vdci.net, Vicki Kramer, Ph.D.

Abstract: Atmospheric rivers (ARs) are a type of storm that produce 50 percent of California's water supply and are responsible for 90 percent of the state's floods. As the name implies, they are like rivers in the sky. These elongated plumes of moisture carry saturated air from the tropics to higher latitudes and deliver large amounts of precipitation in the form of either rain or snow. In the winter of 2023, California experienced 12 of these extreme weather events which led to extensive flooding in areas that have become accustomed to severe drought. In March of 2023, both State and Federal Disaster Declarations were executed to assist communities impacted by flooding, snow, mudslides, avalanches, and debris flows that resulted from storms. Over roughly 3 weeks some parts of the state received 2-3 feet of rain and many communities struggled with flooding as water was diverted away from "towns" and into the once dry Tulare Lake basin which was previously recognized as the largest body of fresh water west of the Mississippi. The sudden reappearance of Tulare Lake, which was drained for farmland in the late 1800s, caused hundreds of millions of dollars in agricultural losses and the emergence of mosquitoes in unprecedented numbers. With assistance from the California Department of Public Health (CDPH), Vector Disease Control International (VDCI) was called in to assist

vector control agencies in Tulare and Kings counties with aerial larval and adult mosquito control operations. This presentation will cover the logistics involved with emergency response, touch on climate change, and highlight the importance of collaboration when dealing with unprecedented mosquito control issues.

56 **Hurricanes, Politics and Mosquitoes: The 3-Year Journey of Expanding the Boundaries of the Collier Mosquito Control District**

Keira J. Lucas, PhD, klucas@cmcd.org, Jonathon Little, ., Patrick Linn, MS

Abstract: Since 1950, the Collier Mosquito Control District has been dedicated to enhancing public health and the overall quality of life within our community. Originally limited to serving the City of Naples with a single truck, the district has since undergone ten expansions to accommodate residential growth in Collier County, Florida. In 2020, recognizing the need to cater to newly developed residential areas outside its existing boundaries, the district embarked on its eleventh expansion. During this expansion process, the district faced a myriad of challenges, including the construction of a new facility, hurricane-related damages, environmental stewardship concerns, and navigating the complexities of local and state politics. A significant aspect of this expansion involved addressing political tensions surrounding special district accountability and opposition to the perceived expansion of government. This presentation highlights the district's unwavering efforts to expand its boundaries and address the mosquito-related concerns of a growing population, while simultaneously managing various environmental and political considerations.

57 **State-mandated Security Standards for Drone Use and Its Impact on Mosquito Control Operations in Florida**

Keira J. Lucas, PhD, klucas@cmcd.org, Atom Rosales

Abstract: Uncrewed aerial systems (UAS), or drones, have assumed a critical role in mosquito control programs throughout Florida. However, owing to the nature of emerging technologies, the legislative and regulatory frameworks governing drone usage by government entities have struggled to keep pace with their use-cases. In 2021, the Florida Legislature passed legislation aimed at bolstering security and accountability regarding the use of drones by government agencies. This statute imposed the obligation to adhere to security standards and outlined a timetable for the grounding of drones produced by unapproved manufacturers, which indirectly affected mosquito control programs reliant on drones. While the intent behind the statute was to enhance security, its implementation resulted in operational disturbances and financial burdens for mosquito control programs. This presentation highlights the impact of state-mandated security standards on mosquito control drone operations and discusses the role played by the Florida Mosquito Control Association in minimizing disruptions to mosquito control drone activities.

58 **The National Special District Coalition**

Ryan J. Clausnitzer, MPA, ryan@mosquitoes.org, Cole Arreola-Karr

Abstract: The National Special District Coalition (NSDC) was formed in 2018 among state associations providing services to all types of special districts in states that also happen to have strong mosquito control programs: California, Colorado, Florida, Oregon, and Utah. Since then, the coalition has

expanded to Arizona, South Carolina, Texas, Washington, and Wyoming, as well as with industry-type associations throughout the country. NSDC began its federal advocacy program in 2020 in response to special districts' hardships obtaining COVID-19 relief funding that went directly to cities and counties. NSDC's top priority with the establishment of its advocacy program is to ensure the term "special district" is formally defined in federal law.

Mosquito and vector control districts will benefit from having another federal advocate to complement the efforts of AMCA that specifically looks at issues affecting special districts as unique public bodies. Underscoring the significance, the National Association of County and City Health Officials (NACCHO) consistently finds in its surveys that competent mosquito and vector control districts have dedicated funded programs. These districts exist across the country and continue to enjoy public support for their services.

Regardless of how these programs are publicly administered – whether independent or dependent –we are all dependent on each other and benefit through a good working relationship with our state and federal partners. NSDC can facilitate this positive, engaging partnership for mosquito and vector control districts and organizations across the states, and coordinated with AMCA.

Student Competition II

59 **3D Printing Mosquito Control: Manufacturing Unique Solutions**

Noah Wehner, techdevintern@cmcd.org, Atom Rosales, Keira J. Lucas, PhD

Abstract: 3-D printing was once perceived as a mere hobby, but has emerged as a powerful force driving innovation across numerous industries, including aerospace, medical, automotive, and now mosquito control. To harness this potential, Collier Mosquito Control District has spent the last year developing a workflow that includes prototype development, design refinement, and part finalization for facilitating the production of custom, cost-effective tools for mosquito surveillance.

60 **Identifying Biochemical Biomarkers for Pyrethroid Resistance in Aedes aegypti Mosquitoes**

Carla-Cristina Edwards, MS, ccedwards@ucdavis.edu, Erin Taylor T. Kelly, PhD, Lindsey Mack, PhD, Geoffrey Attardo, PhD

Abstract: Over the past decade, the invasive Aedes aegypti mosquito has increasingly colonized California, complicating vector control efforts due to its resistance to pyrethroids, the primary insecticides used for control. This study aims to elucidate and evaluate potential biochemical biomarkers associated with metabolic mechanisms conferring pyrethroid resistance. By dissecting these mechanisms, our research seeks to facilitate the development of targeted assays for novel resistance biomarkers to improve monitoring capabilities and identify and evaluate novel synergistic compounds.

61 **Evaluating the toxic effects of hemp extracts against Aedes aegypti mosquitoes**

Erick J. Martinez, martinezrodriguez.2@buckeyemail.osu.edu, Peter M. Piermarini, Ph.D. in Zoology, University of Florida, 2002; B.S. in Biology, James Madison University, 1995

Abstract: The goal of my study is to evaluate the toxic effects of hemp extracts against larvae and adult Aedes aegypti. I evaluated this by exposing 1st instar larvae and adult female mosquitoes for 24h

to different concentrations of leaf and flower hemp extracts. Our results show that both leaf and flower hemp extracts elicit toxic activity on larvae and adult mosquitoes, opening a potential path to use hemp has larvicides and adulticides for mosquito control.

62 **Exploring the role of vegetation in the interactions between invasive Aedes species in southern California**

Benjamin L. Nyman, B.S., bnyma001@ucr.edu, Alec Gerry, Ph.D., Kurt Anderson, Ph.D.

Abstract: The introductions of Aedes aegypti and Aedes albopictus to California and other areas have led to continued research as to how these species interact with each other, native mosquitoes, and the landscapes they inhabit. In an effort to explain the role of plant presence in current distribution patterns, adult mosquito traps were set out with water filled plants to compare larval presence, adult communities, and environmental data including climate, land use, and vegetation indices.

63 **Tick Control by the Pros: Effectiveness of Pest Management Professionals' Practices in Suppressing Nymphal Ixodes scapularis (Acari: Ixodidae) Populations in Wisconsin Backyards**

Zackary J. Sieb, B.C.E.-Intern, PHE, zsieb@wisc.edu, Susan Paskewitz, Ph.D., Lyric Bartholomay, Ph.D., Tela Zembsch, Bradley Tucker

Abstract: We evaluated the effectiveness of mosquito-only and mosquito-tick pesticide application protocols utilized by a multinational pest control company on the abundance of Ixodes scapularis nymphs at residential sites in Eau Claire, WI, USA. Both protocols utilized deltamethrin-based products. Mosquito-only protocol used a mist blower for application, and mosquito-tick used both mist blower and granular applications. Both mosquito-only and mosquito-tick protocols decrease the abundance of ticks. The unexpected impact of the mosquito-only protocol warrants further investigation.

Student Competition II

299 **Evaluating the impact of mosquito control strategies on the environment and public health**

Hannah Dehus, dehus.5@buckeyemail.osu.edu, David Narayanan, Megan E. Meuti, Mary Gardiner

Public concerns that chemical pesticides used to control mosquitoes could negatively impact pollinators prompted a study where we evaluated the efficacy of three different mosquito control strategies in reducing mosquito abundance and their impacts on beneficial insects. By collecting mosquitoes and pollinators from treated and untreated residential properties, we found that integrated mosquito management programs and commercial pesticide applications significantly reduced mosquitoes, but commercial pesticide applications also reduced nontarget insects relative to untreated properties.

302 **Investigation of Target-site and Metabolic Resistance in Florida Culex quinquefasciatus**

TJ Fedirko, fedirko.t@ufl.edu, Alden S. Estep, Neil D. Sanscrainte, Ana Romero-Weaver, Eva Buckner, PhD

Culex quinquefasciatus is a competent vector of many pathogens of public health importance like St. Louis encephalitis virus, Eastern equine encephalitis virus, West Nile virus, and filarial nematodes

that cause lymphatic filariasis. The over-reliance on insecticides for mosquito control has resulted in widespread insecticide resistance. The initial focus of our research was to conduct the first statewide survey of Cx. quinquefasciatus insecticide resistance across Florida, providing a baseline characterization of pyrethroid and organophosphate phenotypic insecticide resistance across the state. After characterizing pyrethroid and organophosphate phenotypic insecticide resistance, we investigated the roles that genetic (target-site) and enzymatic resistance mechanisms contribute insecticide resistance in Florida Cx. quinquefasciatus. The susceptibility of Cx. quinquefasciatus populations across 29 counties were examined using the CDC bottle bioassay against two pyrethroid and two organophosphate active ingredients (AIs). We found the resistant Culex L1014F kdr genotype and allele at every county and determined that kdr genetic resistance marginal is role responsible for insecticide resistance. Our results found that enzymatic families alone or in tandem are largely responsible for enzymatic resistance in Florida Cx. quinquefasciatus populations. Data resulting from this investigation potentially will aid Florida mosquito control programs in effectively addressing Cx. quinquefasciatus resistance using synergized control products.

Variation in pyrethroid resistance and efficacy of triple action adulticide ReMoa Tri Symposium II

64 **Giving Remoa a Tri: A Virginia cage field trial**

Charles Abadam, cabadam@suffolkva.us

Abstract: In 2018 insecticide monitoring in Suffolk, Virginia revealed Culex pipiens was resistant to all pyrethroids, malathion, and chlorpyrifos. Since that year other cities and counties in Virginia began to discover the same results. Since Cx pipiens is our primary vector for West Nile Virus it is important that we find a way to combat this resistance and control this mosquito population when it becomes a public health emergency. Pesticide rotation is an essential component when developing a strategy to control insecticide resistance. Unfortunately these Cx pipiens are not susceptible to any of the active ingredients in ground sprayed adulticides that are available on the market. So when we learned about ReMoa Tri, a new adulticide comprised of three active ingredients with three different modes of action we were interested in seeing how this new player would perform with our resistant Cx pipiens population. A standard cage field trial was performed with mosquitoes from Suffolk and Chesapeake, VA against ReMoa Tri and Zenivex E20. Overall ReMoa Tri was effective against local resistant populations of Culex pipiens in Suffolk and Chesapeake with mortality rates as high as 97.5% and the lowest rate being 32.5% over a 48 hour period. In contrast local populations of both cities were resistant to Zenivex E20, producing high mortality rates at a mere 22.86% and low rates of 0% over a 48 hour period.

65 **Evaluation of ReMoa Tri against resistant West Nile virus vector species in a cage-field ground trial in Maricopa County, Arizona**

James B. Will, james.will@maricopa.gov, John Townsend

Abstract: Maricopa County, Arizona continues to be a hot spot for West Nile virus activity in the United States. To reduce vector-borne disease transmission risk and vector species abundance, Maricopa County Environmental Services utilizes truck mounted ultra-low volume (ULV) ground adulticide

applications as part of their integrated vector management program. An important component of an integrated vector management program is to rotate products with different active ingredients to reduce the likelihood of insecticide resistance development. Therefore, we wanted to evaluate the effectiveness of ReMoa TRI (Valent BioSciences, LLC), and determine if it would be an effective formulation to incorporate into rotation. This presentation will discuss the results of our cage-field ground trial.

66 **ReMoa Tri Field Trial in Davis County Utah**

Gary L. Hatch, ghatch@davismosquito.org, Stephanie Warburton, Elizabeth Hart

Abstract: The Mosquito Abatement District-Davis with Valent BioSciences conducted a ground field trial with ReMoa Tri. Wild caught caged mosquitoes were placed in a standard grid pattern for ground application trials. Two spray applications of ReMoa Tri were conducted and a third application of permethrin with PBO was also conducted that same evening. Effectiveness of the ReMoa Tri was evaluated and a comparison of the ReMoa Tri with our standard permethrin with PBO application.

67 **Semi-field Evaluations of ReMoa Tri with Backpack ULV**

Jacob Tarango, jtarango@cvmosquito.org, Kim Y. Hung, Ph.D., Jennifer A. Henke, Gabriela Perezchica Harvey, Melissa Snelling, Arturo Gutierrez, Michael Esparza, Gonzalo Valadez, John Holick, Leanne Lake, Haley E. Johnson, Ph.D.

Abstract: The Coachella Valley Mosquito and Vector Control District (District) has had concerns about pyrethroid resistance with local mosquito species (Cx. quinquefasciatus). The District primarily uses pyrethroid-based products for adulticide treatments in response to arbovirus detection. Fyfanon (organophosphate: malathion) has shown to be effective, however this still limits the District to two types of active ingredients for product rotation. The lack of choices in active ingredients raises concerns about the inability to effectively rotate products for adulticide treatments. After bottle bioassays demonstrated that there is resistance in local Cx. quinquefasciatus populations to pyrethroids, the District began exploring the potential of Valent's product ReMoa Tri. Semi-field evaluations of ReMoa Tri were conducted using a Colt4 handheld applicator and a Fontan PortaStar S backpack. Both evaluations used a dilution of the product with ReMoa Tri diluent. The Colt4 had a higher dilution ratio (1:4) and did not perform as well. It was later determined that the product could not be diluted more than 1:2 product to diluent. The subsequent semi-field treatments with the PortaStar backpack at a reduced dilution showed that the product was effective against local populations of resistant mosquitoes.

68 **Tri-ing Times for Resistant Mosquitoes from Coast to Coast due to ReMoa Tri**

Haley E. Johnson, Ph.D., haley.johnson@valentbiosciences.com, Leanne Lake, Katie F. Williams,

Abstract: Truck-mounted ultra-low volume ground applications of the novel adulticide formulation ReMoa Tri have been evaluated by mosquito control programs across the United States throughout the 2022-2023 season. ReMoa Tri was evaluated using different types of ground ULV equipment and against a variety of mosquito populations that differ in species and insecticide susceptibility. Highlights from the past year conducting ground ULV trials will be provided as individual state registration for ground-based spraying continues. Additionally, because no two mosquito control programs are the same, lessons learned and best practices for operational success using ReMoa Tri will also be discussed.

Association/Society and Collaboration Symposium I

69 **How Collaboration Across Vector Control Affects Local Health Departments' Work**

Christine Phan, cphan@naccho.org

Abstract: Collaboration is a critical component to ensure programs evolve and produce efficient work by implementing unique prospectives and building relationships with various partners which is what the National Association of County and City Health Officials (NACCHO) has done since 1965. The organization's role is to advocate and support local health departments nationwide. NACCHO's Vector Control and Surveillance workgroup is composed of subject matter experts in local vector control organizations and academia. The importance of collaboration matters because it can solve problems on topics by sharing ideas and experiences to create common goals that will benefit the long term.

The purpose of the workgroup is to identify challenges in the field, discuss and share current best practices, and provide guidance that programs across the country can apply to improve their surveillance and control capacity. In addition, the workgroup provides input on policy statements, technical guidance, and supports collaboration with partner organizations and experts across the field. In 2021, NACCHO published a resource guide on building a local mosquito control program. This guide was created based on results from the 2017 National Vector Assessment where the workgroup has identified and contributed to ensure local health departments establish or improve their programs. As a result, the guide was a success since it was downloaded more than 300 times.

With the ever-present risk of both existing and novel vector-borne diseases, it is critical to ensure local health departments are receiving sufficient resources to establish and improve their vector control programs. This presentation will discuss NACCHO's Vector Control and Surveillance Workgroup.

70 **Centers for Disease Control and Prevention collaborations with societies and associations: promoting good vector control practices broadly and exponentially.**

Roxanne Connelly, MS, PhD, csz5@cdc.gov

Abstract: The mission of the Centers for Disease Control and Prevention's Division of Vector-Borne Diseases (DVBD) is to reduce illness and death from vector-borne diseases. Working with professional associations including the Entomological Society of America (ESA), National Association of City and County Health Officials (NACCHO), Society of Vector Ecology (SOVE), and the American Mosquito Control Association (AMCA) provides a means to reach key audiences broadly and exponentially. These collaborations assist DVBD in providing education, training, and guidance to 1) identify and detect vector-borne pathogens that cause diseases in people; 2) understand when, where, how often, and how people are exposed to vector-borne pathogens; 3) prevent exposure to vector-borne pathogens and mitigate consequences of infection; and 4) implement vector-borne disease diagnostics, surveillance, control, and prevention programs. Discussion will focus on specific past and current DVBD collaborations with ESA, NACCHO, SOVE, and AMCA, and ideas to consider for future projects that contribute to DVBD's mission.

71 **Finding Common Goals to Create Collective Impact: AMCA's Role in Collaboration**

Megan MacNee, MPA, CAE, mmacnee@mosquito.org

Abstract: In today's ever-evolving landscape of public health, mosquito and vector control, and environmental stewardship, unity among diverse organizations is paramount. Discover how the American Mosquito Control Association (AMCA) plays a pivotal role in fostering collaborative efforts across differing perspectives to drive positive change.

Explore AMCA's legislative and regulatory advocacy efforts, which amplify our collective voice and lead to more effective policy outcomes. Learn how AMCA supports state and regional mosquito control associations, facilitating knowledge sharing and capacity building to empower local efforts and create a network of interconnected professionals working towards common goals. As well as our success in securing grants to advance research, education, and innovative solutions, ultimately enhancing our collective capacity to protect communities from vector-borne threats.

Join us as we highlight how AMCA's commitment to collaboration is making a difference in the quest for a healthier, safer world. Together, we'll uncover the power of finding common goals and creating a collective impact for the betterment of our communities, the environment, and the future of mosquito control.

72 **Introduction about the symposium of association collaborations**

Rui-De Xue, rxue@amcdfl.org

Abstract: The purpose of the symposium is to share information about the related several associations for mutual interests in the field of mosquito and vector surveillance and control and look for potential collaborations for exchange of information about legislation issues, training, and funding resources. The associations included American Mosquito Control Association, Entomological Society of American (ESA)'s vector networkers, National Association of City and County Health Officer (NACCHO)'s vector control group, and the Society of Vector Ecology (SOVE), and the technical advisory organization-CDC/Division of the Vector-Borne Disease (DVBD). Each organization will introduce their mission statement, goal, and program about vector control training, legislation issues, and possible collaboration projects in the future.

73 **Society for Vector Ecology**

Michelle Brown, PhD, mbrown@wvmvcd.org

Abstract: The Society for Vector Ecology (SOVE) is a professional organization formed in 1968 by a group of individuals involved in vector biology and control programs in California. The membership has since grown to represent an amalgamation of diverse research and operational and extension personnel from all over the world. The Society is committed to solving many complex problems encountered in the field of vector biology and control. Among these are the suppression of nuisance organisms and disease vectors through integration of control elements, such as environmental management, biological control, public education, and appropriate chemical control technology.

The Society publishes the biannual Journal of Vector Ecology that contains research and operational papers covering many phases of vector biology, ecology, and control. The Society also distributes a periodic newsletter and holds an annual conference.

74 **Vector-Borne Disease Network: Creating one tent for vector advocacy**

Erin Cadwalader, PhD, ecadwalader@entsoc.org

Abstract: Formed in May 2019, the Vector-Borne Disease Network (VBDN) is a stakeholder group of non-profit organizations, including membership and trade associations, vector control groups, and educational institutions such as the CDC Regional Centers of Excellence. The group advocates for vector-borne disease research and management funding, seeks to connect the community of vector professionals, and envisions a world where human suffering from arthropod disease vectors is reduced. The Entomological Society of America (ESA) leads the effort and assumes an organizing role in developing and sustaining the network. The group has grown from ten members to several dozen. We aspire to continue to grow, creating a large tent under which the diverse group of entities can advocate together for increased support for vector-borne disease research, surveillance, and management. As Congress seeks to slash budgets, while the threat posed by these vectors continues to grow, it is increasingly important to work together to ensure policymakers hear one collective message.

Cryptic Mosquitoes: Hide and Seek and Treat? Symposium I

75 **Cryptic habitat of Culiseta melanura in Massachusetts**

Priscilla Matton, M.S., brismosqpc@comcast.net

Abstract: Culiseta melanura spends its larval stage in cryptic habitats under Atlantic white-cedar (Chamaecyparis thyoides) and red maple (Acer rubrum) trees. This habitat is segregated from open water and can be a barrier to larvicide treatment. Eastern equine encephalitis virus (EEEv) is an arbovirus endemic to the eastern United States. Human cases are rare but can be serious. The primary enzootic vector is Cs. melanura, a bird-biting mosquito. This mosquito has been shown to amplify EEEv in the bird population and abundant populations of Cs. melanura help to trigger large EEEv outbreaks. This habitat is unique, large and important in Southeastern MA.

76 **Culex Soup in the Northern Suburbs of Chicago, IL: Hunting down their cryptic habitats**

Patrick Irwin, MS and PhD, pirwin@nwmadil.com

Abstract: The Northern Suburbs of Chicago, IL has consistently been a hot spot for West Nile virus (WNv) since its introduction in 2001. There are several reasons why this area consistently has WNv in its mosquito population and sees spill over into the human population. First, we have a menagerie of Culex species and hybrids which are all competent vectors for WNv. Second, we have diverse above ground habitat for these species to flourish, and lastly, we must consider the ground below our feet – the extensive stormwater sewer system in the area. These subterranean cryptic habitats can serve as oviposition sites, larval development, and make excellent hibernacula for overwintering Culex species mosquitoes. I will be discussing the extent of the cryptic habitats above and below ground and the challenges we face in elucidating the role they may play in the endemic West Nile virus in the area.

77 **Hunting Down Sewer Mosquitoes**

Justin Harbison, Ph.D., jharbison@luc.edu

Abstract: Expansive stormwater sewer systems of metropolitan areas like Chicago can provide excellent habitats for all stages of West Nile virus mosquitoes. Join us as we begin our hunt for these mosquitoes in the very abundant yet logistically elusive habitat of belowground storm sewer pipes. To search for these subterranean insectoid predators, we have pulled together an elite team from the Midwest to employ nothing more than our wits, our strength of will and a couple of robot sidekicks. As we develop a plan of attack, we will discuss ways to assess both the extent of our infestation underfoot and the tools to defeat it.

78 **Updated molecular assay distinguishes Culex pipiens complex from Culex restuans**

Linda Kothera, lkothera@cdc.gov, Nicole L. Foley, M.S. Entomology

Abstract: A real-time PCR melting curve assay that unambiguously distinguishes Culex pipiens complex mosquitoes from the morphologically similar species Culex restuans has been developed. Differentiating between the two species is important because Cx. pipiens complex mosquitoes are more important disease vectors than Cx. restuans. Aligned mitochondrial DNA sequences of each species were examined for suitable priming sites. A 60 bp region of the cytochrome c oxidase subunit II gene was chosen, and designed primers consisted of a common forward primer, and species-specific reverse primers. Additionally, a 20 bp long “tail” was added to the Cx. pipiens complex-specific reverse primer to increase its melting temperature. The pipiens complex-specific amplicon melts at 78°C, while the restuans-specific amplicon melts at 72°C. We tested the assay with pipiens complex colony specimens, and Cx. restuans collected as egg rafts from the Chicago area. Specimens from rafts were raised to adults for genomic DNA extraction, with species determination confirmed morphologically at the 4th instar larval stage. Mixed pools of females were constructed to test the assay’s ability to detect small numbers of one species in pools of 50 individuals. The assay was capable of detecting a single individual of one species in a pool with 49 individuals of the other species; however, the assay is not quantitative because efforts to associate the height of the melt curve with the number of individuals of each species in a sample were unsuccessful. Nevertheless, the assay determined the presence/absence of each species, and worked on individual specimens. Unlike other assays that require a separate visualization step, the assay described herein consists of one straightforward PCR, does not require the purchase of fluorescent probes, and produces unambiguous results.

79 **The Importance of Accurate Mosquito Identification**

Dominic A. Rose, lvd9@cdc.gov

Abstract: Culicidae is diverse and a medically important group of Diptera. More than 3,700 mosquito species are recognized globally, including 200 reported species in the United States. The purpose of this presentation is to reiterate the importance of accurate identification because it is the most important aspect of mosquito surveillance. Accurate identification provides the foundation of species distribution, relative abundance, bionomics, and potentially medical importance. However, accurate identification of mosquito species is challenging. Historically, mosquito species identification has been completed using only morphological characteristics. Identifying mosquitoes collected during surveillance can be complicated by geographic location, bionomics, and habitat; these are important

factors in delineation of a species. Molecular taxonomy has more recently become a useful tool when identifying and classifying a species. In the United States, most species are easy to delineate; however, the genus Culex is often difficult to make species determinations for multiple reasons, including morphological variation, poor or unfavorable characters used to classify the species, and mutilated specimens caused by traps used for surveillance. Although challenging, accurate identification is fundamental to understanding the role and dynamics of various species in arbovirus, using control products efficiently, and implementing a successful integrated pest management program.

80 **La Crosse virus vectors in Appalachia: where do they come from, where do they go?**

Brian Byrd, PhD, MSPH, bdbyrd@wcu.edu, Joseph Davis, MS, Mary Nordgulen, MS, Kaylin Lewandowski, BS, Madeleine Craig, Charles Sither, MS

Abstract: Aedes triseriatus is the primary vector of La Crosse virus (LACV) – the etiologic agent of La Crosse encephalitis (LACE). In spite of its medical importance, there are significant gaps impeding effective surveillance methods for adults of the species. Here we synthesize a number of field studies conducted in our laboratory and within a LACE endemic region of western North Carolina and describe our current rationale for surveillance methods and their effective yields. The results of two trap-type studies investigating BG-Sentinels, gravid traps, Fay-Prince, CO2-baited CDC light traps, and the BG-Pro traps are presented in the context of Ae. triseriatus surveillance for La Crosse virus. The results of four field studies using ovitraps and/or large-bore aspirators are likewise summarized and presented. Entomologic surveillance recommendations for Ae. triseriatus and other LACV virus vectors (e.g., Aedes albopictus and Aedes japonicus) are provided based on these studies. Resting behavior knowledge gaps are also identified and presented in the context of barriers to potential control strategies.

Lesser Known Arboviruses Symposium I

81 **Lesser Known Arboviruses Impacting Animal and Human Health**

Ary Faraji, PhD, ary@slcmad.org, Goudarz Molaei, PhD, Ted Andreadis, PhD

Abstract: The occurrence of exotic and resurgence of endemic vector-borne pathogens have been predicted to further rise in the coming decades. In an effort to address problems surrounding vector-borne pathogens, we have dedicated a series of presentations entitled “Emerging and Lesser-Known Arboviruses Impacting Animal and Human Health”. It is our hope that that this series of presentations provided by subject matter experts will further contribute to our understanding of these lesser-known arboviruses for the benefit of vector control personnel, clinicians, and public health stewards within a One Health approach. This symposium will encompass some of the lesser-known arboviruses transmitted by biting midges (Diptera: Ceratopogonidae), mosquitoes (Diptera: Culicidae), and hard ticks (Ixodida: Ixodidae).

82 **Orbivirus epidemiology: What are bluetongue, epizootic hemorrhagic disease, and African horse sickness viruses?**

Lee Cohnstaedt, lee.cohnstaedt@usda.gov

Abstract: Bluetongue virus (BTV), epizootic hemorrhagic disease virus (EHDV), and African horse sickness virus (AHSV) are in the family orbiviridae and they are of significant importance to the health of

wildlife and domestic animals worldwide. These viruses are transmitted by multiple biting midge (Culicoides) species and their epidemiology is changing as the climate warms. The changes include increased geographic range expansion, more frequent outbreaks, and changes to biting midge species vector competency. As the climate changes, Orbivirus epidemiology will be inextricably altered as has been seen with recent outbreaks of BT, EHD, and AHS outside of endemic areas, and requires interdisciplinary teams and approaches to assess and mitigate future outbreak threats.

83 **Cache Valley Virus: An Underestimated Mosquito-Borne Virus with Deadly Potential**

Amanda E. Calvert, PhD, zpz0@cdc.gov

Abstract: Cache Valley virus (CVV) is a mosquito-borne virus in the genus Orthobunyavirus, family Peribunyaviridae. CVV is teratogenic in ruminants, causing fetal death and severe malformations during epizootics in the United States. CVV has caused severe human disease in seven individuals. Limited information exists on CVV regarding its geographic distribution, ecological cycle, seroprevalence in humans and animals, and spectrum of disease, including potential as a human teratogen. This presentation will outline the current knowledge regarding CVV's virological characteristics, ecology, and clinical disease in ruminants and humans. Current diagnostic techniques available and newly developed reagents for serological detection, including an IgM antibody capture ELISA (MAC-ELISA) with engineered human IgM positive control, will also be discussed. Lastly, the presentation will highlight past and current seroprevalence studies in the United States, Canada, and Mexico and emphasize gaps in current knowledge and considerations for future research.

84 **Everglades virus: an underrecognized disease-causing subtype of Venezuelan equine encephalitis virus endemic to Florida, USA**

Nathan Burkett-Cadena, nburkettcadena@ufl.edu, Amy Vittor, MD, PhD, Scott Weaver, PhD, Durland Fish, PhD

Abstract: Everglades virus (EVEV) is subtype II of the Venezuelan equine encephalitis virus (VEEV) complex (Togaviridae: Alphavirus), endemic to Florida, USA. EVEV belongs to a clade that includes both enzootic and epizootic / epidemic VEEV subtypes. Like other enzootic VEEV subtypes, muroid rodents are important vertebrate hosts for EVEV and certain mosquitoes are important vectors. The hispid cotton rat Sigmodon hispidus and cotton mouse Peromyscus gossypinus, are important EVEV hosts, based on natural infection (virus isolation and high seropositivity), host competence (experimental infections) and frequency of contact with the vector. The mosquito Culex (Melanoconion) cecedei is the only confirmed vector of EVEV, based upon high natural infection rates, efficient vector competence, and frequent feeding upon muroid rodents. Human disease attributed to EVEV is considered rare. However, cases of meningitis and encephalitis are recorded from multiple sites, separated by 250km or more. Phylogenetic analyses indicate that EVEV is evolving, possibly due to changes in the mammal community. Mutations in the EVEV genome are of concern, given that epidemic strains of VEEV (subtypes IAB and IC) are derived from enzootic subtype ID, the closest genetic relative of EVEV. Should epizootic mutations arise in EVEV, the abundance of Aedes taeniorhynchus and other epizootic VEEV vectors in southern Florida provides a conducive environment for widespread transmission. Other factors that will likely influence the distribution and frequency of EVEV transmission include the establishment of Culexpanocossa in Florida, Everglades restoration, mammal community decline due to the Burmese python, land use alteration by humans, and climate change.

85 **Jamestown Virus Comes into View: Understanding the Threat from an Underrecognized Arbovirus**

Philip Armstrong, ScD, philip.armstrong@ct.gov, John Shepard, M.S.

Abstract: In this presentation, we examine the epidemiology, ecology, and evolution of Jamestown Canyon virus (JCV) and highlight new findings from the literature to better understand the virus, the vectors driving its transmission, and its emergence as an agent of arboviral disease. We also reanalyze data from the Connecticut Arbovirus Surveillance Program which represents the largest dataset on JCV infection in mosquitoes. JCV is a member of the California serogroup of the genus Orthobunyavirus, family Peribunyaviridae, and is found throughout much of temperate North America. This segmented, negative-sense RNA virus evolves predominately by genetic drift punctuated by infrequent episodes of genetic reassortment among novel strains. It frequently infects humans within affected communities and occasionally causes febrile illness and neuroinvasive disease in people. Reported human cases are relatively rare but have been on the rise during the last 20 years, particularly within the northcentral and northeastern US. JCV appears to overwinter and reemerge each season by transovarial or vertical transmission involving univoltine Aedes species, specifically members of the Aedes communis and Ae. stimulans Groups. The virus is further amplified in a mosquito-deer transmission cycle involving a diversity of mammalophilic mosquito species. Despite progress in our understanding of this virus, many aspects of the vector biology, virology, and human disease remain poorly understood. Remaining questions and future directions of research are discussed.

86 **La Crosse virus neuroinvasive disease: the kids aren't alright**

Corey Day, PhD, MS, cday11@vols.utk.edu, Brian Byrd, PhD, MSPH, Rebecca Trout Fryxell, PhD

Abstract: La Crosse virus (LACV) is the etiologic agent of La Crosse encephalitis – the most common cause of neuroinvasive mosquito-borne disease in children within the United States. Despite the medical importance of this arbovirus, there remain serious knowledge gaps that prevent effective public health interventions. Ineffective human surveillance and reporting, clinical diagnostics and treatments, actionable risk indices, public awareness, and other factors clearly establish LACV disease as neglected. Here we examine opportunities to develop a larger framework to prevent, detect, and respond to LACV disease.

Cryptic Mosquitoes: Hide and Seek and Treat? Symposium II

87 **Oviposition rates and diversity differences in container breeding mosquitoes of La Crosse, WI**

Drew Tanner Lysaker, Public Health Entomology Certified, drew.t.lysaker@gmail.com, Barrett Klein, PhD

Abstract: Many species of container breeding mosquitoes will use multiple types of containers as sites of oviposition. These may include tires, plastic containers, and natural sources such as tree holes. The availability of artificial and natural oviposition sites may vary with habitat. Forested sites may contain more natural sites for oviposition while urban areas may contain more artificial sites. These differences may also affect the diversity of mosquitoes in each habitat. In 2023, I set out to determine how oviposition rates and diversity differed in forested and urban areas in the city of La Crosse. I set oviposition traps in three sites within La Crosse and three sites in forests surrounding the city. I collected

8,976 eggs across all traps and identified hatched larvae to determine whether there had been any habitat partitioning between native container breeding species and the invasive Aedes japonicus.

88 **Larval Ecology of invasive Aedes notoscriptus in the San Gabriel Valley, California**

Jamie Mangan, M.S., jmangan@sgvmosquito.org

Abstract: Aedes notoscriptus (Diptera: Culicidae) is endemic to Australia and invasive in parts of southern California. First detected in Monterey Park, CA in 2014, it has since been detected in other cities in Los Angeles, Orange, and San Diego counties. Aedes notoscriptus is a competent vector for Barmah and Ross River viruses and has demonstrated susceptibility to Dengue virus in a laboratory setting. To date, Ae. notoscriptus has not been implicated as a vector in the United States.

Larval habitats include cryptic natural and man-made containers, where they may compete with Ae. albopictus and Ae. aegypti. Larval and oviposition surveys were conducted to examine the larval ecology of Ae. notoscriptus and its relationship to other invasive Aedes species. Oviposition cups were placed at ground level, 1m, 2m, and 3m in height. Distilled and plant-infused water were compared at each height. Bamboo stumps, a frequent source of Ae. notoscriptus larvae, were used in the infusion.

We found that Ae. notoscriptus shares cryptic larval habitat with Ae. aegypti and Ae. albopictus in natural and manmade containers and that the infused water yielded more eggs. Current recommended surveillance and control practices for Ae. aegypti and Ae. albopictus are likely to have an effect on Ae. notoscriptus, due to their overlap in larval habitat. Differences in local Ae. notoscriptus ecology and potential competition between the three species may require additional surveillance and control strategies. Continued active larval and adult surveillance combined with community science will be used to further examine Ae. notoscriptus ecology in the San Gabriel Valley.

89 **The identification and rapid expansion of Aedes aegypti in Clark County, Nevada: 2017 - 2023**

Vivek Raman, MPH, REHS, raman@snhd.org

Abstract: The Southern Nevada Health District (SNHD) is the local governmental public health authority for southern Nevada, serving a population of over 2 million residents. Clark County is the southernmost county in Nevada and is composed of 5 municipalities and 1 county government: the city of Las Vegas, city of North Las Vegas, city of Henderson, city of Mesquite, Boulder City, and unincorporated Clark County.

Since 2005, SNHD has maintained a mosquito disease surveillance program to monitor mosquito populations, test for arboviruses and educate the community on breeding source elimination and bite prevention. SNHD does not conduct abatement and there is no single coordinated mosquito control program in Clark County.

In 2014 SNHD purchased Aeded aegypti specific surveillance equipment and in May, 2017 detected this vector for the first time in the city of North Las Vegas. Ongoing surveillance has documented the rapid spread of Ae. aegypti across Clark County, with species-positive traps in 6 zip codes in 2021, 12 in 2022 and 32 in 2023.

In addition to the rapid expansion, Ae. aegypti counts at residential trap sites have dramatically increased. Clark County experienced an abnormally high amount of rainfall in 2023 and complaints of

mosquito activity to SNHD's mosquito surveillance hotline increased from 99 in 2022 to 327 in 2023. Ae. aegypti was trapped at most of these homes. This trend of increased calls for service will continue as Ae. aegypti entrench themselves in communities.

The initial Ae. aegypti samples were submitted to Yale University for genetic analysis, which determined they were most likely introduced from southern California. Recent, longitudinal samples have been submitted to the University of Nevada, Las Vegas for whole genome sequencing, to establish whether the contemporary expansion of Ae. aegypti across Clark County reflects endemic dispersal or multiple reintroduction events from neighboring States.

90 **Cryptic Mosquito sites in Maricopa County**

James B. Will, james.will@maricopa.gov

Abstract: Maricopa County, located in the south-central part of the state of Arizona, had its first ever locally acquired case of Dengue in 2021. Aedes aegypti seem to thrive in this desert environment and we use several different traps to try and find the source. Trapping, along with a lot of groundwork, has led us to find a great number of cryptic breeding sites. We will discuss our findings in this presentation.

91 **Tempest in a container: how socioeconomic factors and Hurricanes Irma and Maria affected population dynamics and nutrient content of Aedes aegypti in San Juan Puerto Rico, U.S.A**

Donald A. Yee, donald.yee@usm.edu, Nicole Scavo, Limarie J. Reyes-Torres

Abstract: Urban environments often contain mosquito species that are responsible for transmitting medically important pathogens to humans. Large disturbance events, like hurricanes, can devastate large urban areas, especially in the tropics, however little data exist for how these storms affect vector populations. During September 2017 Hurricanes Irma (category 5) and Maria (category 4) passed in proximity to the island of Puerto Rico, U.S.A., causing significant damage to the built environment and significantly altering the abiotic environment including the removal of the plant canopy. We measured adult Aedes aegypti populations, the main vector of several pathogens, and larval containers across eight neighborhoods in San Juan, the capitol, that varied in socioeconomic status (SES) across eight sampling events over 17 months following the storms. We also analyzed the nutrient content (%N, %C, C:N) and stable isotopes (δ15N, δ13C) from adults and isotopes from containers to assess how the nutrient environments changed post hurricanes. Mosquito population sizes were invariant throughout sampling, although more females were collected in lower SES neighborhoods that were more enriched in δ15N compared to higher SES locations. We did find that the storms altered the stoichiometric content of adults, with lower C:N values right after compared to a year later; larval containers showed an increase in δ15N through time. The lack of any interactive effects of the storms on specific neighborhoods suggests that Irma and Maria affected all locations equally, however, the storms altered the nutrient content of both adults and larval containers, a result with implications for pathogen transmission.

92 **Lee County Mosquito Control's egg-cellent adventure: Using oviposition surveillance as a component of the sterile insect technique**

Steven Stenhouse, stenhouse@lcmcd.org, Rachel Morreale, Johanna Bajonero, Aaron Lloyd, Danilo Carvalho, David F. Hoel

Abstract: In 2017 Lee County Mosquito Control District began a sterile insect technique (SIT) program targeting Aedes aegypti on Captiva Island. The first step was the establishment of an entomological baseline in the area through a comprehensive surveillance program. While mosquito surveillance often focuses on adults, oviposition monitoring is an important component that can help reveal population dynamics and density, while also providing information on background sterility in the area. After the establishment of an entomological baseline, and once sterile male releases begin, data collected from continued oviposition surveillance can aid in determining the successful progression of a sterile release program and assist in locating areas that might require additional releases. Furthermore, viable eggs collected from the surveillance area are hatched in the insectary, reared to adults, sexed, and identified to species. Through these efforts, we have found that other species, including Aedes albopictus and Aedes triseriatus, also utilize our ovicup containers. Eggs collected from ovicups were the foundation upon which we began the strain of Ae. aegypti that we use for mass rearing and sterile male releases. As we continue to obtain eggs from the field, mosquitoes reared from these eggs are used to maintain genetic diversity in our colony. These added individuals help to limit negative colonization impacts, inbreeding, and ensure that our released males have a genetic background similar to that of the field population. Oviposition surveillance not only helps us to plan our sterile male releases, but it also helps us to produce better insects.

Intern to Imago: Student Professional Development at Mosquito Control Districts Symposium

93 **An overview of internship opportunites offered at the Centers for Disease Control and Prevention's Division of Vector-borne Diseases.**

Roxanne Connelly, MS, PhD, csz5@cdc.gov

The Centers for Disease Control and Prevention (CDC) offers a variety of internships and fellowships for early career public health professionals. For those interested in vector-borne disease control and prevention, the Public Health Entomology for All (PHEFA) and Oak Ridge Institute for Science and Education (ORISE) programs may be a good fit. This presentation will be an overview of PHEFA and ORISE opportunities offered at CDC’s Division of Vector-Borne Diseases (DVBD).

94 **Bridging the DEI Gap in Entomology**

Elynn Owens, MBA, MSN-HA, eowens@entsoc.org

Abstract: Black and Hispanics are heavily underrepresented in science, technology, engineering, and mathematics in academics and the workforce. This underrepresentation is due to the lack of access, resources, and encouragement to pursue these subjects at an early age. Achieving equity in science and other related fields has been an ongoing challenge and many students from underrepresented communities face opportunity gaps due to systemic imbalances and structural barriers in their educational and professional experiences.

To address these systemic and structural barriers, the Entomological Society of America (ESA) created the Public Health Entomology for All (PHEFA) program in partnership with the U.S. Centers for

Disease Control and Prevention. PHEFA offers Internships and Fellowships to encourage students and recent graduates from minority serving institutions who are interested in social justice and health equity to pursue entomology as a career and work toward a future in which all communities benefit from creative, inclusive, and equitable scientific processes and solutions.

During this symposium, participants will get insight into the PHEFA program, have access to professional and hear from experiences of PHEFA interns and/or fellows and entomologists. The goals and objectives of this segment is to offer students and early career professionals the opportunity to network, learn more about PHEFA, how to get involved, and to become educated on the research and findings that is currently happening in public health entomology.

95 **Growing Professionals Among the Mosquitoes at Salt Lake City Mosquito Abatement District**

Michele Rehbein, PhD, C.E., michele@slcmad.org, Christopher S. Bibbs, PhD, Nathaniel Byers, PhD, Ary Faraji, PhD, Gregory White, PhD

Abstract: Salt Lake City Mosquito Abatement District (SLCMAD) was chosen as a host site for the Public Health Entomology for All (PHEFA) internship program funded through the Entomological Society of America (ESA) and Centers for Disease Control and Prevention (CDC). Two undergraduate students from Salt Lake Community College (SLCC) completed 10-week internships and one high school student completed a two-week internship as PHEFA interns at SLCMAD. While this was the first year SLCMAD participated in the PHEFA program, there has been internship opportunities for undergraduate students available during the summers at SLCMAD. Internship projects vary widely and give students hands on learning experiences. Learn how SLCMAD connects with the surrounding schools and community to engage students and other educators in mosquito control work and continues to foster a positive learning environment for students that want to continue their education and training.

96 **High School Students and College Students and Graduate Students Oh My!: How to Create an Internship Program that Spans Different Educational Levels.**

Whitney Qualls, PHD, wqualls@amcdfl.org, Rui-De Xue

Abstract: Since 2005, Anastasia Mosquito Control District (AMCD) has provided multiple internships to all educational levels. The internship program was created to enhance AMCD's program through education and applied research, encourage interest in mosquito control from both scientific and non-scientific students, mentor interns in the scientific method, laboratory standards, and public health, as well as bring new technologies and methods to the field of mosquito control. AMCD has partnered with over 18 Universities and Colleges across the US, the Entomological Society of America's Public Health Entomology for All program, Centers for Disease Control and Prevention, the CDC Southeastern Center for Vector-Borne Diseases at the University of Florida Emerging Pathogens Institute, and the Academies of St. Johns County. In total we have trained 99 students: 32 graduate students, 44 undergraduate students, and 23 high school students. This talk will present an overview of how AMCD's internship programs work and how a mosquito control program can start an internship training program of their own.

97 **Interested in working within the federal government? Consider a fellowship with Oak Ridge Institute for Science and Education.**

Nicole L. Foley, M.S. Entomology, tsv4@cdc.gov

Abstract: Developing your wings post-graduation can be intimidating, yet a training internship or fellowship can alleviate these worries and stimulate career growth. The Oak Ridge Institute for Science and Education (ORISE) is a training organization funded by the U.S. Department of Energy with a mission to "shape the future of science" by offering internships and fellowships to students during their college career and up to five years following graduation. These training positions are stationed at a variety of U.S. government agencies such as the Centers for Disease Control and Prevention (CDC), the Department of Defense, and the National Institutes of Health. Opportunities through ORISE are advertised at www.zintellect.com/Catalog where specifics such as job descriptions, job locations, benefits, and length of appointment can be found. As a current ORISE fellow at the CDC's Division of Vector-Borne Diseases, I have trained in laboratory and field settings, while also being able to observe mosquito control operations. Training opportunities through ORISE are a beneficial way to gain experience and creating meaningful connections with experts in your field.

98 **From Water to Land: Evolving Career Skills and Interest at the Salt Lake City Mosquito Abatement District**

Gavin RH Maes, snyperg12@gmail.com

Abstract: My personal interest in life sciences have always remained in the health and mysteries of ocean life. While I still see myself being a marine biologist in the future, I believe it is important to be well rounded, and you should try to expose yourself to many fields of study. With this in mind, I applied and was accepted to be a Public Health Entomology for All (PHEFA) intern at the Salt Lake Mosquito Abatement District (SLCMAD). As a PHEFA intern at SLCMAD, my personal interests were heard and I was able to learn a large subset of skills that would be applicable to the entomological research I would be taking part in and also any future research in other fields. Beyond the efforts made by PHEFA and SLCMAD to foster my biological research skill set, I was presented with several opportunities to network and grow my professional connections which can be vital for success in anyone's future. After having finished my internship, I can say that I am very grateful for the opportunities to have grown as a biologist and evolved my personal interests to incorporate mosquitoes and other insects, and here I will be discussing my internship experience.

99 **Public Health Entomology for All Fellowship Experience**

Cassandra Durden, MS, bwh4@cdc.gov

Abstract: Public Health Entomology for All (PHEFA) is a program in collaboration with the Entomological Society of America and Centers for Disease Control and Prevention. PHEFA offers three different levels of opportunity: a 10-week internship, a one-year fellowship, and a 2-year fellowship. The two-year fellowship opportunities are research-intensive, requiring a Master of Science or a PhD. As a two-year fellow, I have participated in several research projects, including a large-scale vector control evaluation study in coordination with the North Shore Mosquito Abatement District (NSMAD) north of Chicago, IL. This area has historically high incidence of West Nile virus, and the NSMAD regularly treats catch basins throughout the area to control mosquito populations. The field work for this study has been completed, and data analysis is currently underway. The data collected from this project will be used to inform future vector control operations. Through this experience, I was able to gain valuable field skills in

mosquito control including collecting egg rafts, treating field sites, larval identification, and trapping methods. Participating in this project allowed me to familiarize myself with the operational workflow of a large mosquito abatement district, which has been a valuable part of my training in the PHEFA program.

Latin American Student Competition I

100 **Unveiling the miRNomic paradigms for Aedes aegypti control**

Mariana Lizbeth Jimenez, mariana.jimenez80@gmail.com, Iram P. Rodriguez-Sanchez, PhD, Gerardo Trujillo, Professor

Abstract: Global public health faces significant challenges from vector-borne diseases, with Aedes aegypti being the major vector of viral diseases such as dengue, Zika and yellow fever. MicroRNAs are regulatory molecules that play a critical role in gene regulation. Understanding how their expression varies throughout the life cycle of Ae. aegypti is of great importance to understand their influence on biological processes.

101 **Behavioral profile following exposure to a de novo molecule**

Susan Martinez, susanlizeth01@gmail.com, Gerardo Trujillo, Professor, Mariana Lizbeth Jimenez, Iram P. Rodriguez-Sanchez, PhD

Abstract: There are several effects generated by exposure to insecticides, knockdown is one of the most common, however, many insects can select resistance to this effect achieving a recovery and avoiding death. In the present study we evaluate the effects generated by the insecticide called "Moto" and describe the most important points as a new molecule for the control of Aedes aegypti.

102 **Differential effects of sonic frequencies on Aedes aegypti development in vitro.**

Vanessa Vargas, vane-vargas03@hotmail.com, Mariana Lizbeth Jimenez, Iram P. Rodriguez-Sanchez, PhD, Gerardo Trujillo, Professor

Abstract: There are antecedents that exposure to music works in different ways in the development of plants and animals, our approach is based on the previously mentioned, using different musical genres to evaluate the effect on the larval development of the Aedes aegypti mosquito and to determine if there are positive or negative morphological effects in its adult stage.

103 **An experimental house model for evaluating mosquito repellent formulations against Aedes aegypti and Aedes albopictus**

Devany Contreras, devscontreras@gmail.com, Mariana Lizbeth Jimenez, Iram P. Rodriguez-Sanchez, PhD, Gerardo Trujillo

We describe an experimental house model available at the Collaborative Unit for Entomological Bioassays (UCBE-UADY) that can be used for evaluating repellent formulations against wild, free-flying mosquitoes, including Aedes aegypti and Aedes albopictus, the vectors of dengue, chikungunya and Zika. We present results of the evaluation of the efficacy of a DEET repellent formulation, and the determination of Complete Time of Protection (CPT) on both Aedes species in semi-field trials in Merida, Yucatan, Mexico.

104 **Metabolomic profiling of Aedes aegypti under different nutritional approaches**

Cindy Gonzalez, cindysonica03@gmail.com, Iram P. Rodriguez-Sanchez, PhD, Mariana Lizbeth Jimenez, Gerardo Trujillo, Professor

Abstract: Metabolomics allows us to know the amino acids and acyl carnitines that are expressed under different conditions in Aedes aegypti, in this work we present the metabolomic results of four different larval diets generating knowledge of interest for the modification of metabolic pathways and to propose new control strategies.

105 **Oviposition-deterrent activity of plant extracts against Aedes aegypti resistant to conventional insecticides.**

Selene M. Gutierrez-Rodriguez, M.C., selenegutierrez328@hotmail.com, Jesus A. Davila-Barboza, D.Sc, Beatriz Lopez-Monroy, PhD, Iram P. Rodriguez-Sanchez, PhD, Ivan Cordova-Guerrero, PhD, Sergio A. Galindo-Rodriguez, PhD, Humberto Quiroz-Martinez, PhD, Adriana E. Flores, D.Sc

Abstract: Developing and incorporating new vector control tools based on chemical ecology are necessary to reduce mosquito disease transmission. Chemical substances that mediate the selection of oviposition sites by adult female mosquitoes have been identified. Salvia brandegeei and Salvia pachyphylla were shown to have an oviposition-deterrent effect in Ae. aegypti resistant to temefos and pyrethroids. In addition, both plant extracts produced a high percentage of inhibition in egg-hatching.

106 **Testing sterilizing properties of spiromesifen using WHO bottle bioassay**

Daniela Cerda Apresa, M.C, dcapresa@gmail.com, Selene M. Gutierrez-Rodriguez, M.C., Jesus A. Davila-Barboza, D.Sc, Beatriz Lopez-Monroy, PhD, Ma. Guadalupe Rojas Verde, PhD, Iram P. Rodriguez-Sanchez, PhD, Karla Saavedra Rodriguez, PhD, Adriana E. Flores, D.Sc

Abstract: Spiromesifen is an insecticide/acaricide belonging to the spirocyclic tetronic/tetramic acid derivatives class. It acts on lipid synthesis by inhibiting acetyl CoA carboxylase and causes a significant decrease in total lipids. We investigated the potential effect on the fecundity/fertility of Ae. aegypti exposed to sublethal concentrations of spiromesifen using bottle bioassay. The rates of oviposition and hatching were significantly reduced, besides the content of lipids and carbohydrates of females exposed to sublethal concentrations of spiromesifen.

107 **Evaluation of the susceptibility of Anopheles darlingi from the State of Amazonas, Brazil, to the insecticides deltamethrin, etofenprox and permethrin**

Quesia S. Amorim Martins, Quesia Amorim, quesiamorim90@hotmail.com, Cynara M. Rodovalho, Diogo F. Bellinato, Ademir de Jesus Martins-Junior, Priscila Serravale, Patricia Guimarães, José Bento Pereira Lima

Abstract: The state of Amazonas is one of Brazil's most affected areas by malaria and faces a persistent challenge in combating the disease. This study evaluated the susceptibility of Anopheles darlingi collected in five municipalities of this state to the main insecticides used to control the vector. The results revealed resistance to all compound, highlighting the need for constant insecticide resistance monitoring and exploring innovative strategies, such as combining insecticides with different modes of action.

108 **Insecticide resistance status and VGSC polymorphisms in Aedes albopictus (Skuse) (Diptera: Culicidae) populations from Mexico**

Andre Gabriel Castro Bautista, andrecastrobautista@gmail.com, Karla Saavedra Rodriguez, PhD, Adriana E. Flores, D.Sc, Beatriz Lopez Monroy, Perla Cecilia Martinez Sanchez, Ildefonso Fernandez Salas, Jesus A. Davila-Barboza, D.Sc

Abstract: Mosquito-borne diseases such as dengue, Zika, and chikungunya are major public health concerns, which are mainly controlled by using insecticides against the vectors; unfortunately, continued use has led to widespread insecticide resistance. Aedes albopictus has been reported in 21 Mexican states; however, we lack information about resistance status in this vector. Bioassays in mosquitoes revealed moderate resistance to pyrethroids and high resistance to temephos. Additionally, polymorphisms in the voltage-gated sodium channel were analyzed.

Lesser Known Arboviruses Symposium II

109 **The increasing threat of Rift Valley fever virus globalization: strategic guidance for protection and preparation**

Seth Gibson, PhD, Seth.Gibson@usda.gov, Kenneth Linthicum, PhD, Lee Cohnstaedt, Dana Mitzel, PhD, Melinda Rostal, PhD, Chad Mire, PhD, Assaf Anyamba, PhD, Leela Noronha, PhD, Heidi Tubbs

Abstract: Rift Valley fever virus (RVFV) (order Bunyavirales, genus Phlebovirus) is a prominent vectorborne zoonotic disease threat to global agriculture and public health. Risks of introduction into nonendemic regions are tied to changing climate regimes and other dynamic environmental factors that are becoming more prevalent, as well as virus evolutionary factors and human/animal movement. Endemic to the African continent, RVFV has caused large epizootics at the decadal scale since the early 20th century but has spread to the Arabian Peninsula and shows increasing patterns of interepizootic transmission on the annual scale. This virus can be transmitted by mosquitoes as well as through direct contact with infected tissues and can cause sporadic to widespread morbidity and mortality in domestic ungulate livestock as well as humans. High viremias in infected livestock moved for legal and illegal trade as well as in infected mosquitoes or human travelers can spread this virus worldwide. With increasing global commerce, it is likely RVFV will be introduced to new areas with suitable hosts, mosquito vector species, and environments. However, the strong mosquito component of RVFV epidemiology combined with advancements in vaccines, diagnostics, and virus evolutionary factors create opportunities for strategies to leverage models of connectivity among potential source and emerging regions to target surveillance and mitigation activities to reduce the risk of RVFV introduction, or contain the virus should it be introduced, into new regions.

110 **Snowshoe Hare Virus: Discovery, Distribution, Vector and Host Associations, and Medical Significance**

Edward D. Walker, PhD, walker@msu.edu, Thomas Yuill, PhD

Abstract: Snowshoe hare virus (SSHV), within the California serogroup of the genus Orthobunyavirus, family Peribunyaviridae, was first isolated from a snowshoe hare (Lepus americanus) in Montana, USA, in 1959. The virus, closely related to LaCrosse virus (LACV) and Chatanga virus (CHATV),

occurs across Canada and the northern latitudes of the USA, primarily in the northern tier of states bordering Canada. Reports of SSHV in northern Europe and Asia are probably the closely related CHATV, or the less closely related Tahyna virus. Vertebrate associations include snowshoe hares and ground squirrels, demonstrated by field isolation of virus from wild caught animals, seroconversion of snowshoe hares, seroconversion of sentinel rabbits, isolation of virus from sentinel rabbits, and experimental infections demonstrating viremia. Isolations of virus from field populations of mosquitoes include primarily univoltine and boreal mosquitoes of the genus Aedes, Culiseta impatiens and Cs. inornata; and, rarely, certain multivoltine floodwater Aedes species. Experimental transmission studies in mosquitoes show infection in and transmission by boreal Aedes and Culiseta inornata. Isolation of SSHV from larval Aedes on three occasions, and experimentation in Culiseta inornata, reveal transovarial transmission of the virus in mosquitoes. Serosurveys reveal exposure to SSHV in the human and domestic animal, with rates of seropositivity commonly high in some settings in Alaska and Canada, but disease in humans or horses has rarely been reported, only in Canada. The latter finding contrasts with the very closely related LACV, a common cause of encephalitis in children.

111 **Emergence and Spread of Heartland and Bourbon Viruses in New York State**

Alan Dupuis, alan.dupuis@health.ny.gov, Rachel Lange, Alexander Ciota, Ph.D.

Abstract: Heartland virus (HRTV, Phenuviridae: Bandavirus) and Bourbon virus (BRBV, Orthomyxoviridae: Thogotovirus) are emerging tickborne viruses in the United States. HRTV and BRBV were both identified from human cases in the Midwestern US in 2009 and 2014, respectively. Since the initial discovery of HRTV, more than 60 cases have been recorded in 14 states and at least 4 cases of BRBV in 3 states. Vector surveillance conducted during the epidemiological investigations for HRTV and BRBV and results of experimental infection studies have implicated Amblyomma americanum, the lone star tick, as the vector for both viruses. While A. americanum are typically found in midwestern and southern regions of the US, this species has experienced a recolonization of former territory and an expanded geographic range in the Northeast. Passive surveillance first identified HRTV and BRBV in New York State (NYS) in 2018 and 2019, respectively. Enhanced surveillance efforts conducted in Suffolk County since have consistently detected positivity in A. americanum with high seropositivity rates in white-tailed deer. To further our understanding of the emergence and spread of these viruses, we conducted full genome sequencing and phenotypic characterization of isolates from 2018-2022. Preliminary sequencing revealed distinct clades for both HRTV and BRBV when compared to the original midwestern isolates. Characterization in mammalian cell culture and experimentally infected A. americanum nymphs revealed little phenotypic distinction among and between the midwestern and NYS HRTV isolates. NYS BRBV isolates, however, display high levels of both genetic and phenotypic variability compared to each other and representative midwestern BRBV isolates. Additionally, we found BRBV but not HRTV NY isolates efficiently infect and replicate in Ix. scapularis following virus immersion. Genotypic divergence of both HRTV and BRBV suggest multiple, separate introductions of each virus into NYS with emergence of varying phenotypes potentially due to adaptation to geographically distinct transmission cycles.

112 **Colorado tick fever virus: A review of historical literature and research emphasis for a modern era**

Brian Foy, PhD, Brian.Foy@colostate.edu, Gregory Ebel, ScD, Emma Harris, Ph.D.

Abstract: Colorado tick fever virus is an understudied tick-borne virus of medical importance that is primarilytransmitted in the western United States and southwestern Canada. The virus is the type species of thegenus Coltivirus (Spinareoviridae) and consists of 12 segments that remain largely uncharacterized.Patterns of viral distribution are driven by the presence of the primary vector, the Rocky Mountainwood tick, Dermacentor andersoni. Infection prevalence in D. andersoni can range from 3-58% acrossthe geographic distribution of the tick. Infection in humans can be severe and often presents with feverrelapses but is rarely fatal. We will review literature from primary characterizations in the early 20thcentury to current virus/vector research being conducted and identify vacancies in current research.

113 **The known unknowns of Powassan virus ecology**

Doug E. Brackney, PhD, doug.brackney@ct.gov, Chantal Vogels, PhD

Abstract: Powassan virus (POWV; Family: Flaviviridae, Genus: Flavivirus) is the sole North American member of the tick-borne encephalitis sero-complex. While associated with high rates of morbidity and mortality, POWV has historically been of little public health concern due to low incidence rates. However, over the last 20 years, incidence rates have increased highlighting the growing epidemiological threat. Currently, there are no vaccines or therapeutics with tick habitat reduction, acaricide application, and public awareness programs being our primary means of intervention. The effectiveness of these control strategies is dependent on having a sound understanding of the virus's ecology. In this symposium, we will review what is currently known about POWV ecology, identify gaps in our knowledge, and discuss prevailing and alternative hypotheses about transmission dynamics, reservoir hosts, and spatial focality.

What Have We Learned: A Conversation on 15 Years of Spinosad Use in Public Health Symposium

114 **It Can't Be Done – Daring to Formulate Spinosyns for Public Health**

J. Lyell Clarke, lyell@clarke.com

Abstract: It was a long development journey before spinosad was introduced to the public health market as a new mode of action larvicide portfolio branded Natular® for the 2009 season. This session will reflect on the unique challenges and solutions behind Clarke's development of the Natular portfolio of larvicides, formulated with Corteva's (formerly Dow AgroSciences) Qalcova® brand spinosad.

115 **Utilization of organic approved spinosad-based larvicides by the Sacramento-Yolo Mosquito and Vector Control District**

Steve Ramos, sramos@fightthebite.net

Abstract: Utilization of organic approved spinosad-based larvicides by the Sacramento-Yolo Mosquito and Vector Control District

The Sacramento-Yolo Mosquito and Vector Control District (Sac-Yolo MVCD) places a strong emphasis on effective mosquito control and achieves this by using a wide range of methods and mosquito control products. The total number of organic acres has increased steadily over the years and drastically limits the mosquito control products that are available for use on organic registered properties. The use of Organic Material Review Institute (OMRI) approved larvicides such as Spinosad

plays a large role in achieving mosquito control on these organic properties. The Sac-Yolo MVCD works to strike a balance between respecting the landowners organic credentials and the effective use of products to control the mosquitoes produced on organic property. This presentation will focus on the variety of uses and efficacy of Spinosad based materials in its daily operations.

116 **Deploying spinosad for pre-treatment larval control management strategies in the Cayman Islands**

Kris New, B.S. in Agricultural Engineering, Mississippi State University MBA, Delta State University, kristoffer.new@gov.ky, Alan Wheeler, Ph.D, Medical Entomology, Keele University, Derek Drews

Abstract: Pretreatment applications of larvicides are an important tool in the prevention of large hatch-offs of mosquito broods. Understanding the treatment window and reliability of formulations for pre-treatment applications is critical to operational success. In a collaborative trial, the Cayman Islands Mosquito Research Control Unit and Clarke explored the pre-treatment viability of Natular® G30, a spinosad-based granular larvicide. A mix of field, laboratory, and analytical tests were used to assess the active ingredient's rate of degradation and validate its residual efficacy potential. Study results have informed Cayman Island's continued operational use of Natular G30 as an effective pre-treatment tool for larval control.

117 **How Spinosad enabled the operational journey from single to multi-brood larvicides**

Adriane Rogers, MS, arogers@pascomosquito.org

Abstract: The Pasco County Mosquito Control District has a long history of focusing on a proactive, comprehensive approach to controlling mosquitoes. Larvicide applications play a major role in the District's operation, which covers over 750 square miles. In the early years of the District, staff utilized mosquito ditches to keep salt marsh mosquito populations to a tolerable level. Chemical control options have become more numerous over the years as the District worked to create a comprehensive, integrated mosquito management program. Larvicide options used have ranged from predominantly single to multi-brood products. Pasco County, Florida is one of the fastest growing counties in the nation and the District has worked to increase it's workforce and fleet. However, additional growth is still necessary to keep up with the demands of a rapidly growing community. Over the past few years, the District has increased its use of residual larvicide products, like Spinosad, which has allowed staff ample time to discover new mosquito production sites to more effectively manage mosquitoes county-wide.

118 **Drone use with Natular G30**

Jared Arnold, jarnold@co.madison.id.us

Abstract: Madison County Mosquito District utilizes the use of drones along with Natular G30 in our larvaciding program. The majority of the areas we treat are high in organic matter ranging from large bodies of water, flood irrigated fields, retention ponds, to stagnant ditch/waterways. We have found after extensive field use that we get the most consistent application with Natular G30 vs other products with the variety of hoppers we have used. After years of using drones with Natular G30, we have found a decrease of 25% in the overall cost of product usage.

119 **Operational Use of Spinosad Over Diverse Habitats in Washington State**

Carina LeFave, clefave@gcmcd1.org, Ann Belchik-Moser

Abstract: Grant County Mosquito Control District No. 1 services 540 square miles in eastern Washington. The Columbia Basin Irrigation Project provides this desert environment with a challenging amount of water, creating diverse habitat for mosquitoes. The district utilizes Spinosad in the form of Natular G30 on federal and state lands, endangered species habitat, and agricultural areas. The product is applied using a single engine aircraft with applications beginning in mid-March and continuing until mid-October.

120 **The use of Spinosad on Florida Department of Environmental Protection and United States Fish and Wildlife lands in Lee County, Florida.**

Edward W. Foley, MS, MPA, Foley@lcmcd.org, David F. Hoel, Aaron Lloyd

Abstract: Lee County Mosquito Control District (LCMCD) utilizes the active ingredient spinosad as an integral part of larval mosquito control. With formulations lasting up to 180d, the use of extended release spinosad allows district personnel increased efficiency in the busy summer months. Along coastal marsh habitats, LCMCD routinely utilizes a 30d extended release granular to limit repeated treatments of larval sites. Through great cooperation with our partners from the Florida Department of Environmental Protection (FDEP) and the United States Fish and Wildlife Service (USFWS), LCMCD has worked into agreement the use of extended release larvicide on FDEP and USFWS lands in Lee County. The use of extended-release products over these areas has led to less disturbance from aircraft over lands deemed of sensitive nature by our land managing partners. The decreased treatments also have led to fewer disturbance from hikers and bird watchers enjoying the properties we seek to protect.

121 **Efficacy and nontarget effects of a spinosad-based larvicide in Minnesota vernal pools and cattail marshes**

Scott Larson, PhD, slarson@mmcd.org, Diann Crane, MS

Abstract: Larvicides that contain spinosad are used to control mosquitoes in diverse aquatic habitats. These same habitats are home to other invertebrates, including Crustacea and mollusks. A double-blind study evaluated the effects of Natular G on spring Aedes spp. and nontarget invertebrates in vernal wetlands. Within 14 d after application, Natular G controlled spring Aedes larvae by 53-84%, depending on species, but had no significant effects on fairy shrimp, fingernail clams, or freshwater snails. A second double-blind study evaluated effects on Coquillettidia perturbans and nontarget isopods and amphipods in cattail marshes. Treatment reduced emergence of Cq. perturbans by 25% but did not change the number of isopods or amphipods. The two studies indicate Natular G could be effective against spring Aedes in vernal wetlands, less so against Cq. perturbans in cattail marshes, and yet pose minimal risk to crustaceans and mollusks in either vernal wetlands or cattail marshes.

Breaking news! AMCA Launches FREE Virtual Training Program about Integrated Mosquito Management Symposium

122 **The AMCA's NEW Virtual Training Program on Integrated Mosquito Management**

Jennifer R. Gordon, jennifer@buglessons.com, Daniel Markowski

Abstract: In October 2023, the AMCA launched their virtual training program on Best Practices for Integrated Mosquito Management. The program was funded by the CDC and leveraged the expertise of 24 different instructors located throughout the U.S., Puerto Rico, and Australia. The program contains 13 modules on different topics related to science-based mosquito control, and after successfully completing each module, a student may choose to take a 100-question, comprehensive exam to earn a certificate they can leverage to advance their careers. After completing all readings, lectures, and evaluations, a learner will understand: fundamentals of mosquito biology and ecology necessary to locate and control immature and adult mosquitoes; the role mosquitoes play in disease transmission and the importance of using an integrated approach to protect people from these pests; the five principles of integrated mosquito management including: community engagement, collecting and using data, reducing potential larval habitat, using all control methods available and reasonable, and regularly evaluating the efficacy of the program; how to perform the different components of integrated mosquito management; and how to access additional information needed. This talk will discuss the history and creation, highlight the topics one can expect to learn, and suggest ways that both individuals and mosquito control organizations can use this program.

123 **Community Engagement in Mosquito Control**

Kristen Healy, PHD, khealy@agcenter.lsu.edu

Abstract: The goal of this presentation is to discuss the role of community engagement in a mosquito control program. It is part of a symposium highlighting the AMCA's new virtual training program. Learn the importance of community engagement, and useful tools that even low resource districts can utilize.

124 **Alexa, What is Arbovirus Surveillance?**

Kyndall Dye-Braumuller, MS, PhD, kyndallb@email.sc.edu, Jonathan Darbro, MS, PhD

Abstract: In the age where artificial intelligence can synthesize and write your research thesis for you, and evidence-based information is less popular than Doctor Google, MD, finding easy-to-consume and accurate science can be challenging. This can be especially true for individuals diving into mosquito and vector control for the first time, or someone intending to expand their own program. Where should they start? An example of such an expansion is beginning arbovirus surveillance. The Arbovirus Surveillance Module in the AMCA Integrated Mosquito Management Virtual Training Program aims to provide viewers an introduction to mosquito arboviruses, the process of surveillance, and various testing avenues. Beginning with accurate information will not only help viewers gain a high-level overview of this crucial step in mosquito and vector control, but also lead to better standardized methods. This talk will address the overall module genesis and process, while also highlighting the importance of consistent and evidence-based training in mosquito and vector control.

125 **Utilizing GIS Mapping and other Data Management Programs in a Mosquito Management Program**

Daniel Markowski, amca.ta@mosquito.org, Christopher M. Barker, PhD

There are numerous types of data that can be collected while conducting routine mosquito surveillance and management operations. But, how can you use this data to help make management

decisions? Data that is stored in a geospatial database and visualized in a geographic information system (GIS) can make your data leap from a printed page and transform your program's operations. When you incorporate a centralized database that can be easily accessed, the ability to analyze your daily operations, understand historical patterns, and develop predictive analytics becomes very powerful.

126 **Biological Mistakes and Novel Technologies**

Constance Darrisaw, darrisaw@lcmcd.org, Elizabeth Hart

Abstract: The Biological and Novel Control Techniques module of AMCA's new Virtual Training Program breaks down the definition of and need for biological control measures in a mosquito control program. It provides an overview of more familiar methods such as mosquitofish and Toxorhynchites, then sheds light on some emerging bio controls like Mermethid nematodes and SIT. The module also covers the importance of the ever-evolving arsenal of tools being made available to mosquito control in the form of new active ingredients, new trap designs, or newly integrated machinery like drones. Creating this compendium through a collaborative effort across three time zones presented certain challenges. Those, along with typical technological foibles, and the pressure of presenting to an audience one can't yet see made this a dynamic adventure to embark upon.

127 **The How-tos and What-nots of Adult Mosquito Control**

Broox Boze, PhD, bboze@vdci.net

Abstract: Area-wide adulticide applications rely on specialized equipment capable of atomizing a liquid insecticide to form millions of tiny droplets that persist in the air for short periods of time, rely on weather conditions to facilitate movement through a target site, and are only effective when they come in contact with flying mosquitoes. While the use of ultra-low volume (ULV) control strategies can be controversial, when used as part of a comprehensive Integrated Mosquito Management program, it is a necessary and highly effective solution for reestablishing populations to more manageable levels.

This presentation will cover the foundational principles required for ensuring an effective application, including equipment calibration, confirmation of droplet size, drift modeling, and weather parameters that facilitate movement of a spray cloud to its target site. The specialized equipment used for ULV space sprays can be mounted on aircraft, trucks, ATVs, or even handheld and backpack devices. Each of these application strategies has advantages and disadvantages that must be considered prior to use.

128 **Monitoring and managing insecticide resistance in mosquitoes**

Alden S. Estep, alden.estep@usda.gov

Abstract: The American Mosquito Control Association has produced a series of instructional videos for each chapter of the Best Practices for Mosquito Control guide that provides guidance and data-based instruction on a variety of common topics faced by vector control agencies and operational personnel. Monitoring and managing insecticide resistance (IR) is one of these lessons and IR is an increasingly common problem for vector control programs. IR can compromise the control of public health pests like mosquitoes by reducing the efficacy of operational control methods. Mosquito control programs must still be effective to control the spread of disease, even though insecticide resistance may be strong. Thus, successful implementation of the latest knowledge-based resistance monitoring and

management strategies is required to maintain effective control.This presentation reviews the video lesson on Monitoring and Managing Insecticide Resistance. Areas discussed are the mechanisms that result in IR; the standard methods that are used to characterize IR; how laboratory detection of IR relates to field operations; the strategies that can be implemented to manage IR; and the implementation of integrated vector management as the most effective means for long-term control.

Disease & Vector Studies I

129 **West Nile Virus in Tangipahoa Parish. What a Difference a Year Makes!**

Colby Colona, M.S., colby@tangimosquito.org

Abstract: At Tangipahoa Parish Mosquito Abatement in Hammond, Louisiana, 2022 saw the most West Nile virus activity since the district began in 2003. However, a sharp decline occurred in 2023. A comparison of both years (and previous years) will be discussed.

130 **Resources for arbovirus detection in vectors: support from the Centers for Disease Control and Prevention**

Kristen L. Burkhalter, ktb3@cdc.gov

Abstract: The Entomology and Ecology team (EET) within the Centers for Disease Control and Prevention's (CDC) Division of Vector-Borne Diseases, Arboviral Diseases Branch is located in Fort Collins, Colorado. EET has long provided support for domestic arbovirus detection in vectors to mosquito control districts, public health labs, and other agencies by way of specimen testing, technical assistance, and laboratory capacity building. This presentation will review our vector testing services, including how to request support, criteria for sample acceptance, and required specimen preparation and shipping protocols. Other resources offered by CDC, such as assay controls and technical assistance, will also be discussed.

131 **Developing mosquito bait-and-kill systems for local control of Aedes aegypti and other vector species.**

Jason Pitts, jason_pitts@baylor.edu, Heidi Pullmann-Lindsley, Robert Huff, John Boyi

Abstract: Adult mosquitoes possess an innate ability to detect and respond to volatile odor cues emitted by resources in their natural habitats. Amongst the most important cues are plant volatiles that facilitate nectar feeding and potentially direct individuals to suitable microhabitats for sheltering. Although some studies have identified chemical compounds in preferred plant hosts of Aedes aegypti, comparatively less is known about the molecular receptors that underlie plant choice. In the current study, we have utilized a cell expression system to study the activation of Ae. aegypti odorant receptors by a suite of plant-derived compounds. In addition, we have characterized small molecules that significantly reduce the lifespan of adults in sugar-feeding assays. The information we obtain from both areas of investigation can be used to design bait-and-kill trapping systems for local surveillance and control of target species. Moreover, this information establishes a baseline for studies of the chemical ecology of Ae. aegypti and, by extension, chemical detection mechanisms in other vector species for which highly conserved odorant receptors are encoded in their genomes and expressed in chemosensory appendages.

132 **Vector Control and Public Health Response to the First Locally Acquired Dengue Virus Infection in Maricopa County—Arizona, November 2022**

John Townsend, BS, john.townsend@maricopa.gov, Melissa Kretschmer, MA, Jennifer Collins, MPH, Ariella Dale, PhD, MPH, Brenna Garrett, Lia Koski, DrPH, MPH, Karen Zabel, MSN, Jessica White, DrPH, MS, MLS(ASCP), Katie Turnbow, Nicole Busser, James B. Will

Abstract: Dengue is not endemic in the contiguous US. Maricopa County Department of Public Health (MCDPH), Maricopa County Environmental Services Department Vector Control Division (MCESDVCD), and Arizona Department of Health Services (ADHS) monitor dengue virus (DENV) presence in Maricopa County. MCDPH and MCESD maintain a joint locally acquired mosquito-borne disease response plan. DENV infection was identified in a Maricopa County resident on November 8, 2022. The individual reported < 4 hours travel to Mexico on October 12th with febrile illness onset October 19th. In response, MCESDVCD conducted targeted mosquito pool testing. Both the patient and one mosquito pool collected October 5th tested positive for DENV-3, a DENV not known to be circulating in the travel region.

Per the response plan, MCDPH and MCESDVCD canvassed residences within a 150-meter radius of the case and positive mosquito pool November 17–19 to interview residents, collect human specimens for DENV testing, and assess properties for mosquito breeding. ADHS conducted DENV testing for participating residents. CDC confirmed IgM-positive samples by plaque reduction neutralization and PCR-positive samples with whole genome sequencing. MCESDVCD tested mosquito traps countywide for DENV by PCR.

DENV testing of 4,320 mosquito pools collected September 18–November 19 were PCR-negative. MCDPH and MCESDVCD approached 241 households; 72 (29.9%) consented to environmental assessments and 59 (24.5%) were interviewed. DENV IgM testing was done on 53/73 interviewees (72.6%). Thirteen respondents (24.5%) reported recent dengue-like symptoms; all were PCR-negative. One (1.9%) person had confirmed DENV-3 by PRNT and reported no travel in the 2 weeks prior to symptom onset. Environmental assessment of this residence identified Aedes aegypti mosquitoes.

We report the first probable locally acquired human DENV infection in Maricopa County. Response activities identified 2 likely autochthonous DENV infections. Established partnerships and pre-existing exercised plans were essential to mount a rapid, coordinated response to nonendemic arboviral transmission.

133 **Development of environmental DNA (eDNA) sampling for arbovirus vector surveillance in southern Nevada**

Katharine Major, BS, majork2@unlv.nevada.edu, Vivek Raman, MPH, REHS, Chad L. Cross, PhD, MFT, PStat(R), David Greer, Southern Nevada Health District, Christian De Haan, Southern Nevada Health District, John Cataline, Southern Nevada Health District, Joseph Franceschini, Southern Nevada Health District, Daniel Goldstein, Southern Nevada Health District, Christopher Begay, Southern Nevada Health District, Louisa A. Messenger, MSc, PhD,

Abstract: Accurate, rapid, and cost-effective surveillance of arbovirus mosquito vectors is critical for monitoring species distribution and infection prevalence and ultimately mitigating transmission risk. Currently, vector surveys conducted by the Southern Nevada Health District (SNHD) are limited to a few

productive sentinel sites, with considerable infrastructure and logistical requirements. New vector surveillance methods that are simple and unbiased at the sampling stage are needed. One potential method to increase efficient vector sampling capacity may be to exploit detection of environmental DNA (eDNA), shed by vectors breeding in aquatic environments.

In this study, we first designed and optimized a novel multiplex TaqMan quantitative PCR (qPCR) assay, based on single nucleotide polymorphisms in cytochrome oxidase I, for simultaneous detection of the three major regionally important arbovirus vector species: Culex (Cx.) quinquefasciatus, Cx. tarsalis, and Aedes (Ae.) aegypti. Next, 50ml water samples were collected from across Clark County using sterile plastic syringes and were filtered through 0.22µm sterile polyether sulfone syringe filters. Collection sites included water bodies that were adjacent to overnight gravid traps and BG sentinel traps, set by the SNHD, to compare vector species composition between sampling methods and additional aquatic environments in local public parks, golf courses, and drainage ditches. eDNA was extracted from filter membranes and screened for vector species presence using our qPCR assay. eDNA deposited by co-occupying Cx. quinquefasciatus and Ae. aegypti was detected in water samples, without observable larvae breeding, from multiple drainage ditches. Cx. tarsalis was identified in water samples from stormwater runoff and drainage channels in a public park.

eDNA surveillance has the potential to be implemented as a field-friendly, arbovirus vector surveillance tool for expanded entomological monitoring capacity in southern Nevada, to detect changes in dispersal patterns of arbovirus vector species as well as the spread of new invasive vector species.

134 **Wolbachia and larval competition: impacts on fitness and West Nile virus infection in Culex quinquefasciatus**

Abdullah Alomar, a.alomar@irmosquito2.org, Barry W. Alto, Eric P. Caragata

Abstract: Wolbachia bacteria are extremely widespread among arthropods but the roles that native Wolbachia infections play in mosquito biology and vector competence are still to be elucidated. This study evaluated the influence of Wolbachia in fitness and West Nile virus (WNV) infection in Culex quinquefasciatus under different levels of larval competition. Mosquitoes experienced longer development time as larval competition increased regardless of the presence or absence of Wolbachia. The presence of Wolbachia promotes adult eclosion under high larval competition stress. High competition leads to loss of Wolbachia density in adults. Although Wolbachia did not affect the susceptibility to WNV infection, it did lower WNV load in adults but only under low larval competition. These findings suggest that native Wolbachia infections can produce fitness benefits by promoting adult eclosion during high stress and reducing viral load when stress is low.

135 **Psorophora ferox colonization and bionomics**

Robert L. Aldridge, PhD, robert.aldridge@usda.gov, Kenneth Linthicum, PhD

Abstract: Bridge vectors have the potential to harbor and transmit pathogens outside the typical range of their primary vectors, and therefore are not traditionally targeted in evaluation of control efforts. Furthermore, a lack of lab based colonies to support insecticide evaluation through the use of

bioassays renders them less targeted. Here we present the methods to colonize Psorophora ferox, a bridge vector, from a wild population from Gainesville, FL, and the bionomics of this species. We also discuss potential projects with this bridge vector to help understand other target/primary vectors of interest.

136 **Mosquito management summary of the 2023 locally acquired malaria infections in Sarasota, Florida.**

Wade Brennan, wbrennan@scgov.net

Abstract: Florida has not seen autochthonous malaria infections in twenty years, but in the summer of 2023 Sarasota County experienced locally acquired malaria cases in our human population. Seven people were infected with Plasmodium vivax. Pools of Anopheles crucians and Anopheles quadrimaculatus were collected and positive specimens for P. vivax were found. Sarasota County Mosquito Management attacked this threat aggressively with the use of its robust integrated pest management program. During this presentation, timeline of events, strategies of pest management practices, communication networking, and more will be discussed. In conclusion, Sarasota County was removed from Florida Department of Health's Mosquito-borne Illness Alert status on September 12, 2023.

137 **Malaria in Florida, a regulatory and historical perspective of the 2023 locally acquired outbreak in Sarasota and Manatee counties**

Marah Clark, marah.clark@FDACS.gov, Jessica L. Ber, M.S.

Abstract: At the end of May 2023, the Florida Department of Health reported a locally acquired case of Plasmodium vivax in the Sarasota/Manatee County area of Florida. Within a two-month period, it escalated to seven cases and three positive Anopheles crucians, a first for the state in recent years. The most recent activity prior to this outbreak was twenty years ago on the other side of the state. Due to the infrequency of locally acquired malaria outbreaks in Florida, the mosquito control response to the 2023 outbreak required the two counties, as well as participating agencies to rely on available resources and limited knowledge. Despite these challenges, both Sarasota and Manatee counties, with support from Florida Department of Agriculture and Consumer Services (FDACS), mounted a targeted response to decrease the presence of Anopheles species. To overcome the different challenges the counties experienced, FDACS will be working to compile historical information to draft a guideline specific to addressing malaria in Florida. This tool will compile historical data and recent trends in mosquito control.

Latin American Student Competition II

138 **Genetic diversity and population structure of Aedes aegypti (L.) in the main areas of dengue transmission in México**

Damaris A. Luis Solis, damaris.luis95@gmail.com, Angel David Garza Robledo, Adriana E. Flores, D.Sc, Jesus A. Davila-Barboza, D.Sc, Beatriz Lopez-Monroy, PhD

Abstract: The study of molecular phylogeny and population genetics reveal evidence of biogeographic events and history traits that contribute to shaping the distribution of genetic variation among populations. In this study a 294bp fragment of the NADH dehydrogenase 4 gene (ND4) sequence

of Aedes aegypti from 35 localities of Nuevo León, Yucatán and Veracruz in Mexico was analyzed by PCR to identify the genetic diversity and population structure in these localities.

140 **IMPACT OF XENOBIOTIC EXPOSURE IN Aedes aegypti (L.) ON RESISTANCE TO DELTAMETHRIN.**

Mizael Gonzalez-Escandon, MEMV, mizael.gonzalezescn@uanl.edu.mx, Beatriz Lopez-Monroy, PhD, Adriana E. Flores, D.Sc, Humberto Quiroz-Martinez, PhD, Ildefonso Fernandez-Salas, Jesus A. Davila-Barboza, Dr.

Abstract: One of the main insecticide resistance mechanisms in Aedes aegypti populations is an increase of detoxifying enzymes activity. It has been shown that there are several xenobiotic compounds, including polycyclic aromatic hydrocarbons, which, through anthropogenic actions, reach urban mosquito breeding sites, contributing to the development of resistance to insecticides due to a cross-induction of detoxifying enzymes. The aim of this study was to evaluate the deltamethrin-resistance impact of xenobiotic exposure on Ae. aegypti populations.

141 **Genetic structure and kdr mutations in Aedes aegypti populations along a road crossing the Amazon Forest in Amapá State, Brazil**

Barbara Souza, MS, barbara.s.souza@hotmail.com, Leticia Lima, Allan Gallardo, Vincent Corbel, Jose Bento Lima, Ademir Martins

Abstract: In the state of Amapá, Brazil, insecticide resistance in Aedes aegypti, driven by kdr mutations in the NaV gene, was investigated in six isolated locations in the Amazon Rainforest. Using microsatellite markers and qPCR, we identified three prevalent KDR mutations and two distinct genetic clusters, with Oiapoque showing greater genetic differentiation and frequency of kdr mutations. These findings emphasize the importance of passive dispersal and the need for surveillance to combat resistance in Ae. aegypti.

142 **Metabolic mechanisms associated with deltamethrin and bifenthrin resistance in Aedes aegypti (L.) from Mexico**

Perla Cecilia Martinez Sanchez, ceciliamschz@gmail.com, Andre Gabriel Castro Bautista, Adriana E. Flores, D.Sc, Beatriz Lopez-Monroy, PhD

Abstract: Widespread use of pyrethroid insecticides to control the main dengue vector Ae. aegypti, has caused resistance in natural populations induced by increased metabolic activity. Metabolic resistance to pyrethroids is mediated mainly by glutathione S-transferases (GSTs) and esterases. In this study, we evaluated the relationship between the increased activity of detoxifying enzymes and the response after exposure to bifenthrin and deltamethrin in Mexican populations of Ae. aegypti.

143 **Effect of semiochemicals released by predators on Aedes aegypti oviposition**

Isaura Aguilar-Delgado, 1767520, isauraaguilard@gmail.com, Humberto Quiroz-Martinez, PhD, Violeta Ariadna Rodríguez-Castro, Beatriz Lopez Monroy, Eduardo A. Rebollar-Telléz, Jesus A. Davila-Barboza, Dr., Mara Ivonne Garza Rodriguez

The study focused on evaluating the impact of predators (and a naturally occurring insecticide as control treatment) on the oviposition of Ae. aegypti. The evaluation covered three densities and three different temperatures to measure the effect of predators, recording oviposition rates. Indexes of

oviposition activity, oviposition selectivity, and oviposition activity were calculated to understand species preferences in treatments.

144 **Effect of temperature on Wolbachia during Culex pipiens development**

Jovany Barajas, M.S., sbarajas14@ucmerced.edu, Fabián Gonzalez, Shaoming Huang, Andrea Joyce, PhD

Abstract: Cx. pipiens is a WNV vectors in North America and is natural carrier of Wolbachia. Temperature can influence the mosquito life cycle, and Wolbachia replication and density in its host is also sensitive to temperature. This research aims to determine the effect of temperature on Wolbachia presence in Cx. pipiens. Molecular and microscopy techniques were used for Wolbachia detection and quantification in embryo tissues from mosquitoes reared at three different temperatures. Preliminary outcomes are showed.

145 **Isolation and evaluation of entomopathogenic fungi of soils from the northeast of Mexico.**

Eduardo A. Sanchez Saldivar, M.S., asaldivar0@gmail.com, Jesus A. Davila-Barboza, D.Sc, Adriana E. Flores, D.Sc, Beatriz Lopez-Monroy, PhD, Selene M. Gutiérrez, M.S.

Abstract: Biological control agents are an alternative to chemical agents, but their application is limited in certain regions due to climatic conditions. For this reason, we develop a methodology for the isolation and evaluation of entomopathogenic fungi, native to northwest Mexico, to be used as a control agent against mosquitoes, such as Aedes aegypti, taking advantage of their natural resistance to the environment.

203 **Evaluating Spinosad Susceptibility in Brazilian Aedes aegypti**

Luciana dos Santos Dias, MA, lucianad@ioc.fiocruz.br, Ademir de Jesus Martins-Junior, José Bento Pereira Lima

Abstract: Aedes aegypti mosquitoes remain a significant public health concern in Brazil due to arboviruses transmission. Ongoing concerns involve cross-resistance, as many mosquito populations are resistant to insecticides such as temephos. In 2013, WHO-guideline lab tests revealed that Ae. aegypti populations were temephos resistant but susceptible to spinosad. Presently, spinosad is officially used and new tests show high susceptibility. This reaffirms the positive potential of spinosad as part of Ae. aegypti control programs.

300 **An experimental house model for evaluating mosquito repellent formulations against Aedes aegypti and Aedes albopictus.**

Devany Contreras, devscontreras@gmail.com, Anuar Medina-Barreiro, Biologist, Wilberth Bibiano-Marin, Biologist, Luis Felipe Ramírez-Sánchez, Undergraduate student, Iram P. Rodriguez-Sanchez, PhD, Gonzalo M. Vazquez-Prokopec, PhD., Azael Che-Mendoza, Gabriela Gonzalez-Olvera, PhD, Gerardo Trujillo, Professor, Pablo Manrique-Saide,

We describe an experimental house model available at the Collaborative Unit for Entomological Bioassays (UCBE-UADY) that can be used for evaluating repellent formulations against wild, free-flying mosquitoes, including Aedes aegypti and Aedes albopictus, the vectors of dengue, chikungunya and Zika. We present results of the evaluation of the efficacy of a DEET repellent formulation, and the

determination of Complete Time of Protection (CPT) on both Aedes species in semi-field trials in Merida, Yucatan, Mexico.

UAS Ops in Mosquito Control Symposium I

146 **UAS Operations at Lee County Mosquito Control District**

Nick Lefkow, lefkow@lcmcd.org, Aaron Lloyd, David F. Hoel

Abstract: In 2023, the use of Unmanned Aerial Systems endured a complete overhaul for all governmental agencies in Florida. While this was anticipated, the scope of what it would take to get back on track was beyond measure. 2023 has been a year of rebuilding as we bring our fleet and our operations into compliance with Florida Statute 934.50 and Florida's Department of Management Services rule 60GG-2.0075. In this presentation, I will detail how Lee County rebuilt the Drone & LiDAR Program with new drones and new staff in the wake of landscape altering Hurricanes and State governmental oversight.

147 **From Couch to 400 feet: Midland County Mosquito Control's Journey into Drone Operations**

Carl W. Doud, cdoud@co.midland.mi.us

Abstract: Midland County Mosquito Control (MCMC) began working towards being drone capable in 2022 in an effort to mitigate seasonal crew hiring woes. With only one existing drone pilot among the MCMC crew, efforts would lead to an additional four staff members as FAA certified drone pilots. A suitable treatment drone was researched and purchased, and the various administrative requirements at state and federal levels were tackled. Drone treatment was carried out in 2023 on 60 acres of larval mosquito habitat. Also discussed are plans and next steps with the drone program.

148 **Metropolitan Mosquito Control District Unmanned Aircraft Systems Larvicide Program.**

Jake Kirkman, BS in Biology and AAS in Land Surveying, Jkirkman@mmcd.org, Joe Elling, BS in Unmanned Aircraft Systems

Abstract: The Metropolitan Mosquito Control District has started to utilize unmanned aircraft systems (UAS) as viable treatment applicators. MMCD has been working over the last five years on how to adapt UASs to effectively fit within our abatement program. We have found that unmanned aircraft systems can be utilized greatly when it comes to applying granular larvicides. We have been comparing treatments with other means of applying larvicide to see how effective a UAS will be versus helicopter and ground field technician treatments. We are also working on integrating these systems with our current mapping technologies, as well as exploring the morale, safety, and efficiency benefits that come from utilizing UAS treatments. In this presentation, we will be discussing the steps we took to begin our drone program at MMCD, including obtaining a Certificate of Authorization (COA) from the FAA, receiving the required certifications to fly and treat with a UAS, and hiring field staff to perform daily treatments. We will also illustrate studies done comparing drone efficiency with ground applications, as

well as the benefits and shortcomings of the UASs we decided to purchase for the 2023 season. Presented by Jake Kirkman and Joe Elling

149 **Brunswick County, NC UAS Mosquito Control Operations**

Abram Young, abram.young@brunswickcountync.gov

Abstract: Brunswick County Mosquito Control has developed a specific workflow to make UAS mosquito treatment operations on dredge disposal sites successful. Traditionally, Brunswick County used backpack sprayers to larvicide these areas, along with a combination of water management strategies and source reduction projects to control salt marsh mosquitoes. These control methods are limited because dredge material "mud" within these areas can be deep and physically unable to support a team member or equipment. Drones provide a solution to this problem and allow for more acres to be treated.

Long before the first UAS treatment flight, a surveillance drone maps out the cell/dredged material. Water management strategies and source reduction efforts continue within these areas to remove all excess water from the site. Aerial spray polygons are developed and are inspected after rainfall events. Budget, staffing, access, environmental and seasonal conditions are key factors that determine product selection.

All UAS team members have specific tasks to keep the treatment drone in flight. Brunswick's UAS mosquito treatment team is made up of the following: UAS pilot, chemical tech, maintenance tech and ground surveillance. The UAS pilot reviews all aerial polygons and ensures the overall safety of the operation. Chemical tech loads the drone and tracks the application. The maintenance tech changes/charges batteries, cleans the hopper and checks the drone over after every flight. Finally, ground surveillance maintains line of sight and ensures larvicide is hitting the target area.

Each treatment cycle has a lot of moving parts to make each flight a success. It is essential to have a treatment system in place. Understanding this workflow will allow for a successful treatment cycle, address the challenges to come, keep mosquito populations at a manageable level and can reduce the larvicide technician's physical workload.

150 **The use of UAS for large area larviciding and adulticiding with multiple payload systems**

William H. Reynolds, breynolds@leateam.com

Abstract: This presentation will focus on operational applications of the PrecisionVision UAS for wide area ULV adulticiding and larviciding. The adulticiding and larviciding treatment sites range from .5 acres to 2,000. Application, multispectral and LiDAR payload systems will be discussed.

151 **Taking Flight with Drone Photogrammetry: Operational Uses for Aerial Imagery in Mosquito Control**

Atom Rosales, arosales@cmcd.org, Sara Grant, Keira J. Lucas, PhD

Abstract: Unmanned Aerial Systems (UAS), or drones, have had a transformative impact within mosquito control due to their operational ease, efficiency, and cost-effectiveness. At Collier Mosquito Control District, drone photogrammetry has become an integral component of our integrated mosquito management program for collecting and maintaining up to date aerial imagery which informs the

District's surveillance and treatment decisions. For these tasks, the District utilizes a Skydio X2E small mapping drone and a Inspired Flight 1200A heavy-lift drone equipped with a Sony A7R camera for mapping large areas. In response to land-use changes occurring in Collier County, the District uses these drones to acquire imagery for constructing maps that are used for planning aerial larvicide treatment missions, ensuring that the application of treatment materials is precise and accurate. The rapid development occurring necessitates routine drone inspections and mapping to ensure that the treatment areas reflect actual field conditions. In addition, these maps are also integrated into the District's field data collection service, FieldSeeker, as a custom basemap which aid field technicians in the placement of traps and landing count locations. This presentation will outline the District's workflow for acquiring, processing, and utilizing drone photogrammetry for operational purposes and highlight the advantages of leveraging aerial imagery for integrated mosquito management programs.

152 **Drones and the Residual Advantage at Turlock Mosquito Abatement District**

DAVID E. HEFT, MS/MPA, dheft@turlockmosquito.com, Samer Elkashef, Ph.D.

Abstract: The Turlock Mosquito Abatement District (District) was established in 1946 and is tasked with providing mosquito control to the 966 square mile area of Southern Stanislaus County in the Central Valley of California. Typical of the Central Valley, Stanislaus County is home to XXXX acres of agricultural which provides a breeding ground and harborage zone for several mosquito species, including vectors of arboviral diseases such as West Nile virus. In addition to agricultural areas, the District is responsible for controlling seepage caused by fluctuating levels of the Tuolumne and San Joaquin Rivers. If left uncontrolled these sources can produce aggressive mosquitoes that will eventually make their way into residential areas looking for a blood meal. Historically these sources have been treated via ground equipment such as amphibious vehicles and backpacks, which can be a lengthy process as well as costing the District in maintenance fees. Recently, with the advances in Unmanned aerial systems (UAS) the District has re-examined how public health applications are made with the goal to streamline workflows and cut down cost. By incorporating residual products such as Altosid P35 into UAS applications, the District has achieved these two goals. With the improvement in workflow staff has been able to inspect and treat more sources and provide a higher level of service to the residents the District serves.

Artificial Intelligence in Mosquito and Vector Control/Behavior/Biology/Genetics

153 **Aedes aegypti mosquitoes use the Ionotropic Receptor Ir68a to identify water sources**

Elaine Chu, M.S., echu004@fiu.edu, Andre L. Costa-da-Silva, Ph.D., Anthony J. Bellantuono, Ph.D., Helen Wagner, Ph.D., Kristian Lopez, B.S., Joshua Benoit, Ph.D., Matthew DeGennaro, Ph.D.

Abstract: Female mosquitoes rely heavily on chemical cues to effectively navigate their environment to survive. A key component that dictates the survival of mosquitoes is the ability to swiftly find water sources to successfully complete their life cycle. Larvae and pupae develop in water before becoming adults that eclose into the air. Adult mosquitoes must avoid dehydration; their susceptibility to desiccation which like other insects arises from their open circulatory system. Thus, hygrosensory behavior is essential to their role as competent disease vectors. Ionotropic Receptors (IRs) are a family of olfactory receptors that have evolved from ionotropic glutamate receptors that are conserved across

many taxa. IRs are indicated in sensory roles in invertebrates such as chemosensation and thermosensation. However, the role of IRs in mosquito hygrosensory behavior merits further investigation. Here, we identify a behavioral phenotype — mutant Ir68a mosquitoes show decreased ability to find water. Further studies are underway to elucidate how Ir68a allows mosquitoes to sense water.

154 **Barcoding Quantitative PCR assay to distinguish between Aedes aegypti and Aedes sierrensis**

Miguel Barretto, miguelb@mosquitoes.org, Dereje Alemayehu, Ryan J. Clausnitzer, MPA, Eric Haas-stapleton, Ph.D.

Abstract: Aedes aegypti mosquitoes are increasingly spreading across California. These mosquitoes are known carriers of mosquito-borne diseases including chikungunya, dengue and Zika. The ability for vector control to act quickly if this invasive species is found is vital to slowing or stopping their propagation. Typical species identification, visual morphological taxonomy, can pose issues for certain specimens, such as atypical and damaged larva and adults and morphologically similar interspecies eggs. DNA barcoding using the mitochondrial Cytochrome Oxidase I(COI) gene can be used to assign these problematic specimens to species given its conserved regions within species and single nucleotide polymorphisms (SNP) that distinguish interspecies differences. In this study, a multiplex quantitative PCR assay was developed to classify an ambiguous sample to two species: Aedes aegypti and Aedes sierrensis. The assay demonstrated an average sensitivity of 97.29% and an average specificity of 94.69% when tested on Aedes sierrensis. For Aedes aegypti, the assay had an average sensitivity of 98.61% and an average specificity of 93.89%. We expect that this Aedes ID assay could be employed by vector control organizations to identify potentially invasive Aedes aegypti specimens, especially when conventional methods prove inadequate for atypical samples.

155 **Why Mosquitoes Bite Me More Than You: How Differences in Human Skin Bacteria Influences Mosquito Host-Seeking Behavior**

Kaylee M. Marrero, B.S. in Biology, kmarr037@fiu.edu, John S. Castillo, Ph.D. in Biology, Andre L. Costa-da-Silva, Ph.D., Anthony J. Bellantuono, Ph.D., Niels Verhulst, Ph.D. in Biology, Matthew DeGennaro, Ph.D.

Abstract: Every year, mosquito-borne illnesses continue to be amongst the leading cause of death worldwide. Learning how to control mosquito behavior through traps and repellents is critical to reducing these diseases. Body odor varies across individuals and may be the key to understanding why mosquitoes selectively bite some people more often than others. Both human sweat and bacteria living on the skin comprise body odor, the latter creating a volatile blend that mosquitoes use to host seek. Four bacteria have been identified as important in Anopheles gambiae host-seeking behavior: Staphylococcus epidermidis, Brevibacterium epidermidis, Corynebacterium minutissimum, and Pseudomonas aeruginosa. In vitro community models of these bacteria on sweat plates are sufficient to show mosquito attraction in experimental settings. We tested the responses of host-seeking mosquito females to these four bacteria in equal and non-equal ratios identifying high attraction (HA) and low attraction (LA) blends. Using a uniport olfactometer to determine the attraction rates of Aedes aegypti, Aedes albopictus, and Culex quiquefasciatus, we found striking differences in response rates when comparing these species. Our research has expanded on this study to use a two-choice behavioral assay to determine if the mosquitoes prefer one in vitro skin bacterial community over others. We presented

Ae. aegypti females with one of three treatment groups: LA vs sweat (no bacteria), HA vs sweat, and HA vs LA. These results have shown us that Ae. aegypti mosquitoes prefer HA communities over LA communities. Additionally, we are utilizing mutant Ae. aegypti females to determine which olfactory receptors mosquitoes use to discriminate between skin bacteria. These studies will allow us to identify which are the most salient odors produced by these bacterial blends. This knowledge will further the development of long-lasting and effective probiotic repellents and attractants to mitigate the spread of mosquito-borne illness.

156 **Developing a vector monitoring in Berlin, Germany**

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Abstract: Aedes albopictus was repeatedly found in a garden colony in one district of the city in 2021 and in 2022. The city administration asked the Health authority of Central Berlin to start a vector monitoring programme with a special focus on the "tiger mosquito". The Health authority opened an email contact point, provides consultations for citizens and runs a pilot project on vector monitoring in all twelve districts of the city.Citizens are reporting on seen mosquitoes, send samples for identification and the Health authority performs an active search in selected areas of the city using BG-Pro traps without light, with Mozzibait and CO2 as attractants. The identification of found mosquitoes and the evaluation is performed using the Vectech´s artificial intelligence (AI) diagnostic entomology system (IDx).The campaign gained interest of the public, even on the federal level. Culex pipiens and Aedes vexans are the most common mosquito species reported by the citizens. After an email report from a citizen, one Ae. albopictus was actively found and thus its presence was confirmed in the Neukoelln district.Involving the public seems to be a good opening measure for a vector monitoring programme. Ae. albopictus is present in the city of Berlin, Germany, but more research is needed to confirm which mosquito species are established, what are the exact locations and the public health risk. Using an AI solution saved money for hiring an own entomologist and made the development of a monitoring programme much easier.A higher proportion of Ae. vexans in our database from citizens´reports could be a bias due to some similarity with Ae.albopictus and an interest of the public to "find the tiger mosquito", which results in frequent reporting to the Health authority.

157 **An AI imaging attachment for remote automated assessment of vector abundance and species diversity in mosquito traps**

Jewell Brey, MSE, jewell@vectech.io, Jaykob Cave-Stevens, BS, Roy Faiman, PhD, Sameerah Talafha, PhD, Thomas Jenkins, BS, Alyssa Shultz, Sanket Padmanabhan, BS, George Constantine, BS, Rongjun Wu, BS, Tristan Ford, MSE, Autumn Goodwin, MSE

Abstract: Vector surveillance is critical to understanding mosquito abundance, species diversity, and distribution. When fast and reliable surveillance data is available, mosquito control programs can effectively optimize interventions and assess impact. Unfortunately, conventional surveillance programs require significant labor, taxonomic expertise, and logistics to deploy traps on a daily basis, retrieve specimens, and sort, identify, and record specimen data. Recent advancements of AI algorithms known as convolutional neural networks (CNNs) have enabled image recognition tools, such as Vectech's IDX, to augment species identification in the lab. This presentation reports on the translation of such AI imaging systems to a tool called Scout designed to attach to mosquito traps. Scout immobilizes and images mosquitoes as they enter a trap, extracts abundance and species data from the images, and transmits

the information to a web dashboard in real time. This presentation will describe the attachment design, initial lab test results, and field testing planned in summer 2024.

158 **Deployed use and performance of IDX for AI vector identification in Maryland's mosquito surveillance program**

Autumn Goodwin, MSE, autumn@vectech.io, Roy Faiman, PhD, Sameerah Talafha, PhD, Thomas Jenkins, BS, Alyssa Shultz, Jewell Brey, MSE, Jaykob Cave-Stevens, BS, Sanket Padmanabhan, BS, George Constantine, BS, Rongjun Wu, BS, Tristan Ford, MSE

Abstract: Convolutional neural networks (CNNs) for image recognition, a deep learning method, have emerged as a promising modality with the capability to visually differentiate between mosquito species. However, use of this technology on wild field-collected specimens in an operational vector surveillance program has been limited. Here we present the first performance metrics of the IDX, Vectech's system for AI mosquito identification, as part of Maryland's mosquito control program in Anne Arundel County, MD. Specimens were collected on a weekly basis from twelve CDC gravid trap collection sites throughout Anne Arundel County over five weeks. Specimens were first identified and separated by species and sex using conventional methods by a professional entomologist inspecting morphology under a microscope. A technician then imaged the specimens using Vectech's IDX system. By comparing entomologist identification to the algorithm output by IDX, we are able to calculate the accuracy of the system across species. Over the study period, 2,591 specimens were collected and imaged representing 14 species, 10 of which were available in the identification algorithm on the device during the study period. The micro average accuracy was 94.9%. Of these 10 species, 7 species consisted of less than 30 samples. The macro average accuracy when including these species was 79%, while the macro average when excluding these species was 93%. Roughly three-fourths of the specimens collected were Culex pipiens sl, with algorithm identification accuracy of 96.4%. These advancements demonstrate the current capabilities of the IDX in the Mid-Atlantic region and its potential to support vector surveillance programs that may not have access to expert taxonomists or may have limited capacity to evaluate significant quantities of specimens collected at peak season.

159 **Dancing in the purple rain: color affinity and oviposition choices in the Western tree-hole mosquito, Aedes sierrensis (Diptera: Culicidae).**

Christopher S. Bibbs, PhD, chris@slcmad.org, Kai Casci, Student, Neil Vickers, PhD

Abstract: The western treehole mosquito is a pestiferous day-biting mosquito with a range extending the entire pacific seaboard and looping down to portions of the intermountain west. As a heartworm vector and urban opportunist, it demands at least some level of surveillance to understand its abundance. However, the species is refractory to a majority of conventional wisdoms for tracking mosquitoes. To attempt to find more options for Ae. sierrensis surveillance, a variety of oviposition attractants were evaluated in arena-style choice assays using colony reared adults. Among a gamut of alfalfa, oak, and beet infusions combined with color investigation and ovicup structure, it was ultimately found that Ae. sierrensis have an affinity for purple shades, plain water, and larger entryway sizes for the cup. A prototype cup was 3D printed using purple filament and suitable entryways, and used to re-test infusion waters. No particular attraction differences were detected after normalizing for the purple color. Comparisons to black 3D printed cups yielded unexpected observations that male mosquitoes aggregated on purple cups while females sheltered, but not necessarily oviposited, in black cups.

Although this is only a laboratory development, plans for field validation will be informed with insightful findings from literature to try to maximize success in future study.

301 **AI Driven Surveillance and Metagenomics for Modeling and Predicting Mosquito-Borne Diseases**

Miguel Saldaña, PhD, Miguel.saldana@phs.hctx.net

COVID-19 and more recently malaria, have acutely demonstrated the immediate need for new systems, innovations, and partnerships to better predict biothreats. With this purpose in mind Harris County Mosquito & Vector Control (MVC) has joined with Microsoft Research and other Academic partners to integrate an AI powered biological sensing network into their public health infrastructure. In addition to deploying novel AI powered Biological Weather Stations (BWS), MVC also has established the tools and infrastructure to genomically sequence samples collected by the BWS and rapidly analyze them for pathogens. Using one of the most advanced genomics AI developed at Microsoft Research, this system provides MVC with the tools for early detection and precise prediction of biological threats. A number of these BWS (mosquito smart traps) are already deployed around the county to evaluate their capabilities in mosquito population monitoring and collection, more devices arriving soon. This novel real-time pathogen sensing network aim to exploit mosquito vectors as sentinels of human and animal diseases, while monitoring them as they move through the environment to build innovative predictive models that can alert public health entities prior to major disease associated events, including outbreaks and pandemics.

Disease & Vector Studies II

160 **Factors impacting thermal tolerance in mosquitoes**

Kristen Healy, PHD, khealy@agcenter.lsu.edu

Abstract: Temperature, in general, impacts many aspects of mosquito biology, physiology, vectorial capacity, life history, and behavior. Species distributions are often partitioned out over time and space, due to climate and availability of resources. With climate change as a potential concern, there is much needed research to understand how temperature (especially at extremes) impacts mosquitoes. This presentation will be an overview of some factors that impact thermal tolerance in mosquitoes, as well as some data from our pilot studies on the impact of temperature on Culex and Aedes mosquitoes.

161 **Resistance and inhibitor testing on Aedes aegypti populations in the Florida Keys**

Heidi Murray, M.S., hmurray@keysmosquito.org

Abstract: Aedes aegypti is the species of greatest concern for mosquito-borne disease in the Florida Keys. Previous locally transmitted dengue outbreaks in Key West (2009-2010) and Key Largo (2020) show the need for an immediate and effective response to Ae. aegypti populations in the Florida Keys. An important part of the Florida Keys Mosquito Control District's vector response plan is adulticide application because it can provide an immediate reduction in Ae. aegypti adults. It has become apparent that in the Florida Keys, and throughout Florida, Ae. aegypti resistance to pyrethroids is prevalent. In this study, the CDC bottle bioassay method was used to look at resistance in Ae. aegypti collected from Key

Largo, Vaca Key, and Key West, Florida. Inhibitor testing was also conducted to look at which metabolic enzymes may be involved with observed resistance. Kdr-associated resistance was also examined with all three populations. Results from this study show that multiple factors are involved with resistance in Ae. aegypti populations in the Florida Keys and that resistance mechanisms vary between islands.

162 **Towards environmental surveillance of the invasive vector species Anopheles stephensi in sub-Saharan Africa**

Louisa A. Messenger, MSc, PhD, louisa.messenger@unlv.edu, Mojca Kristan, MSc, PhD

Abstract: Anopheles (An.) stephensi is a highly competent malaria vector whose historical distribution encompassed the Indian subcontinent, parts of South-East Asia and the Arabian Peninsula. Recently it has become an invasive vector species in the Horn of Africa, where it was first reported in Djibouti in 2012 and since then has spread to Ethiopia, the Republic of Sudan, Somalia, Yemen and most recently Nigeria, Kenya and Ghana. Unlike An. arabiensis, the main regional malaria vector species, An. stephensi breeds in man-made water containers, buckets, discarded tyres, and water storage tanks for domestic use and construction. These are sites that may not be under routine surveillance by the National Malaria Control Program; such larval habitats are often used by arbovirus-transmitting Aedes species. To inform prospective control strategies, novel surveillance methods for tracking An. stephensi dispersal dynamics and insecticide resistance mechanisms are urgently required, which are both agnostic to mosquito larval morphology and simple to implement at the sampling stage. Using new multiplex TaqMan assays, specifically targeting An. stephensi and Ae. aegypti, we validated the use of environmental DNA (eDNA) for simultaneous vector detection in shared artificial breeding sites. Study findings demonstrated that An. stephensi and Ae. aegypti eDNA deposited by as few as one larva in 1L of water was detectable. Characterization of molecular insecticide resistance mechanisms, targeting genetic fragments of the voltage-gated sodium channel, acetylcholinesterase and glutathione-s-transferase epsilon 2, was possible from eDNA shed by as few as 16-32 larvae in 50ml of water. An. stephensi eDNA, derived from emergent pupae for 24h, was remarkably stable, and still detectable ~2 weeks later. eDNA surveillance has the potential to be implemented in local endemic communities and at points of country entry, to monitor the spread of invasive vector species. Ongoing community studies are validating the feasibility of this technique under field conditions.

163 **Novel application of electrospun monofilament prototype textile fibers impregnated with DEET and picaridin for improved warfighter protection.**

James Cilek, PhD, james.e.cilek.civ@health.mil

Abstract: Prototype electrospun monofilament microfiber textiles were fabricated using “fresh” or recycled polyethylene terephthalate (PET) (from plastic drink bottles) impregnated with DEET, picaridin, or a recycled PET 1:1 blend of both produced by the Naval Research Laboratory, Chemistry Division. Target goal for materials was ≥80% mosquito repellency for ≥2 wks. Laboratory repellency bioassays were conducted in screened 3.8 diam by 30.5 cm glass cylinders using female Aedes aegypti. Fresh and recycled PET fibers with DEET provided >95% repellency through 24 h. Of these, only recycled-DEET fibers continued to provide >80% repellency for 2 wks then decreased below this level for the rest of the 5 wk study. Fresh PET textile with picaridin provided ~55% mosquito repellency at 0 h, spiked to nearly 90% at 24 h, and decreased to < 60% thereafter. Mosquito repellency of recycled PET fibers with picaridin was about 83% at 0 h but quickly lost efficacy afterward and remained at < 65% thereafter.

Repellency of 1:1 DEET/picaridin recycled PET fibers provided >97% repellency through 24 h, continued at >90% for 2 wks, then decreased to < 75% for the remainder of testing. In summary, impregnating repellents into PET fibers was successful from both a textile standpoint and for mosquito repellency. The recycled PET DEET and 1:1 blend textiles met the repellency criteria of ≥80% for 2 out of the 5 wk trials. Based on the results of this study, we continue to investigate novel, wearable textile repellent-impregnated materials capable of large-scale textile manufacturing for improved long-lasting protection of fielded military personnel against host-seeking mosquito vectors.

164 **Madariaga virus: What are you and where are you found?**

Michael J. Turell, mbturell@gmail.com, Gabriel Hamer, Tereza Magalhaes

Abstract: Prior to 2010, eastern equine encephalitis virus (EEEV) was known from North, Central, and South America, with lineage 1 found in North America and lineages 2-4 found in Central/South America. The Central/South American lineages 2-4 were considered to be much less virulent due to the scarcity of reported disease in either horses or humans. In 2010, it was shown that lineages 2-4 of EEEV were a distinct virus, Madariaga virus (MADV), in the EEEV complex. Recent finding of severe disease in both humans and equines indicates that MADV can be highly virulent. Unfortunately, very little is known about the epidemiology of MADV to include the identity of the vertebrate amplifying hosts and the actual vectors, or even its actual distribution. We will present current knowledge on amplifying vertebrate hosts, more likely to be small rodents for MADV in contrast to avian species for EEEV, and potential enzootic vectors are probably Culex(Melanoconion) spp. for MADV in contrast to Culiseta melanura for EEEV. Data will also be presented on the current known distribution of MADV. As MADV is now known to be causing human and equine deaths, it is critical to develop a better understanding of the factors affecting MADV transmission.

165 **Edge of range invasion and infection of Aedes albopictus**

Jennifer Shimola, Doctorate in philosophy in Biology, jshimola@toledomosquito.org, Jacob Sublett, Master of Science in Biology, Gayathri Beligala, Ph.D., Paul Bauman, M.S.

Abstract: Aedes albopictus was first detected within Lucas County, Ohio at a commercial tire facility in 2017. Following the initial collection, Ae. albopictus have been collected every subsequent year with an increasing abundance and distribution. The average female Ae. albopictus count has increased at the original location from 2 to 44 mosquitoes per trap since their detection. Currently Ae. albopictus has been detected up to 12.9 km from the presumed introduction site and is repeatedly observed in the same locations between years, though a clear source of reintroduction is not present at most sites. Given these findings, Ae. albopictus has likely become established in northwest Ohio and is overwintering. In 2023, seventy-two field-collected Ae. albopictus pools were tested for West Nile virus and seven positive pools were detected. Collections were made over a 17-week period, but all positive pools occurred between epidemiological week 30 and 33. Currently, weeks with positive pools have a minimum infection rate between 34 to 83. The virus appears to be wide-spread within the introduced range as thirty-five percent of the 17 locations sampled had positive samples.

167 **Diel Activity Patterns of Arizona Mosquito Species in Urban Settings**

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Abstract: Maricopa County (AZ) frequently leads the United States in West Nile Virus (WNV) cases and has reported its first locally transmitted Dengue case in 2022. Being one of the fastest expanding metropolitan areas in the nation, there is increasing concern of mosquito-borne illnesses due to human influence and urban impacts in a desert environment. Currently, we have a good understanding on vector species dynamics and diversity across the area, but disease transmission (especially Aedes spp.-borne diseases) depends on the spatial-temporal movement of both humans and mosquitoes. It is important that the risk of contracting arboviruses is studied in more detail, to better understand where and when humans get infected. Collection bottle rotators with EVS traps have surveilled mosquito activity in 5 representative urban areas, by collecting mosquitoes in hourly intervals. Here, we report species diversity and abundance per hour, throughout the mosquito season of 2023 (April to November). This data will be compared with hourly human movement patterns to establish disease transmission risk maps, and to identify the locations and/or communities most at risk for mosquito-borne diseases throughout the Arizona mosquito season.

168 **Selective pressures for insecticide resistance; may the selective force be with us**

Silvie Huijben, PhD, shuijben@asu.edu, Brook Jensen, B.S., Don Ward, BS, MSPH, Joshua Ain, Yazid Aldosari, Mackenna Berg, Simranpreet Chatta, Jillian Higbee, Ashlyn Maag, Tara Magana, Emma Royster, BSc

Abstract: Insecticides are rapidly failing to control mosquito populations around the world. It is thus of critical importance to understand the spread of insecticide resistance and use resistance management strategies (RMS). However, to do so, we need to know the selective pressures acting of mosquitoes both in the presence of a range of insecticide dosages, as well as in the absence of insecticides. We generated genetic crosses of three Aedes aegypti mosquitoes both resistant and wildtype at the kdr V1016I + F1534C and exposed these to different dosages of insecticides to determine the selective pressure at high and waning insecticide dosages. We further assessed how this selection is dependent on temperature. Next, we determined the cost of resistance associated with these resistance mutations, both at optimal conditions and under temperature stress of colder and hotter environments, as well as under high and low larval densities. Finally, we assessed the selection acting on these kdr mutations in field populations in Maricopa County, Arizona. We found that the double homozygous mutation is incomplete recessive and has a huge selective advantage at high insecticide dosages. We did not find evidence for a fitness cost associated with these mutations at optimal temperatures, but a potential fitness cost at high temperatures. These data predict a rapid selection for double mutants that is unlikely to revert in the absence of insecticides. Indeed, the field data show a rapid increase of double mutants in Maricopa County over the past five years. Overall, these results suggest that RMS that assume fitness costs are unlikely to be effective on these mosquitoes.

169 **Rainfall and the population dynamics of Aedes triseriatus in a forested area of southern Indiana.**

Luis Chaves, PhD, lfchavs@gmail.com, Sajjad Khan, Madison Abel

Abstract: Aedes triseriatus (Say) is a medically important and common mosquito in the US Midwest. Here we present results of a season long study quantifying the response of Ae. triseriatus to weather changes. In this study we set two types of ovitraps (250 and 350 ml) in three transects at the Research and Teaching Preserve of Indiana University, in Bloomington, Indiana. To investigate the role of

rainfall regimes, in the first transect we paired the small ovitraps, in the second transect we paired the large ovitraps and in the third transect we paired a small and large ovitraps. In the transects with ovitraps of the same size we refilled water to a set volume each week in one of the ovitraps during the study, while water in the other ovitraps followed rain dynamics. From June 26 to October 2 2023 we collected a total of 918 4th instar larvae. Using a repeated measurements ANOVA we found no differences on the number of Ae. triseriatus larvae per ovitrap, as function of trap size (df= 39, F= 2.78590, P< 0.1031) and weekly water refilling (df=39, F=0.25204, P< 0.6185). The average number of larvae per ovitrap being (mean ± SD) 1.46 ± 2.80. We also analyzed the response of the time series to locally measured temperature, accumulated water and relative humidity which suggest this mosquito species is sensitive to temperature and rainfall changes.

From Buzz to Bust: The Future of Mosquito Surveillance for Innovative Control Strategies Symposium

170 **From Convention to Innovation: How Can we Bridge the Gap Between Conventional Surveillance Methods and Innovative Control Strategies?**

Jennifer McCaw, M. Sc., jennifer.mccaw@biogents.com

Abstract: The last few decades have seen a significant amount of innovative control strategies including mass trapping, SIT techniques, GMO, drones for larvicide dispersal and even citizen science programs to name a few. While the control strategies are rapidly evolving, the mosquito surveillance scene has remained relatively unchanged for the last half of a century. Since the development of the New Jersey Light trap in the 40s and the CDC light trap in the 60s very few innovative technologies have been accepted or implemented by the mosquito surveillance programs.

Mosquito surveillance is and always has been closely related to successful mosquito management and the control of vector borne diseases. In principle, proper surveillance should guide us when and where mosquito control measures are applied and inform us whether the measures were successful or not. So why is the surveillance scene not rapidly evolving as well?

Different techniques have indeed been developed and are used for various application cases and these conventional surveillance methods used today will be highlighted in this introductory talk. Putting the future in mosquito surveillance though involves embracing cutting-edge technologies, interdisciplinary approaches, and innovative strategies.

171 **Deploy, Optimize, Rely: An Operational Case Study on the Broad Adoption of BG Counter**

Lauren Lavezzi, llavezzi@clarke.com

Abstract: Clarke's operational experience with BG counter traps for mosquito population monitoring: A large regional surveillance network containing more than 300 mosquito traps expands the use of next-generation BG counter technologies to monitor adult populations. This session highlights comparison data and useful BG Counter deployment and management tips discovered throughout the experience. We will also illustrate how the traps are used to monitor populations on a regional basis to provide appropriate control decisions to adult populations.

172 **Using BG Sentinels to estimate the vectorial capacity of Aedes aegypti for dengue-1 virus the Florida Keys**

Catherine A. Pruszynski, BCE, MSPH, cpruz@keysmosquito.org

Abstract: Aedes aegypti is an invasive mosquito species distributed in tropical and sub-tropical environments and is the primary vector for dengue and Zika viruses in the western hemisphere including the southern United States. Dengue outbreaks have occurred sporadically in the Florida Keys, but transmission remains unpredictable. Therefore, a study was conducted to understand the factors involved in dengue transmission in three urbanized areas of Key West, Marathon, and Key Largo in the dry and rainy seasons through the use of the vectorial capacity equation. Estimates for each variable of the equation were either produced using data gathered from Aedes aegypti females collected in BG Sentinel traps from Key West, Marathon, or Key Largo, or information obtained from the literature. These variables include human biting rate, human biting habit, vector competence, daily survival of the vector, and the extrinsic incubation period. Based on these estimates for the dry season, vectorial capacity never exceeded the 1.0 calculation that indicates at least one mosquito is capable of dengue virus transmission. However, in the rainy season, both Key Largo and Marathon had vectorial capacity calculations of 2.66 and 5.48, respectively. The VC estimates enable mosquito control to make more informed treatment decisions with the ultimate goal of interrupting and preventing dengue transmission in the Florida Keys.

173 **BugOut Wolbachia: Data-driven support for a community-driven project**

Johanna Ohm, PhD, joohm@verily.com, Amy Lynd, PhD, Jacob Crawford, PhD, Bradley White, PhD

Abstract: BugOut Wolbachia is a community-driven campaign to eliminate Aedes aegypti from Virgin Gorda in the British Virgin Islands. The project is a partnership between Green VI, a non-profit NGO based in the BVI, and Verily's Debug Team, a global team experienced in using Wolbachia male releases for suppression of Ae. aegypti. The program combines traditional source reduction efforts with mass trapping and incompatible male releases to suppress Ae. aegypti on Virgin Gorda.

Phase 1 of our program launched in 2022 and established an island-wide surveillance program to capture data on male and female Aedes numbers using BG-Sentinel traps and egg hatch rates using ovitraps. We also conducted mark-release-recapture studies to evaluate dispersal and survival of packed and shipped male mosquitoes from Verily's centralized production facility to the remote release sites on Virgin Gorda.

Following 10 months of surveillance data collection and four replicates of MRR studies, we launched Phase 2 of our program with regular releases of Wolbachia males starting in January 2023. We have used BG-Sentinel and ovitrap data to track the impact of the program on hatch rates and numbers of biting females in release areas compared to untreated sites and compared to previous surveillance data in the same sites. We have shown significant reductions in both biting females and hatch rates in areas treated with Wolbachia male releases compared to untreated sites. We are continuing to conduct studies on the value of adding mass trapping efforts ahead of releases and ongoing work on source reduction to maximize the impact of released males.

174 **Innovative hardware, software, and citizen science techniques to combat Anopheles stephensi and the global spread of malaria**

Sriram Chellappan, PhD, sriramc@usf.edu, Brandon Wolfram, MS, Farhat Azam, Tanvir Bhuiyan, PhD, Johnny Uelmen, PhD, Russanne Low, PhD, Ryan Carney, PhD, MPH, MBA

Abstract: Malaria has plagued humankind for millennia, and remains an intractable challenge. In 2023, local transmission occurred in the U.S. for the first time in 20 years (Florida, Texas, and Maryland). Additionally, with rising temperatures and increased human mobility, malaria vectors are spreading into new areas. This includes the recent introduction of the Asian species, Anopheles stephensi, in at least eight nations throughout Africa. An. stephensi is a malaria vector that is highly competent, resistant to insecticides, breeds in artificial containers, and has already led to unprecedented urban epidemics in Africa. To combat the threat of An. stephensi and other vectors, we are taking a three-pronged approach, combining innovative hardware, software, and citizen science techniques. First, we have designed a novel and low-cost smart trap device that consists of 3D-printed components, a WiFi-enabled microcomputer, multi-modal sensors, and UV imaging useful for mark-release-recapture studies. We are also experimenting with various baits for luring An. stephensi. Second, we have developed artificial intelligence (AI) algorithms to identify the species and gonotrophic stages of trapped mosquitoes using images, operating locally and in the cloud. These AI tools analyze adult and larval mosquitoes, and are available at www.mosquitoID.org (beta versions, primarily targeting An. stephensi). Finally, we have built a GIS mapping platform, the Global Mosquito Observations Dashboard (GMOD), which is freely accessible at www.mosquitodashboard.org. This dashboard standardizes and integrates data streams from three established mobile apps—Mosquito Alert, iNaturalist, and GLOBE Observer (Mosquito Habitat Mapper and Land Cover tools)—and enables users to visualize and download data in multiple formats. To encourage contributions to such mosquito surveillance, we have also launched international media and citizen science campaigns (e.g., www.mosquitoesInAfrica.org). Ultimately, our goal is to develop and deploy tools to enhance the surveillance and control of vectors such as An. stephensi on a global scale. [publication: https://doi.org/10.5334/cstp.616]

175 **Mosquito Traffic Light: Should You Stay or Should You Go – collecting data and educating the public in unconventional ways**

Charles Abadam, cabadam@suffolkva.us

Abstract: Public education benefits a mosquito control program by telling the people who we are, what we do, and why. Finding unique ways to inform our citizens in a way that is impactful and memorable can be challenging but we believe this project will fulfill this need. Our goal is to utilize a BG Sentinel with the BG counter's adult mosquito counting function in combination with a decommissioned traffic light and an outdoor public message board in a public parks to notify and educate citizens as well as collect data for our mosquito control operations. The BG Sentinel with BG Counter will quantify the mosquitoes caught and when that number reaches a determined threshold it will trigger the green, yellow, or red light housed in our traffic light. The traffic light is affixed to the message board that will explain what each color means, how citizens should protect themselves, and what mosquito control will do. This system creates a live mosquito exposure index that updates every 15 minutes and warns citizens in the vicinity to any risks that are possible.

176 **Mosquito Beacons Working Group – Advancing mosquito surveillance by cross-state cooperation**

Bryan Giordano, PhD, bryanvgiordano@gmail.com, Michael Riles, Lindsay Campbell, PhD, Daniel Killingsworth, Benjamin Allen, Elmer Gray, Yoosook Lee, PhD

Abstract: The Mosquito BEACONS (Biodiversity Enhancement And Control of Non-Native Species) committee was formed in 2021 with support from the Southern Integrated Pest Management Center and the United States Department of Agriculture. We are a multi-state committee dedicated to providing leadership and communication on invasive mosquito species-related issues in the Southern Region. Our mission is to support the implementation of an Integrated Pest Management (IPM) approach for surveillance and control of invasive mosquito species in the Southern region and improve knowledge transfer through stakeholder engagement. Our stakeholders include public health officers, mosquito control professionals for local government or pest control industry, government agencies, researchers, and graduate students in academia. We actively engage with our members through quarterly meetings, surveys, workshops, participation in state and national mosquito control association meetings through presentations and booths, extension publications, and online communications. Through this process, we strengthen multi-state collaborations, provide a forum for real-time pest/disease/biocontrol monitoring, and promote sustainable IPM infrastructure.

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177 **Aerial deployment of IIT mosquitoes in Hawai‘i to suppress the non-native Southern house mosquito for endangered forest bird conservation**

Adam Knox, aknox@abcbirds.org, Chris Farmer, Ph.D., Josh Fisher, Christa Seidl, Peter Landon

Abstract: The Insect Incompatibility Technique (IIT) is increasingly being used worldwide to suppress mosquitoes for human health benefits. The controlled release of Wolbachia-infected mosquitoes has proven effective in reducing wild, disease-carrying mosquitoes in urban areas as well as at the wildland/urban interface. In Hawai‘i, mosquito suppression is urgently needed to reduce non-native Culex quinquefasciatus mosquitoes that vector avian malaria because they are driving multiple, endemic forest bird species toward extinction. Wolbachia IIT applications performed by an interagency partnership called Birds, Not Mosquitoes have started on Haleakalā, Maui, where due to the remoteness and terrain comprising the species' wildland habitat, helicopters must be used to deploy the mosquitoes. While helicopters provide a practical platform to perform this work, a primary goal of the Birds, Not Mosquitoes project is to drive innovation in the use of Uncrewed Aerial Systems (UAS) toward release of IIT Culex mosquitoes into some of the least accessible areas of Hawai‘i. While the project is currently in a 3000 acre trial phase, the ultimate aim is to conduct larger-scale, IIT mosquito deployment using UAS aircraft beyond line of sight (BVLOS). We provide an overview of the Maui aerial IIT operation, its tools, regulatory pathways, and future steps necessary for expanding operations across the state.

179 **Utilizing Drones in Contra Costa County to Conduct Larviciding Treatments During an Above Average Rainfall Mosquito Season**

David Wexler, Dwexler@contracostamosquito.com, Paula Macedo, DVM, Ph. D, Jeremy Shannon, Terry Davis, Miaja Mc Cauley, Heidi Budge, Tim Mann, Steve Fisher

Abstract: During the first four months of 2023, Contra Costa County experienced above-average rainfall leading the Contra Costa Mosquito and Vector Control District (District) to consider alternative methods to effectively control sites throughout the county that began producing mosquito larvae. Previous methods included utilizing a helicopter, but this method was not viable due to certain sites' size, location, and/or limitations due to proximity to homes or protected areas; however, District employees had no previous experience with drone applications. As this presentation will show, the challenges brought on by the above-average rainfall became a learning opportunity that revealed the potential of integrating drones into the District's integrated vector management program as a tool for mosquito control.

180 **AMCA Drone Program: Removing Barriers and Encouraging Innovation**

Joel B. Buettner, M.S., joelb@placermosquito.org, Jonathan Rupprecht, esq., Daniel Markowski

Abstract: The American Mosquito Control Association (AMCA), in cooperation with the Federal Aviation Administration (FAA), developed a new program that provides regulatory compliance resources, training, and specific exemptions from FAA regulations to conduct aerial operations with Unmanned Aircraft Systems (UAS) commonly known as "drones".

The goals of the AMCA Drone Program are:

< ![if !supportLists] >1. < ![endif] >Provide required exemptions from FAA Regulations that enable AMCA members to use UAS to apply mosquito control materials and conduct other operations to support mosquito control efforts.

< ![if !supportLists] >2. < ![endif] >Engage AMCA with current and future FAA rulemaking processes and the associated regulations related to drone use like pesticide label language and potential concerns over the UAS impacts on sensitive habitats or endangered species.

< ![if !supportLists] >3. < ![endif] >Provide a platform for AMCA members to participate in innovation and testing of advanced and novel uses of UAS technology to combat mosquitoes and vector-borne diseases.

The need for this program is supported by a growing number of AMCA members who have expressed interest and invested in drone technology as a new tool for mosquito control. AMCA surveyed its membership on drone use in 2018 and again in 2023 and survey results support a continued interest, but also identified challenges like regulatory complexity and uncertainty that prevents widespread adoption. The AMCA Drone Program aims to decrease the barriers for drones and encourage the mosquito control community to embrace this technology and better protect public health.

Adult Control I

181 **A systematic review of Aedes aegypti control trials to investigate publication bias in relation to author conflicts of interest.**

Abdisalam A. Abdi, cabdisalaan990@gmail.com, Gabriel Hamer

Abstract: The yellow fever mosquito, Aedes aegypti, transmits the agents of dengue and other arboviruses, resulting in an estimated 390 million disease cases per year, which justifies control trials

aimed at vector population suppression. Many studies evaluate different control approaches, but only a subset are published in peer-reviewed journals. The lack of publishing results, or publication bias, could be due to many reasons. One source of publication bias could result from a conflict of interest (COI), such as being employed by the company conducting the trial or having a financial conflict tied to intellectual property. We conducted a systematic literature review of trials controlling Ae. aegypti to test the hypothesis that author COI influence the reported suppression of the vector. We found 39 published studies from 2010-2020 that met inclusion criteria and extracted metrics regarding COI and Ae. aegypti population suppression. Our first discovery is that some journals either do not ask authors about COI or, if present, do not include those disclosures with published articles. We also noticed inconsistencies in authors disclosing a conflict which did not adhere to the internationally recognized definition of COI. We will present the results comparing Ae .aegypti population suppression for studies that either report a COI or not. These results are a call to action that all journals should require authors to acknowledge a COI, and all disclosures, whether conflicts exist or not, should be published in the article. Also, journals should enforce adherence to the internationally recognized definition of a COI.

182 **Insecticide treated resting stations reduce parity rate of the enzootic mosquito vector of EEE virus, Culiseta melanura**

Edward D. Walker, PhD, walker@msu.edu, John Keven, PhD

Abstract: Laboratory and field experiments were conducted to develop and test the concept of insecticide-treated, resting stations to reduce the vectorial capacity of Culiseta melanura for eastern equine encephalitis (EEE) virus. Of four commercial insecticides applied to the inner surfaces of resting stations (black-painted, durable molded fiber containers used in the greenhouse industry) and presented to adult Cs. melanura, the microencapsulated formulation of lambda cyhalothrin Demand CS showed the highest mortality and longest duration of effect (>98% mortality for 5 weeks). Mosquito density in treated boxes was nearly nil in the field, compared to untreated boxes. A field evaluation was implemented at six bog sites in southwestern Michigan with natural populations of Cs. melanura and history of EEE activity, where treated sites received 300 boxes treated with Demand CS and distributed at bog perimeters, and control sites had no treated boxes. Mosquitoes were sampled once weekly for 9 weeks from mid-July to mid-September from 75 untreated boxes at each site. Results showed a statistically significant decrease in the percentage of parous, female Cs. melanura at treatment compared to control sites following distribution of treated resting boxes, with up to 50% reduction in parity rate during the course of the experiment (3,185 dissected), and further revealed a shift towards a younger population age structure when considering unfed, blood fed, half gravid, and gravid physiological categories. Survival analysis suggested that the vectorial capacity of Cs. melanura populations at the treatment sites was reduced meaningfully with regard to control of EEE virus transmission. Blood meal analysis showed an avian host selection profile, with northern cardinal, American robin, and blue jay as the most commonly selected hosts. Overall, the results of the study support a proof of concept for use of insecticide treated resting stations for targeted control of EEE virus transmission.

183 **First documented report of insecticide resistance in the WNV vector Culex tarsalis from Wyoming**

Mikenna Smith, M.S., msmith@tcweed.org, Kelsey M. Mitchell, M.S.

Abstract: Insecticide resistance is well-documented in many areas within the United States. In rural areas such as Wyoming, monitoring for insecticide resistance can be all but absent. Teton County Weed & Pest District has been developing its insecticide resistance monitoring program to address these knowledge gaps. In 2022, CDC bottle bioassays were conducted with Culex tarsalis against permethrin and malathion. Initial evidence of resistance to both insecticides was detected, so in 2023 we set out to confirm these results and characterize the mechanisms of resistance. Cx. tarsalis larvae were collected from flood-irrigated pastures from two neighboring ranches in Jackson, Wyoming. The larvae were reared to adults in our insectary under controlled environmental conditions. A series of bottle bioassays using malathion and permethrin were conducted with and without synergists. A subset of mosquitoes from each experimental group were stored under -80℃ for further resistance characterization using microplate assays. Cx. tarsalis from both ranches showed similar resistance to malathion in the bottle bioassays, with 50% mortality after 120 m from ranch one, and 60% mortality from ranch two. Bioassays using the synergist DEF with malathion brought mortality to 100% at 45 m for ranch one, and 60 m for ranch two. Permethrin bioassays showed 70% mortality at 120 m for ranch one, and 80% mortality for ranch two. After the introduction of PBO with permethrin, percent mortality for ranch one was not affected at 70% after 120 m, and between 93-97% for ranch two. Multiple mechanisms of resistance were detected using the bottle bioassays. Mechanisms of resistance varied between the two ranches, despite collections being just one mile apart. Further resistance characterization results from the microplate assays will be reported.

184 **Variation in efficacy of essential oils deployed as spatial repellents**

Frances V. Golden, frances.golden@usda.gov, Seth Gibson, PhD, Robert L. Aldridge, PhD, Barbie Bayer, MS, Edmund Norris, PhD, Kenneth Linthicum, PhD

Abstract: Spatial repellents are a desirable alternative to pesticides for myriad reasons. They protect groups from nuisance and disease-transmitting vectors, rather than individuals. Due to the nature of their deployment, they are a passive method of repelling mosquitoes. Nothing further is required after initial setup as long as the repellent remains efficacious. There is no need to remember to apply or re-apply. Furthermore, there is little selective pressure to induce resistance to a spatial repellent due to the presumption that they do not cause mortality. Essential oils can take this desirability further if they are proven to be efficacious. They are seen as “natural,” are potentially safer than traditional repellents, and may therefore be more accepted by the general populace. We attempted to determine the efficacy of five essential oils (Cassia, Cognac, Origanum, Patchouli, and proprietary “Essential Oil Z”) against a control when deployed in the field. Six CDC light traps were set in a wooded area, far enough from each other to ensure the treatments did not interfere with one another. The rain shields of the traps were modified so that eight cotton balls could be wrapped in tulle and hung with a clip along the outside rim of the shield. Traps were baited with CO2 and run for 24 h with cotton balls treated with an essential oil or control. Each treatment was rotated through all trap locations to account for differential catch due to location. All rotations were set multiple times with the same treated cotton balls to determine if efficacy remains after weathering. After trapping was concluded, all collections were identified and tallied to species, and the percent reduction in collections for each treatment relative to the control was calculated. We discuss differences in total numbers collected, as well as differences in total numbers of individual species.

185 **An Update on Research into Nontarget Effects of Mosquito Adulticides on Wild Bees in Manatee County, Florida**

Jacob D. Hart, BS, jacobhart@manateemosquito.com, Samantha Ramirez-Lachmann, MPH, CPH, Katelynn Hare, Kimiko Baptist, Mark D. Latham, BA and MA in Natural Sciences from the University of Cambridge, Christopher Lesser

Abstract: Pollinators in the superfamily Apoidea are a nontarget group of primary concern and their numbers continue to broadly decline in North America. Mosquito adulticides used per EPA regulations are designed to minimize nontarget impacts on pollinators with special attention given to honeybees (Apis melifera). The importance of wild pollinators (i.e., nondomestic bees of the family Apidae, or families Colletidae, Halictidae, and Megachilidae) has led to growing scientific and public attention, cementing the need for further research. The work described here provides an update to Manatee County Mosquito Control District's ongoing and expanded efforts monitoring the impact of aerial adulticides on wild bee populations. This research was conducted using Blue Vane Traps (BVTs) set weekly at 14 sites served by MCMCD to selectively sample hymenopteran pollinators. Research was conducted June-October of 2022 and 2023. Collected bees were counted and identified to the lowest possible taxa, a minimum of genus. Data include 28 species of bee across 10 genera. Samples were compared against the timing and spray blocks of helicopter adulticide missions in a before-after control-impact (BACI) design and analyzed for any resulting changes in abundance or diversity. Missions analyzed for 2022 include 12 pre-post samples under 10 adulticide missions, while 2023 includes 19 samples under 11 adulticide missions. Results to-date detect no significant effect of MCMCD's aerial adulticide program on wild bee populations. This research may be of operational use to other agencies interested in monitoring nontarget effects of aerial missions and will serve to further establish trust with an environmentally conscious public.

186 **Evaluation of Three Battery Powered Backpack Sprayers for Barrier Applications**

Muhammad Farooq, PhD, mfarooq@amcdfl.org, Whitney Qualls, PHD, Steven Smoleroff, Rui-De Xue

Abstract: It can be difficult for mosquito control programs to select which battery powered backpack sprayer on the market may fit the program best based on the product specifications. This study compared the Field King 190515, the Birchmeier AS1200 AC2 and the Ryobi Electrostatic backpack sprayers as a tool to apply mosquito control barrier applications to vegetation. Talstar® P insecticide (AI. Bifenthrin 7.9%) was applied to vegetation at maximum label rate by mixing 30mL formulation to 3.8L water to cover 93 m2. As Ryobi has the electrostatic feature, 30mL formulation was mixed with 1.9L of water to cover 1000 ft2. Twelve vegetation plots, 61 m long, separated by at least 61 m ft, were selected at three sites in St. Johns County, Florida. Three randomly selected plots were assigned to each sprayer and three to control. The effectiveness of the applications was evaluated by leaf bioassays and monitoring mosquito populations using CDC light traps. Leaf bioassays were conducted in the laboratory and leaves were removed from the field at distances of 0, 1.5, 3.0, and 4.5 m into the canopy for each treatment and control area. For leaf bioassay, leaves were attached to bottom of petri dish and 10 female Aedes aegypti were aspirated into the petri dish and mortality was recorded at 24 hours. Mosquitoes were collected weekly, starting 2 weeks pre-treatment and four weeks post-treatment using CDC light traps baited with dry ice and octenol. Two traps per treatment and control area were placed out for 24 hours. All mosquito collections were identified to species. Based on bioassays, Field King,

Birchmeier and Ryobi, had control for 2, 3 and 1 weeks after application, respectively. The three sprayers on average reduced mosquito collection by 71.9%, 55.5%, and 31.3 % for the Field King, Birchmeier and Ryobi respectively.

187 **The impact of next-generation dual-active ingredient long-lasting insecticidal net deployment on insecticide resistance in malaria vectors in Tanzania**

Louisa A. Messenger, MSc, PhD, louisa.messenger@unlv.edu

Abstract: Insecticide resistance among malaria vector species is now a pervasive problem, which threatens to jeopardize global disease control efforts. In sub-Saharan Africa, novel vector control tools, including long-lasting insecticidal nets (LLINs) incorporating new active ingredients (A.I.s), with different modes of action, are urgently needed to delay the evolution and spread of resistance. During a three-year, four-arm cluster-randomised controlled trial in Tanzania, evaluating the effectiveness of three dual-A.I. LLINs compared to pyrethroid-LLINs (PY-LLINs), we measured longitudinal phenotypic and genotypic insecticide resistance profiles among 47,258 female Anopheles mosquitoes collected over 36 months. In the PY-LLIN arm, a significant increase in alpha-cypermethrin and permethrin resistance intensity and concomitant decline in mortality, following exposure to the synergist PBO,was observed in An. funestus s.l. (the predominant vector species complex) over 24 months. A similar phenomenon was apparent in the pyriproxyfen-PY LLIN arm over three years, with the greatest escalation in resistance intensity evidenced in the PBO-PY LLIN arm. The chlorfenapyr-PY LLIN arm had no significant effecton pyrethroid resistance, supported by minimal reductions in chlorfenapyr susceptibility. By comparison, An.funestus s.l. populations displayed limited sterility following pyriproxyfen exposure. Highly over-expressed detoxification enzymes presented dynamic patterns of selection throughout the trial. Phenotypic data strengthened clinical trial epidemiological findings; chlorfenapyr-PY LLINs provided superior protection from malaria across multiple transmission seasons, with little impact on insecticide resistance. Rapid fifty-fold pyrethroid resistance intensification in the PBO-PY LLIN arm and pre-existing tolerance of vector populations to pyriproxyfen in the trial site may explain the poorer performance of these two interventions on malaria outcomes. Ongoing work is elucidating potential mechanisms driving cross-resistance between pyrethroids and novel A.I.s, to better inform pragmatic design of resistance management schemes.

188 **A new approach to using CDC bottle bioassay data to inform semi-field or field mosquito mortality**

Edmund Norris, PhD, Edmund.Norris@usda.gov, Casey Crockett, MSc, MPH, PhD, Sarah S. Wheeler, PhD, Laura C. Harrington, PhD, Aine Lehane, MPH, Lindsay Baxter, M.S.

Abstract: The Bottle Bioassay (BB), developed by the Centers for Disease Control (CDC), is commonly employed to characterize insecticide resistance levels of mosquito populations in laboratory environments. The BB versatility is remarkable; it can be used with different species, lab or field-acquired strains, and a variety of different insecticidal active ingredients or formulations. As an established assay, the BB is widely utilized by mosquito control professionals throughout the country and world; however, few studies have established a clear correlation between BB outcome and semi-field and/or field mortality. Most correlations between the BB and operational control activities are anecdotal, despite the need for a standardized correlation method. As part of ongoing discussions with the National Insecticide Resistance Working Group and the Northeastern Center of Excellence in Vector-borne Diseases, we

employed a new method to compare previously obtained CDC Bottle Bioassay data and semi-field mortality results. Mean lethal times (MLT) were obtained using Kaplan-Meier survival analysis for different BB strain/insecticide combinations. The analysis was performed on over 15 strain/insecticide combinations for which matching semi-field trial data (truck mounted ULV spray trials) was available. Our initial results show that mean lethal times were remarkably similar on the same strain/insecticide combination, even when mosquitoes were assayed on different days demonstrating the robustness and consistency of the analysis method. MLTs were then correlated with semi-field mortality data across different times and distances from ULV spray transects. Strong correlation (r = 0.78, p-value=0.002) was observed at one distance and time (300-ft, 12 h) compared to the BB MLTs for matching strain/insecticide combinations. These results demonstrate the potential utility of this novel analysis in predicting semi-field/field results. Moreover, the MLT analysis requires minimal modifications to testing regimens, making it practical for mosquito control professionals to adopt.

189 **Spinosad adulticidal activity by contact and ingestion in toxic sugar bait: another potential approach to control Aedes aegypti.**

Maria Alice V. Melo-Santos, Phd, maria.varjal@fiocruz.br, Kathyanne Barbosa, Constância Ayres, Phd

Abstract: Aedes aegypti is a species of mosquito with high vector capacity for the transmission of arboviruses such as Dengue, Zika and Chikungunya. Strategies aimed at eliminating adult mosquitoes in Brazil, since 1996, have been restricted to the perifocal or spatial (ultra-low volume) application of chemical insecticides. These products are applied every two weeks at strategic points, such as cemetery, tire repair shop and junkyard, as a “shock” treatment, to eliminate mosquitoes in the first few days after application. This constant use can cause a selection pressure for resistance in the field, which makes rotation between products necessary. Although spinosad is considered an excellent biological product with larvicidal action, we raise here the possibility of its adulticidal effect, through direct contact and/or ingestion in toxic sugar baits, for the control of Ae. aegypti. Bioassays with Ae. aegypti RecL, a laboratory colony, were carried out with different concentrations (0.5, 1.0, 2.0 and 5.0%) of NATULAR®NT technical powder (93% of the spinosins A and D) in a 20% sugar suspension, against groups of recently emerged males and females. The results revealed that for the lowest concentrations, total mortality occurred within four days, while with 2% and 5% it occurred two days after ingestion. On the other hand, the immediate contact of adult mosquitoes with the impregnated filter paper with aqueous suspensions of 10, 30 and 50 ml/10L of NATULAR®EC20 led to total mortality of males and females exposed within 24 h, despite the concentration of 50 ml/10L already eliminated all of them with just 30 min of exposure. These results point out a new effect of this biological product, which could lead to its indication for interventions at strategic points, acting on the joint elimination of larvae and adult mosquitoes, in a single form of application.

Innovative, Operational Non-Chemical Approaches to Mosquito Control Symposium I

190 **Senecio cookie factory - Lessons learned from its 2023 field deployment addressing the logistics and operations aspects**

Hanan Lepek, Hanan@senecio-robotics.com

Abstract: During 2023 mosquito season in Israel, Senecio deployed an automated sterile mosquito mass production facility. The program took place in close to ten different municipalities in Israel at the same time, addressing all aspects of a commercial ready program, including logistics and operations, interface between an automated mass production facility and a pest control company acting as the operator, mission planning and program monitoring.

The campaign included both the release in public areas, as well as private home owners and business. In the presentation, Senecio will share insights on its efforts and results of the program, with feedbacks received from the field release, providing evidence on the potential scale-up of the sterile insect technique for large audience, including municipalities as well as private people and business.

191 **Research, radiation, and resilience: Use of the sterile insect technique for Aedes aegypti (L.) in Lee County, Florida**

Rachel Morreale, morreale@lcmcd.org, Steven Stenhouse, Johanna Bajonero, Danilo Carvalho, Aaron Lloyd, David F. Hoel

Abstract: Lee County Mosquito Control District (LCMCD) established a sterile insect technique (SIT) program to target Aedes aegypti in 2017. Captiva Island was selected as the initial intervention site with a nearby non-intervention site on Sanibel Island and background entomological surveillance began to determine the baseline population in these areas. Meanwhile, LCMCD conducted research to prepare for mass releases of sterile male Ae. aegypti. Operational releases began in June 2020 and continued through September 2022. Due to the severity of impacts from Hurricane Ian, intervention was disrupted and necessitated the selection of a new area of operation. After conducting preliminary surveillance in potential new sites, downtown Fort Myers and surrounding neighborhoods were selected as the new areas of focus. Collection of the entomological baseline began at these new sites in November 2022 with collections ongoing. The pause in mosquito production for field releases has allowed for additional research and improvements to mass rearing and sterilizing Ae. aegypti. Releases of sterile male Ae. aegypti are planned to begin in February 2024.

192 **Update on Preliminary Studies of the Southern California SIT Joint Pilot Project Using X-ray Sterilized Male Aedes aegypti**

Sokanary Sun, MS, ssun@ocvector.org, Nicolas Tremblay, BS, Ryan Amick, BS, Colt Bellman, BS, Tim J. Morgan, MS, Tanya Posey, BS, Amber Semrow, MS, Steven F. Vetrone, MPH, Xiaoming Wang, PhD, Susanne Kluh, MS, Lora Young, MPA

Abstract: Since the arrival of Aedes aegypti (L.) in Los Angeles County in 2014 and Orange County in 2015, this mosquito species has proliferated throughout southern California. The species' rapid population growth and its synanthropic behavior have elevated the risk for autochthonous transmission of viruses that cause diseases such as Zika, chikungunya, and dengue. The Greater Los Angeles County Vector Control District (GLACVCD) and the Orange County Mosquito and Vector Control District (OCMVCD) partnered to develop a sterile insect technique (SIT) project, a tried and tested method for suppressing insect abundance, for use in southern California to combat Ae. aegypti. The SIT Joint Pilot Project plans to sterilize male Ae. aegypti using X-ray irradiation, releasing them en masse to compete with wild males for mating opportunities resulting in nonviable eggs, which reduces the local Ae. aegypti population over time. In contrast to SIT programs that apply ionizing X-ray radiation to sterilize

mosquitoes at the pupal stage, this project is focused on developing a process to irradiate mosquitoes at the adult stage. Two mosquito strains were used in this project, a wild strain collected from the city of Mission Viejo in Orange County and a mixed population strain from both Los Angeles and Orange counties. This presentation will highlight the SIT Joint Pilot Project's development of methods and preliminary findings, including cold-induced anesthesia (chilled) and compacting adults in preparation for irradiation, as well as the impacts of radiation dose on survival, sterility, and mating competitiveness. These and future studies aim to develop an area-wide SIT-based mosquito suppression program in southern California.

193 **Temperature and Wolbachia infections in Culex pipiens mosquitoes: Implications for novel mosquito controls**

Andrea Joyce, PhD, ajoyce2@ucmerced.edu, Jovany Barajas, M.S.

Abstract: A number of novel mosquito controls are being investigated and used for reduction of mosquito populations and protection of public health through prevention of infectious disease such as dengue. Wolbachia is sensitive to high temperatures, and lab studies have shown that increasing temperatures can reduce Wolbachia density in insects. Culex pipiens hybrids are one of the primary vectors of West Nile virus in California, and it is commonly infected with Wolbachia. In the Central Valley of California, summer temperatures can exceed 40^{o}C. This study uses field collected Cx. pipiens in cool and warm months to investigate variation in Wolbachia levels in adult Cx. pipiens under varied, natural field conditions. Results will be discussed, along with potential considerations for novel mosquito controls.

194 **Incompatible insect Techniques against container-breeding Aedes mosquito species in Houston, Texas.**

Jimmy Mains, PhD, jimmymains@gmail.com, Karen L. Dobson, Stephen L. Dobson, PhD

Abstract: Aedes aegypti and Aedes albopictus are invasive species and of public health concern due to their aggressive day-biting behavior and ability to vector medically important pathogens (e.g., Zika, dengue, chikungunya). Despite the use of chemical pesticides to manage these species, they have colonized much of the U.S.A. and continue to expand their range. Several types of autocidal approaches have been proposed for the control of these mosquitoes. Autocidal technologies are 'self delivering,' and there is no known insecticide resistance for many of these approaches. Autocidal technologies use the 'mosquito against itself,' and include Wolbachia-based and auto-dissemination of insecticides. Similar to traditional Sterile Insect Technique (SIT), the Wolbachia approach is based upon repeated, inundative releases of incompatible male mosquitoes, with the goal of decreasing the number of viable eggs. The ADAM approach uses repeated, inundative releases of non-biting males as vehicles to deliver small doses of a potent insect juvenile hormone analogue (pyriproxyfen; 'PPF') into the small, cryptic containers in which Ae. aegypti and Ae. albopictus often oviposit. Males can deliver PPF to breeding sites either directly or indirectly, by cross contaminating females during copulation attempts. Presented here are regulatory updates related to these technologies and results from field trials in Houston, Texas, which were performed to examine efficacy under field conditions.

195 **Generation and mass production of a universally incompatible Culex quinquefasciatus line for Wolbachia-based sterile insect technique**

anna buchman, PhD, abuchman@google.com

Abstract: Wolbachia based incompatible insect technique (IIT) has been leveraged to control Aedes and Culex mosquito populations in the field. Debug, based at Verily Life Sciences in California, has partnered with Birds Not Mosquitoes (BNM), a multi-agency partnership that is urgently working to save the native honeycreeper birds of Hawai‘i from extinction driven by the transmission of avian malaria (Plasmodium relictum), to develop an IIT system for suppression of Cx. quinquefasciatus in Hawai‘i.

In Culex sp., a number of naturally occuring wPip Wolbachia forms exist that exhibit complex incompatibility interactions. With an aim of generating a universally incompatible Culex line, we have performed Wolbachia transinfections of wAlbB from Ae. albopictus into Cx. quinquefasciatus previously cleared of endogenous wPip. The DQB (Debug Cx. quinquefasciatus wAlbB) line has been tested for phenotypes pertinent to population suppression via release of sterile (Wolbachia) males, and confirmed to function as expected. Debug has also optimized automated larval mass rearing and pupal and adult sex sorting pipelines to support mass production and release of DQB males. Additionally, Debug has developed packing and shipping protocols to support transport of DQB males from Verily in California to release sites in Hawai‘i (Maui and Kauai). The mountainous and densely vegetated habitat of the native Hawaiian Honeycreeper means aerial release of mosquitoes will be necessary for deployment of DQB males, and Debug and partners are also developing aerial release systems using compostable packets of DQB males.

After the recent EPA approval of a Section 18 Emergency Use Permit for the release of DQB3 males on Hawai‘i, Debug and partners hope to begin testing the IIT system for suppression of Cx. quinquefasciatus in the coming months.

Latin American Symposium I

196 **Over a Decade of Breakthroughs in Urban Mosquito Control: Exploring Droplet Dynamics and Advancements in Wide Area Larviciding Techniques**

Grifith S. Lizarraga, deinocerites@gmail.com

Abstract: In recent years, significant advancements have been made in the use of physics and statistical analysis for urban mosquito control. These techniques have played a crucial role in combatting vector-borne diseases. Central to these developments is a thorough understanding of droplet dynamics, rooted in fundamental principles of physics. This has proved essential when spraying in intricate urban environments. In this presentation, we will explore the scientific intricacies and methods involved, demonstrating how they have revolutionized our ability to target hidden breeding sites and implement a more effective disease prevention approach in cities.

197 **Machine-learning methods to unravel underlying patterns and correlations among four anthropophilic sandfly species (Diptera: Psychodidae) in the Yucatan Peninsula, Mexico**

Eduardo A. Rebollar-Telléz, eduardo.rebollartl@uanl.edu.mx, Francisco Hernández-Cabrera, Dr., Sergio Ibáñez-Bernal, Dr.

Abstract: Localized cutaneous leishmaniasis caused by Leishmania mexicana is endemic in the Yucatan Peninsula. Entomological studies to date have pointed out the medical importance of four species of sand flies (Diptera: Psychodidae) such as Bichromomyia olmeca, Lutzomyia cruciata, Psathyromyia shannoni and Psychodopygus panamensis. Although entomological studies have focused on the identification of vectors, assemblage structure in diversity and on the effects of climate change, among others. An aspect that has not been evaluated to date is the interrelationship between these species in the same sites and seasons, especially with the species most likely to have contact with humans and thus potentially transmit Le. mexicana. Therefore, the objective of this work was to carry out a meta-analysis using machine learning tools. The database includes collections of females in Shannon traps conducted between 2001-2007, which includes 31 georeferenced collection sites and recorded values of relative humidity and temperature. Using multivariate models and the algorithm called “random-forest” it was possible to find underlying geographical and ecological patterns in the database. The captures were classified into three groups (clusters), a pattern of presence and activity was also revealed between the species Pa. shannoni and Ps. panamensis as a function of geographical longitude.. In the group (cluster A) a strong correlation was observed between the pattern of population dynamics among the species Lu. cruciata and Pa. shannoni. On the other hand, correlations were also observed with relative humidity values, while for Ps. panamensis activity increases with high humidity values and, on the contrary, Pa. shannoni activity decreases. The implications in epidemiological terms of these findings are discussed.

198 **Efectos tóxicos del extracto de cáñamo en Aedes aegypti**

Erick J. Martinez, martinezrodriguez.2@buckeyemail.osu.edu, Peter M. Piermarini, Ph.D. in Zoology, University of Florida, 2002; B.S. in Biology, James Madison University, 1995

Abstract: El objetivo de mi estudió es evaluar los efectos tóxicos de los extractos de cañamo (Cannabis spp.) en larvas y adultos de Aedes aegypti. Lo evalué exponiendo larvas de primer instar y mosquitos hembra adultos durante 24 h a diferentes concentraciones de extracts de hojas de flores de cañamo. Nuestros resultados muestran que tanto los exctractos de ojas como los de flores de cáñamo provocan cierta actividad tóxica en las larvas y los mosquitos adultos, abriendo un posible camino para utilizar el cáñamo como larvicida y adulticida en el control de mosquitos.

199 **STATUS OF ACARICIDE RESISTANCE IN Rhipicephalus microplus CANESTRINI (ACARI: IXODIDAE) FROM NORTHEASTERN MEXICO**

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Abstract: Rhipicephalus microplus is the most important tick in veterinary medicine, given its repercussions on animal production. The principal strategy to avoid adverse effects associated with R. microplus is the chemical control of tick populations through organosynthetic acaricides. Therefore, monitoring susceptibility to acaricides is paramount in any control program. This study aimed to analyze the resistance status of 2 populations of R. microplus from northeastern Mexico to the organochlorine (OC) lindane, organophosphates (OP) coumaphos, chlorfenvinphos, diazinon, and chlorpyrifos, and the synthetic pyrethroids (SPs) flumethrin, deltamethrin, and cypermethrin.

Discriminating doses (DD) of each acaricide were used in the larval packet bioassay (LPT). Additionally, the presence of the knockdown resistance (kdr) mutation T2134A associated with pyrethroid resistance was evaluated using allele-specific polymerase chain reaction (PCR). The populations of R. microplus showed a high frequency of resistance to SP, with mortality rates of less than 5%; they also showed resistance to the OPs (diazinon and chlorpyrifos) with mortality rates ranging from 1.29% to 34.62%; meanwhile, they were susceptible to coumaphos and chlorfenvinphos. Mortality rates higher than 66% were observed for lindane, indicating susceptibility. The mutant allele of the kdr mutation T2134A was detected in 75% and 100% of the pools analyzed. The populations studied presented a highly resistant profile to pyrethroids, with the presence of the kdr mutant allele A2134. The susceptibility to the organophosphates such as coumaphos and chlorfenvinphos of R. microplus from northeastern Mexico should be noted.

200 **Landscape of mosquito's physiology by "omics" tools**

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Abstract: The Laboratory of Molecular and Structural Physiology (LFMyE) of the School of Biological Sciences of the Autonomous University of Nuevo Leon is dedicated to the study and unraveling of complex biological processes of mosquitoes, such as insecticide resistance, the physiology of each life stage, the feeding process, among others. The above is done by using state-of-the-art technological tools that allow describing biological explorations such as the metabolome, the miRNome, the metalome, the genome and the microbiome. To date, the following have been described:

- The miRNome of different life stages of Ae. aegypti (eggs, males and females).

- The microbiome of Ae. aegypti and its relationship to insecticides.

- The metalome in mosquitoes and its relationship to the ability to transmit pathogens.

- The Ae. aegypti genome as an editing target for alternative biological control.

- The Ae. aegypti metabolome from different biological explorations.

The intention of exploring different biological approaches of Ae. aegypti using new generation tools (OMICS) is to have a global picture of the physiology (interactome) of this important vector to describe the natural biological footprint and thus propose new and alternative control strategies.

201 **Monitoring and evaluation of vector control interventions implemented in a malaria endemic area on the pacific coast of Colombia**

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Abstract: Malaria vector control in Colombia has long relied on the use of long-lasting insecticidal nets (LLIN) and indoor residual spraying (IRS). Thus, evaluating the efficacy of these tools is essential to decision making around national vector control strategies. Here we measure the durability of two vector control tools in use in Cauca Department. First, we assessed physical integrity, bio-efficacy, and survivorship of an alpha-cypermethrin-impregnated LLIN. Second, we determined coverage and

residual efficacy of both a deltamethrin- and an alpha-cypermethrin-based IRS. Durability was evaluated at six and 12 months post-distribution in 40 LLINs randomly selected from across 20 clusters that had previously received one round of distribution in 2021. Residual efficacy of IRS was measured using WHO cone bioassays (with a susceptible strain of Anopheles albimanus) conducted seven days post-spraying in 40 households randomly selected from across 20 clusters that had previously received IRS in four different spray campaigns between 2021-23. For the LLINs, at six months post-distribution, 80% of the nets were in serviceable condition, however bio-efficacy was very low, with a mean knock-down of 3% and mean mortality of 5%. By 12 months post-distribution, 60% of the nets were in serviceable condition. Survivorship of nets was 97% at six months and 86% at twelve months. For the IRS, coverage decreased with each subsequent round (approximately every six months), from 85% to 76% to 70% to 64%. WHO cone bioassay results showed a mean mortality of 46% and 74% for deltamethrin and 76% for alpha-cypermethrin. Taken together, these data raise serious concerns about the entomological efficacy of both the LLINs and IRS used in the study area. To ensure that vector control interventions are performing as expected, and to enhance their community acceptance and use, we recommend rigorous quality control monitoring and pilot testing prior to widespread distribution and implementation.

202 **Evaluación de la tasa de eclosión de huevos de Aedes aegypti y Aedes albopictus en campo en Tapachula, Chiapas, México**

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Abstract: The hatching of Aedes eggs can be divided into those that hatch immediately after embryonic development and those with a resting period after embryonic development. This period is related to humidity, temperature, amount of light, food, larval density, and water oxygenation. The objective of this work was to evaluate the egg-hatching rate of Ae. aegypti and Ae. albopictus obtained from temporary breeding sites sorted as wet and dry and then compared with eggs collected from ovitraps. A search for temporary household breeding sites was carried out, and concurrently, 250 ovitraps were placed in 125 of the 192 backyards on the site. The identified artificial breeding sites and the positive ovitraps were taken to laboratory conditions to monitor the hatching dynamics. Of the 125 houses, 100% tested positive for Aedes in ovitraps, and 50.4% tested positive for temporary artificial breeding sites. Of the 250 ovitraps placed, 64.4% were positive, and 38% of the artificial breeding sites collected were positive. The production of adult mosquitoes from 7,328 eggs collected in ovitraps was 55.41% for Ae. aegypti and 22.4% for Ae. albopictus. The percentage of adults obtained from artificial breeding sites was 65.39% for Ae. aegypti and 34.61% for Ae. albopictus. In this work, we observed that the hatching percentage for the artificial larval sites was 99.9%. For the ovitraps, it was 77.81%, reflecting the high distribution of mosquitoes associated with artificial containers. Therefore, targeting domestic oviposition and eliminating larval breeding leads to opportunities for better control.

204 **Design and evaluation of an attractant sticky trap for indoor and outdoor surveillance of female populations of Aedes aegypti in Mexico**

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Abstract: Surveillance is the systematic collection, analysis, and interpretation of data essential for planning and implementing control activities. The lack of success in the control and surveillance of Ae. aegypti requires developing new accessible and effective strategies. This work aimed to develop and evaluate an adhesive and attractive trap for intra- and peri-domestic surveillance of Ae. aegypti. Based on a bibliographic review, linalool, lactic acid, hexanoic acid and ammonium chloride were identified as the compounds that present significant percentages of attraction for Ae. aegypti. We use the HITSS system and entomological cages to determine an effective attractant mixture. A sticky trap was designed to which the chosen mixture was incorporated and semi-field and field tests were carried out. In the HITSS system, mixture 2 (linalool 15%, lactic acid 10%, hexanoic acid 1%, and ammonium chloride 1%) presented the best percentage of attraction with 47.50 ± 4.80% and a Spatial Activity Index (SAI) of -0.45 ± 0.05. In entomological cages, mixture 2 presented the best attraction percentages with 15.8 ± 4.4% without fan use and 40.8 ± 6.3% with a fan. The capture percentages in the semi-field tests 24 hours after the first release were 8.9 ± 2.1% for the sticky trap alone; 21.6 ± 3.5% for mixture 2 and sticky trap; 43.2 ± 4.0% for the sticky trap, mixture 2 and fan; and 63.6 ± 11.1% for BG-Sentinel. In field tests mixture 2, sticky traps and the use of a fan captured 28 mosquitoes of Ae. aegypti in and 30 mosquitoes for BG-sentinel trap in a period of 7 days. In most Latin American countries, there is a lack of formal and accessible strategies to monitor adult populations of Ae. aegypti, so it is necessary to develop tools that reinforce entomological surveillance methods, such as the device designed in this work.

309 **Targeted indoor residual insecticide applications shift Aedes aegypti age structure and arbovirus transmission potential.**

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Abstract: While residual insecticide applications have the potential to decrease pathogen transmission by reducing the density of vectors and shifting the age structure of the adult mosquito population towards younger stages of development, this double entomological impact has not been documented for Aedes aegypti. Aedes collected from households enrolled in a cluster-randomized trial evaluating the epidemiological impact of targeted indoor residual spraying (TIRS) in Merida, Mexico, were dissected and their age structure characterized by the Polovodova combined with Christopher's ovariole growth methods. In total, 813 females were dissected to characterize age structure at 1, 3, 6, and 9 months post-TIRS. Significant differences in the proportion of nulliparous Ae. aegypti females between the treatment groups was found at one-month post-TIRS (control: 35% vs. intervention: 59%) and three months (20% vs. 49%) post-TIRS. TIRS significantly shifted Ae. aegypti age structure towards younger stages and led to a non-linear reduction in survivorship compared to the control arm. Reduced survivorship also reduced the number of arboviruses transmitting females (those who survived the extrinsic incubation period). Our findings provide strong evidence of the full entomological impact of TIRS, with important implications for quantifying the epidemiological impact of vector control methods.

Sugar Feeding and Diurnal Resting of Mosquitos Symposium

205 **Attraction distance of mosquitoes to different types of mosquito traps and natural blood sources.**

Gunter C. Muller, PhD, guntercmuller@hotmail.com, Alexey M. Prozorov, Edita E. Revay, Mohamed M. Traore, Amy Junnila, Rui-De Xue, Karen McKenzie, PhD

Experiments were carried out in Mali West Africa, in the flood plain of the River Niger, at a time where large populations of mosquitoes were present.

The trapping pattern of concentric Malaise-trap circles, separated by distances, of 4m up to 50m, was employed. Two systems were marked and alternately used as control and experimental sites. Human, cow, chicken, a CDC candescent light trap, and two commercial mosquito traps, (one CO2 combustion trap the MM 4200, UV-light trap Dynatrap, with and without lure) were used as attractants. The corresponding control system was at the same time operated without an attractant. In each experiment the circles of Malaise-traps were placed, opening opposite to the center, in a radius that was presumed suitable for the tested attractant. According to the results, in the following nights, traps were positioned in shorter or longer distances from the same bait. The catches of females, sorted to genera, from each circle in the experimental site, were compared to that of the parallel circle in the control. A statistical difference (10 repetitions) between control and experimental catch was considered attraction. Maximal attraction distance of the different baits varied significantly. The results will be presented and discussed.

206 **Mosquito Plant Attraction: Attraction from a distance; Relative plant attraction; Plant feeding rates and long term plant meal survival rates.**

Alexey M. Prozorov, alexeymprozorov@gmail.com, Mohamed M. Traore, Edita E. Revay, Aidas Saldaitis, Rui-De Xue, Liwang Cui, Gunter C. Muller, PhD

We will show how we measured, in the field, with Malaise trap circles, the attraction distances of different sugar sources (flowers, fruits, seedpods, honeydew, extrafloral nectars). We also show, with glue net traps how we determined relative attraction of the same in choice trials, and how we calculated attraction indices. In the laboratory, we evaluated daily feeding rates on these sugar sources and explored long term survival rates of mosquitoes exposed to the same.

In the field we observed measurable attraction distances up to 44m with attraction indices (AI) up to 37 folds (flowering plants compared to green non-flowering vegetation as controls). In the laboratory we found daily feeding rates ranging from 3% up to 92%, with long term survival rates equivalent to water only diets with up to 85% survival rates for a month. It is of interest that long distant attraction, relative attraction, as well as daily feeding rates and long term survival rates did not match for some sugar sources.

207 **Invasive plants in Mali West Africa: Their impact on seasonal sugar feeding and diurnal resting of Anopheline populations and implications for vector competence.**

Liwang Cui, liwangcui@usf.edu, Mohamed M. Traore, Edita E. Revay, Alexey M. Prozorov, Rui-De Xue, Aidas Saldaitis, Gunter C. Muller, PhD

Anophelines breed inside urban Bamako. They move into the city from nearby flooded wasteland and agricultural areas. Regardless from where they come from, they have to forage daily on local sugar sources inside this vast city.

We will show how in these urban settings mosquitoes opportunistically change their sugar sources and diurnal resting sites during the rainy season and how these two critical factors in mosquito survival are becoming bottlenecks during the dry season. Daily sugar feeding rates were often high. We found old and even malaria parasite infected Anophelines. We identified invasive/ ornamental plants like Prosopis juliflora and Lantana camara as main sugar sources in the rainy season and were the only natural sugar sources in the dry season. With environmental manipulation experiments we showed the direct impact of these plants on Anopheles populations and their vector competence in urban and sub-urban environments. The results will be presented and discussed.

208 **The importance of indoor sugar feeding and indoor resting for mosquitoes during the dry season in Mali West Africa**

Edita E. Revay, erevay@gmail.com, Mohamed M. Traore, Alexey M. Prozorov, Rui-De Xue, Aidas Saldaitis, Liwang Cui, Gunter C. Muller, PhD

In rural Mali, during the rainy season there are no limitations in suitable outdoor resting sites while in the dry season (both cold and hot) mosquitoes are practically not able to survive outdoors. In the dry season we could only find diurnal resting mosquitoes indoors and they were accumulating in houses where they had access to water.

In the laboratory we observed high feeding rates on different human food stuffs which was directly related to an increase in mosquito longevity. In experimental huts and in village settings Anophelines showed clear preferences for specific anthropogenic sugar sources. Favorites were fruit peals, soft drinks and spills of sugar-rich traditional Malian tea. Mosquitoes with permanent access to the same showed significantly higher long-term survival rates. This was verified by ovarian dissections and food-die staining experiments. Additionally, the daily access to water was crucial! Most viscous sugar meals alone did not guarantee long term survival. The exceptions were soft drinks and some liquid fruits like honey melons.

209 **Convenience foods and waste management: an emerging problem for urban malaria and Dengue?**

Gunter C. Muller, PhD, guntercmuller@hotmail.com, Edita E. Revay, Alexey M. Prozorov, Mohamed M. Traore, Rui-De Xue, Liwang Cui

We will disclose for the first time disturbing observations and results of laboratory/field trials showing how Anopheline and Aedes populations are thriving on sugar rich trash in urban Bamako, and how this is influencing their vector competence. We are convinced that this new type of urban sugar source has significant implications for urban malaria transmission in Africa and may contribute to vector competence of Aedes populations.

210 **Assessing Anophles gambiae s.l feeding on Attractive Sugar Bait (ASB), versus feeding on natural sugar sources in a village in Mali, West Africa.**

Mohamed M. Traore, mohamedmoumine@gmail.com, Younoussa Ziguime, Gergely Petranyi, Rabiatou A. Diarra, Alou Keita, Edita E. Revay, Alexey M. Prozorov

Malaria control is undermined by insecticide resistance and the slow development of new vector control tools. ATSB is a new vector control approach based on attract and kill principle. Vector field feeding rate on stations, and competition between stations and natural sugar sources are key points for the success of ATSB. In the current study, we determined sugar feeding rates of Anopheles gambiea s.l on stations in the field with uranine dye and no active ingredient in a village. Mosquito were collected with CDC UV light traps in and outdoors during one rainy season from July to October 2020. Baseline study was conducted in July, ASB sugar feeding from August to October. Uranine dye positive mosquito were determined with UV microscope. Natural sugar feeding from uranine negative mosquitoes was determined by cold anthrone test.

During this trial the majority of the mosquitoes shifted from natural sugar sources to ASB resulting in very high ASB staining rates. Based in our findings, the field feeding rate of Anoheles coluzzi, a major malaria vector in Sub-Saharan Africa on bait stations is likely to substantially reduce malaria transmission.

211 **ATSB entomological randomized trial in twenty villages in a malaria low endemicity setting from June to December 2019, in North Mali, West Africa.**

Mohamed M. Traore, mohamedmoumine@gmail.com, Amy Junnila, Seydou Doumbia, Rabiatou A. Diarra, Edita E. Revay, Rui-De Xue, Alexey M. Prozorov

Application of Attractive Targeted Sugar Baits (ATSB) has the potential to significantly reduce or eliminate infective female mosquitoes and malaria sporozoites in arid areas with an already low mosquito population size and sporozoite positivity rate. A total of 5,677 attractive targeted sugar bait (ATSB) “bait stations” were placed during late July/early August 2021 in ten villages in north-western Mali. Ten villages served as untreated controls. The effect of ATSB placement was monitored from August to December using CDC traps, Pyrethrum Spray Catches (PSC), and Human Landing Catches (HLC), both in and outdoors. A total of 2,703 female Anopheles gambiae s.l. were caught from treated villages and 4,582 from control villages which is a 41.0% difference. Bait station placement significantly reduced both the number of “older” females, having undergone three or more gonotrophic cycles and the number of sporozoite positive females, regardless of trapping method.

Collaboration and Innovation: CDCs COE Partnerships with AMCA Professionals Symposium I

212 **Genomic epidemiology of West Nile virus in the southwestern United States**

Crystal M. Hepp, Ph.D., chepp@tgen.org

Abstract: Since the first detection of West Nile virus (WNV) in the US in 1999, nearly 55,000 people have tested positive and more than 2,700 have died. Our study reveals novel insights regarding West Nile virus in Maricopa County and the greater southwest: 1) WNV is endemic in Maricopa County, overwintering and reemerging annually, with a limited number of new and short-lived importations, 2) This endemic WNV population is the longest known in any US county, persisting over the past decade, 3) Preliminarily, that genomically-derived effective population size estimates are strong predictors of

spillover risk, and 4) WNV in Maricopa County repeatedly spills over into other southwestern counties, indicating that this viral population is not only important for the public health of Maricopa County residents, but the rest of the region as well. Network analyses have revealed that a limited number of trap sites actually contribute to the ongoing transmission network in Maricopa County, and these traps trap sites may be ideal locations for additional mitigation activities.

213 **Collaborating with Vector Control to explore the connection between laboratory resistance assays and control efficacy for Culex tarsalis**

Tara Thiemann, tthiemann@pacific.edu, Sarah S. Wheeler, PhD, Mario Novelo Canto, Debbie A. Dritz, Natalie Linker, Leen Yousef

Abstract: One of the research priorities for the Centers of Excellence was to evaluate the impact of insecticide resistance on operational mosquito control. To approach this priority, the Thiemann Lab at University of the Pacific and the Sacramento-Yolo Mosquito and Vector Control District are collaborating on a project to make connections between laboratory resistance assays, semi-field cage trials, and changes in abundance that result from insecticide application. The first insecticide tested was a natural pyrethrin. Culex tarsalis, from the same population in Natomas, CA, were used in standard bottle bioassays with and without piperonyl butoxide (120-minute mortality and median lethal time), topical applications (LD50s), and a novel individual bottle bioassay (individual knockdown time). The results from these assays were compared to detoxifying enzyme levels, as well as kdr prevalence, in the population. In addition to the laboratory work, mosquitoes from the same population were treated with Pyronyl 525 Oil Concentrate [active ingredients: 5% pyrethrins, 25% piperonyl butoxide] in cage trials (evaluating percent mortality) and field trials (evaluating abundance reduction). Analysis is ongoing to explore the relationship between susceptibility, as measured in the lab, and operational success in the field.

214 **Catalysts of Change: Transformative Projects and Collaborations in Vector-Borne Disease Response**

Mark E. Clifton, Ph.D., mclifton@nsmad.com, Lyric Bartholomay, Ph.D., Susan Paskewitz, Ph.D., Justin Harbison, Ph.D., Haley E. Johnson, Ph.D.

Abstract: Since the initial formation of the Midwest Center of Excellence in Vector-Borne Disease, the North Shore Mosquito Abatement District (NSMAD) in Northfield, Illinois has collaborated on a variety of projects that have greatly improved our operational response to vector-borne disease within our district. From the development of larval and adult resistance monitoring, to the exploration of new wide-area larval control methods, to the retrospective analysis of historical surveillance data, each of these projects has changed how the NSMAD operates. This talk will focus on key projects and collaborations undertaken between the MCE-VBD and the NSMAD with an emphasis on projects that led to fundamental operational change.

215 **Daily impacts of adulticide application on Culex pipiens and Cx. restuans abundance, age structure, and West Nile virus infection rate in the Chicago suburbs**

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Abstract: Yearly seasonal outbreaks of West Nile virus persist in the city and suburbs of Chicago, IL, which is now considered a 'hot spot' for WNV activity. To reduce WNV transmission, ultra-low volume (ULV) adulticide applications are regularly used to kill Culex pipiens and Cx. restuans mosquitoes. The real-world effectiveness of adulticide application has not been comprehensively assessed, and prior studies have yielded inconclusive or conflicting results. Therefore, we evaluated the effects of five sequential weekly truck-mounted ULV adulticide applications in large, residential areas in the northern suburbs of Chicago, IL in collaboration with the Northwest Mosquito Abatement District. Each day, Cx. pipiens and Cx. restuans host-seeking and gravid mosquitoes were collected for assessment of abundance, age structure, and WNV infection rates. Adulticide application resulted in significant reductions of both host-seeking and gravid abundance the night of treatment. The reduction in host-seeking mosquitoes was followed by a reduction in gravid mosquitoes trapped three and four days after adulticide application, and an increase in the proportion of nulliparous mosquitoes. WNV infection rates were unchanged in 2019, when WNV infection rates were already low. However, WNV infection rates were significantly reduced in treatment as compared to control sites when infection rates were overall higher.

216 **NEVBD's Regional Pesticide Resistance Program and the Vital Collaborations that make it Possible**

Lindsay Baxter, M.S., lb694@cornell.edu, Charles Abadam, Laura C. Harrington, PhD

Abstract: The Northeast Regional Center for Excellence in Vector-Borne Diseases (NEVBD) pesticide resistance monitoring program was created in 2019 to expand resistance monitoring capacity across Northeast and Mid-Atlantic regions and gather baseline data for medically important mosquito populations. We developed a specimen submission system and testing protocols for larvicide and adult active ingredients commonly used regionally. During the first 5 years of the program, NEVBD collaborated with 40 county and regional mosquito control programs, and conducted resistance assays on larval and adult Culex pipiens and Aedes albopictus from 10 states totaling 176 different sampling locations. This regional network of collaborators has accomplished what one institution could not. Our partnerships have enable us to investigate insecticide resistance through field trials, provide on-site trainings, and characterize insecticide resistance mechanisms. We will highlight our collaboration with Virginia mosquito control agencies that has enabled us to further evaluate resistance in Cx. pipiens beyond the CDC bottle bioassay.

Adult Control II

217 **Temperature and time of biting impact the efficacy of chemical control interventions targeting the West Nile Virus vector, Culex tarsalis**

Joshua Kalmouni, jkalmoun@asu.edu, James B. Will, John Townsend, BS, Krijn Paaijmans, PhD

Abstract: West Nile Virus (WNV), vectored by Culex tarsalis, is the leading mosquito-borne disease in the United States. Concerningly, there are no prophylactics or drug treatments for WNV, thus public health programs rely heavily on vector control efforts to lessen disease incidence. Insecticides can be effective in reducing vector abundance if implemented strategically but diminish in efficacy and/or promote insecticide resistance otherwise. Vector control programs which employ mass-fogging applications of insecticides, often conduct these methods during the late-night hours, when diel

temperatures are coldest. This study's aim was to quantify the effect of temperature on the toxicity of conventional insecticides: malathion and deltamethrin, to Cx. tarsalis. An additional aim was to quantify the time of biting of local mosquitoes. Immature Cx. tarsalis were collected and reared, where adult non-blood-fed females (aged 2-5 days old) were used in experimentation during April – June 2021. Under three temperature regimes (15, 25, and 35°C; 80% RH), the WHO tube bioassay for insecticide resistance monitoring was used to evaluate the toxicity of insecticides on Cx. tarsalis. Insecticide doses ranged from low, medium, and high. Collection bottle rotator traps were deployed simultaneously to capture adult female mosquitoes seeking blood meals. The data show that malathion became less toxic to local Cx. tarsalis at colder temperatures, while deltamethrin was less toxic at colder temperatures except for the highest dose, where no effect of temperature was observed. Cx. tarsalis, Aedes vexans, and Culex quinquefasciatus were the most abundant vectors captured. Post-midnight biting (00:00 – 6:00) accounted for 70.28% of all captures, while pre-midnight biting (18:00 – 24:00) accounted for 28.85% of all captures. Our results suggest that programs employing large-scale applications of insecticides should consider temperature-toxicity relationships coupled with time of biting data during relevant seasons to maximize their efficacy to reduce mosquito-borne disease burden.

218 **Laboratory and semi-field evaluation of the dried attractive bait station (DABS) against Ae. aegypti mosquitoes**

Leonardo D. Ortega López, PhD, leinfloyd@yahoo.com, David Larsen, PhD, Marco Neira, PhD

Abstract: Aedes aegypti is the most important arbovirus vector in the world, but disease prevention is limited by the absence of vaccines against dengue, Zika and chikungunya, and by the increasing development of insecticide resistance of Ae. aegypti. Despite several vector control alternatives have been developed, none of them has been shown to be fully effective against mosquito populations. The application of combined vector control methodologies is essential to tackle the spread of vector populations and thus reduce disease transmission. A recently developed technique that uses the nectar feeding behaviour of mosquitoes has shown promising results in showing killing effects over Ae. aegypti populations, without developing insecticide resistance by the target species. Such is the case of the dried attractive bait station (DABS). This device consists of foamy sheets coated with a mix of sucrose 10% and boric acid. In these experiments, we assessed the optimal concentration of the main killing component, boric acid, under laboratory conditions, by testing 1%, 2% and 4%, against a non-toxic control treatment. Also, we evaluated the optimal size of the device (total exposed surface) as well as the optimal density of devices within rooms under semi-field experiments that were exposed to a fixed number of female Ae. aegypti mosquitoes. Results indicate that no significant difference was found between different concentrations, thus 1% boric acid was used in further experiments. Experiments on optimal size and density of devices will be finished by December 2023. Upcoming evaluations will consist of field testing in Caguas, Puerto Rico by deploying the optimal device settings to local houses and assessing Ae. aegypti populations before and after implementation in a comparison control trial.

219 **Dengue Prevention and Exclusion of Aedes aegypti with Screens in Doors and Windows in Puerto Rican Houses**

Nexilianne Borrero, MS,MBA, nborrero@prvectorcontrol.org, Julieanne Miranda Bermúdez, Jania Paola García, MPH, Grayson Brown

Abstract: The Puerto Rico Vector Control Unit (PRVCU), the Ponce Health Science University (PHSU) and the Puerto Rico Department of Health (PRDH) established a collaborative project funded by the US Department of Housing and Urban Development to prevent dengue using house screens against Aedes aegypti mosquitoes in Puerto Rican housing. The implementation of the study started in August 2023 and the evaluation will be over 2 years. The study site is in Ponce, Puerto Rico through the Communities Organized for the Prevention of Arboviruses (COPA) project; a cohort study of 38 clusters in Ponce with over 5,000 participants. The recruitment goal is 500 households: 250 households as intervention group with screen installation in doors and windows and 250 households as control group.

The recruitment process involves scheduling a household visit to evaluate existing doors and windows in the home. Over 360 calls were made, with a total of 211 contacted participants and 22 refusals. Preliminary results from 5 of the 19 clusters selected showed that 72 households were evaluated for eligibility and a total of 59 were eligible in which n=31 (12.40%) were assigned to y a treatment (screening installed) group and n=28 (11.20%) for control group.

Screened houses had about 1/3 as many mosquitoes compared to unscreened homes (1.0 female Ae. aegypti/home vs 2.89 female Ae. aegypti/home). Thus, the risk of contracting dengue in screened homes is much lower than in unscreened homes.

220 **Field trial on the efficacy of Oviposition enhancer fused to the In2Care® Mosquito Stations in attracting Culex quinquefasciatus and Aedes aegypti**

Jennifer Castellon, jthieme@wvmvcd.org, Solomon K. Birhanie, Michelle Brown, PhD

Abstract: The In2Care® Mosquito Stations attract and kill Aedes mosquitoes with pyriproxyfen and Beauvaria bassiana that target both larvae and adults, helping suppress invasive Aedes mosquito population. Research is currently underway to optimize the Station further to enhance oviposition of other vector mosquitoes such as Culex quinquefasciatus, a primary vector of West Nile Virus. In this study, we tested a novel oviposition enhancing ingredient that attracts and kills both Culex quinquefasciatus and Aedes mosquitoes. Two quantities (5g and 25g) of the enhancer was utilized to compare their efficacy with the control (the original In2Care® Mosquito Station). Four sites were selected in the city of Chino, California, and followed up for 16 weeks. The Stations were serviced every four weeks by emptying all contents for mosquito larvae examination and refilling them with water and ingredients. Both 5g and 25g of the enhancer attracted more Culex quinquefasciatus for oviposition than the original traps. Two-fold Cx quinquefasciatus egg rafts and five-times more larvae were collected in Stations with 25g enhancer than the 5g. Both Cx quinquefasciatus and Ae aegypti were identified in the larval samples. Overall, our preliminary findings suggested that the new ingredient enhanced oviposition of Culex quinquefasciatus which could have an added benefit to the existing In2Care® Mosquito Stations.

221 **Corporate Responsibility in Action, Leading the Fight Against Malaria: The Role of IR3535® in this Battle**

Howard A. Epstein, PhD, howard.epstein@emdgroup.com

Abstract: Malaria remains a major health and social challenge. Half of the global population is at risk of malaria, with more than 240 million cases worldwide. 95% of the cases in Africa, striking hardest among pregnant women and children in Sub-Saharan Africa. Children under five account for about 80% of all malaria deaths globally. The World Health Organization recommends vector control as the main

approach to prevent and reduce malaria transmission. The Center for Disease Control recommends insecticide-treated nets, indoor spraying and insect repellent use for people traveling to or living in malaria-endemic countries. Further, pregnant women and babies are at particular risk, there is no repellent safe for daily use with long-lasting efficacy requiring minimal reapplication and pleasant to use. An unmet need identified, IR3535® was found to be a long-lasting DEET-free alternative repellent. Since 2015 Merck KGaA, Darmstadt, Germany embarked on a program "As One Against Malaria," an integrated approach to fight malaria with the aim of developing and providing new drugs to prevent and treat infection, block malaria transmission, promote research initiatives to develop innovative technologies and strengthen the resilience of health systems. The program includes collaboration with partners, all with the common goal to fight malaria. The key advantage of IR3535®is its safety profile, being biodegradable, safe for the environment. For this reason, a collaboration with a US-based company, LivFul and the Noguchi Memorial Institute for Medical Research in Ghana was initiated to conduct efficacy studies of a promising insect repellent delivery technology intended for everyday use. Arm-in-cage studies show the potential for this technology to provide an average protection time of 14 h, repelling mosquitos with a very light skin-feel and little or no scent. The formulation is suitable for children older than 2 months and pregnant women. Repellent field testing is scheduled to confirm efficacy.

222 **Incorporating Sterile Insect Technique into IPM toolbox to control invasive Aedes mosquitoes in the West Valley region of San Bernardino County, California**

Solomon K. Birhanie, sbirhanie@wvmvcd.org, Jennifer Castellon, Mayra Macias, Michelle Brown, PhD

Abstract: Sterile Insect technique (SIT) has brought novel opportunities to intensify efforts to control the invasive Aedes mosquitoes in California. The West Valley Mosquito and Vector Control District has embraced this tool and is working to incorporate it into the conventional IPM toolbox for invasive Aedes mosquito control. Our approach in utilizing SIT for invasive Aedes control is unique since it only targets hotspots instead of large-scale blanket releases. This work aims to assess if targeted sterile male mosquito point releases can suppress invasive Aedes population in hotspot neighborhoods. In our pilot program, we released sterile male Aedes aegypti mosquitoes at three sites in three cities. First, a site was selected based on counts from BG Sentinel trappings. Baseline (prior to release) and follow-up cluster mosquito trapping was conducted within 100 and 200 yards from each site. A 100-times the number of female Ae aegypti from BG Sentinel traps were released at each site. Follow-up cluster mosquito trapping was conducted at 9 sites around each release site for four consecutive weeks. The results and their implications are discussed. Lessons drawn from this pilot program help to optimize SIT as an additional tool in our IPM toolbox for the control of invasive mosquitoes.

224 **Comparing the effectiveness of various spatial repellents in the lab and field: the utility of a small-tube glass repellency assay**

Edmund Norris, PhD, Edmund.Norris@usda.gov, Jedidiah Kline, M.S., Greg Allen, B.S., Robert L. Aldridge, PhD, Kenneth Linthicum, PhD, Dan L. Kline, PhD, Seth Gibson, PhD

Abstract: Spatial repellents are a novel mosquito control technology with great potential. Many of these products require little input from end-users as they involve an active emitting device or a volatile chemistry that is passively deployed. As such, there is a greater possibility for user compliance

without onerous reapplication regimens and constant redeployment protocols, as in the case of topical repellents. While numerous laboratory assays exist for the identification of spatial repellents, little is known about how the results from these various assays translate to field efficacy. Our group evaluated the potential of a laboratory small-tube glass spatial repellency assay to predict efficacy in a series of spatial repellency field trials on a field site in Gainesville, FL. The laboratory assay identified numerous plant oils that were as active as other known, commercial repellents. Moreover, a number of oils were also not highly active in this assay and therefore a spectrum of activity was available for correlation to field work. In the field characterization of these oils, select oils produced statistically significant repellency when looking at total mosquito capture. On the basis of individual mosquito species capture, these trends were very similar (i.e., no significant difference in the rank potency of each oil was observed among the three most abundant mosquitoes species - Aedes infirmatis, Anopheles crucians, and Culex coronator). While direct linear correlations between laboratory bioassay results and field trial outcomes were not achievable, the best oils in the lab generally performed better in the field. Overall, this study highlights the utility of this small-tube glass repellency assay in characterizing spatial repellents, as field efficacy was similar to that observed in the laboratory. Future work will expand these comparisons to further evaluate potential correlation or lack thereof, and better understanding what parameters contribute to good correlations.

225 **Easy colonization of field strains of Culex quinquefasciatus and novel PCR assays for speciation and detection of strong organophosphate resistance**

Neil D. Sanscrainte, neil.sanscrainte@usda.gov, Alden S. Estep

Abstract: With increasing levels of insecticide resistance (IR) being reported in mosquito populations across the US, mosquito control districts are relying more on laboratory and field testing to determine pesticide susceptibility in local mosquito populations. Common methods to identify and quantify IR, and the conduct of spray testing, require large numbers of organisms. While some common disease vectors, such as Aedes aegypti, are easily colonized, others, such as Culex quinquefasciatus, provide challenges when rearing in the lab. Here we present an easy protocol that does not require avian hosts or require expensive laboratory equipment. This method has been used to colonize over 10 strains of Cx. quinquefasciatus from rafts collected in Florida and Louisiana. This has produced sufficient organisms for detailed examinations of the mechanisms involved in IR, which differ dramatically between the Aedes and Culex genera. Two novel PCR based assays are described that have been developed to assist in detecting strong organophosphate resistance in Culex quinquefasciatus and to assist with the speciation of closely related Culex species.

Collaboration and Innovation: CDCs COE Partnerships with AMCA Professionals Symposium II

226 **How insecticide resistance monitoring and management has integrated into the Suffolk Mosquito Control program**

Charles Abadam, cabadam@suffolkva.us

Abstract: In 2018 Suffolk Mosquito Control began to monitor insecticide resistance of adulticides in two of our most important mosquito species. Initial results revealed that Culex pipiens was resistant to all pyrethroids, malathion, and chlorpyrifos; Aedes albopictus was susceptible to all pyrethroids and

organophosphates. Learning that Cx pipiens, our primary vector for West Nile Virus, was resistant to every adulticide in our tool box was a surprise. Our commitment to annual insecticide resistance monitoring strengthened and we developed our program further. We re-examined several aspects of our program considering our adulticides, proper adulticide application, adulticide rotation protocols, action thresholds, and alternative control methods. Understanding this problem and finding a solution has become a major focus of the program. Our initial training on the CDC bottle bioassay started our exploration into understanding insecticide resistance and our continued partnership with the Northeast Regional COE for Vector-borne Diseases helps keep us focused and motivated to carry on with this work. Although unwelcomed, insecticide resistance has integrated itself into the program but strong collaborations with these institutions provide support that will help us answer our questions.

227 **Developing Future Leaders: Mosquito Control Training Through the Collier Mosquito Control District and CDC Southeastern COE Internship Program**

Keira J. Lucas, PhD, klucas@cmcd.org, Rhoel Dinglasen, PhD

Abstract: This presentation explores a collaborative initiative by the Collier Mosquito Control District and the CDC Southeastern Center of Excellence in Vector-borne Disease in offering mosquito control internships to undergraduate and graduate students. Central to this initiative is the pivotal role that internships play in nurturing future talent in mosquito control. Focusing on pesticide resistance in mosquito disease vectors, the program provided hands-on research experiences and mentorship from experts in mosquito control. Through this partnership, students developed essential research skills, contributed to understanding pesticide resistance mechanisms in mosquitoes, and cultivated leadership in the realm of mosquito control and vector-borne disease management. This presentation underscores the two programs' role in building a skilled workforce capable of addressing emerging challenges in public health and mosquito control.

228 **Evaluation of truck-based adulticiding in Harris County, Texas on Culex quinquefasciatus abundance and infection with West Nile virus**

Gabriel Hamer, gabe.hamer@ag.tamu.edu, Luis Chaves, PhD, Charlotte Rhodes, MS, Chris Fredregill, MS, Maximae Vigilant, PhD, Luke Bergmann, PhD, Rudy Bueno, PhD, Mustapha Debboun, PhD

Abstract: Since its introduction in 2002, West Nile virus (WNV) has been reported annually in Harris County, Texas. To mitigate transmission, the Harris County Public Health Mosquito and Vector Control Division (HCPH MVCD) routinely conducts truck-based adulticiding. Previous studies in Harris County have investigated insecticide resistance in mosquitoes, compared resistance to different insecticide classes, and evaluated different forms of vector surveillance. However, long-term efficacy of adulticiding on vector populations has not been evaluated. This study utilized a time series analysis to characterize the monthly and weekly influence of adulticiding on Culex quinquefasciatus Say abundance and WNV infection over an 18-year period. Our models were unable todetermine a consistent relationship between adulticiding and Culex abundance among the different surveillance traps and temporal scales of analysis (week and month). The models suggest a long-term negative association between adulticiding and Culex infection with WNV such that infection is lower 9-12 weeks following adulticide treatment. Further studies should continue to investigate the efficacy of truck and aerial

adulticiding for the management of WNV using improved study designs for building the evidence base for assessing vector control interventions.

229 **Surveillance of Ticks and Tickborne Diseases: Collaboration Between Harris County Public Health and the Western Gulf Center of Excellence for Vector-borne Diseases**

Michelle Downey, MS, michelle.downey@phs.hctx.net, Erik Aguirre, BS, Brianna Weber, BS, Maximae Vigilant, PhD

Abstract: Ticks and tickborne diseases (TBD) are of increasing concern for public health, and the need for continuous surveillance of ticks and their potential pathogens has become apparent in the decades since Ixodes-vectored Lyme disease was recognized. In the United States, the past twenty years have seen a steady increase in the number of reported cases of vector-borne diseases, with TBD doubling in number during that time. Climate, land use, and environmental changes have likely led to the range expansions of different ticks that vector disease. All these factors demonstrate the importance and need for formal surveillance programs for ticks and tick-vectored pathogens. Here I will summarize the activities of the Vector Surveillance Section within the Harris County Public Health Mosquito and Vector Control Division, including our methods, findings, and future direction. Collaboration with the Western Gulf Center of Excellence for Vector-borne Diseases, based at the University of Texas Medical Branch in Galveston, was pivotal to the establishment of non-mosquito vector surveillance in Harris County, Texas.

Innovative, Operational Non-Chemical Approaches to Mosquito Control Symposium II

230 **Advances in the development of an SIT Program for mosquito control districts to control Aedes aegypti**

Robert L. Aldridge, PhD, robert.aldridge@usda.gov, Kenneth Linthicum, PhD, Seth Gibson, PhD, Barbie Bayer, MS

Abstract: Area wide control of Aedes aegypti is notoriously difficult given its cosmopolitan distribution, its affinity to live in close proximity to humans, and its ability to utilize cryptic habitats both as adults and immatures. To that end, the sterile insect technique (SIT) has been further refined for Aedes aegypti as it utilizes males to locate their conspecifics and mate with them to render their eggs sterile. In this presentation we explore some methods to improve the performance of SIT for Aedes aegypti release.

231 **Application of genetically engineered mosquitoes for malaria elimination**

Anthony Cornel, Dr., ajcornel@ucanr.edu, Gregory Lanzaro, Prof.

Abstract: The University of California Malaria Initiative (UCMI), a for-non-profit initiative, has a core mission to contribute to eradication of human malaria using genetically engineered mosquitoes. UCMI approach is to modify natural populations of Anopheles coluzzii Coetzee & Wilkerson mosquitoes, which are primary malaria vectors in Africa, using technology that alters natural mosquito populations to prevent malaria transmission by coupling 2 genes that block the parasite (beneficial genes) with a “gene drive” that spreads beneficial genes in a mosquito population. The benefits of population modification include that once the parasite blocking genes are fixed in a population it provides a layer of sustainable

malaria control whether at malaria phase of control, pre-elimination or elimination and, if at elimination phases, will provide sustainable control to combat reintroduction of malaria. Aspects of the 4 main components of UCMI, namely, Laboratory Science, Modeling, Field Science and Community Engagement will be presented to provide insights into the UCMI goal of a World Health Organization) WHO defined Phase II ecologically confined field trial.

232 **Autocidal control tools for Aedes aegypti and Aedes albopictus - Population Suppression using Wolbachia infected males**

Stephen L. Dobson, PhD, sdobson@mosquitomate.com

Abstract: Wolbachia pipientis is a naturally occurring, maternally inherited, obligately intracellular bacterium that is estimated to occur naturally in over half of all insect species, including medically important mosquito species. In mosquito populations that are uniformly infected with the same Wolbachia infection type, Wolbachia is a commensal symbiont, having little or no effect on the mosquito host. But matings between mosquitoes with different Wolbachia types can result in cytoplasmic incompatibility (CI) and the failure of the mosquito eggs to hatch. Therefore, the release of incompatible, non-biting male mosquitoes can be used as a species specific pesticide to reduce egg hatch and suppress mosquito populations. MosquitoMate has worked with multiple mosquito abatement districts to develop and test the Wolbachia suppression method against invasive Aedes mosquitoes, including field trials in multiple states that target Ae. albopictus and Ae. aegypti. This presentation will summarize the current status and near term plans for the Wolbachia suppression tool. The presentation will also summarize additional, non-Wolbachia autocidal tools, including the current regulatory status in the USA, where the Wolbachia method is regulated in the USA by the Environmental Protection Agency (EPA).

233 **Developing biocontrol technologies for mosquitoes**

Shih-Che Weng, PhD, s2weng@ucsd.edu, Igor Antoshechkin, PhD, Eric Marois, PhD, Omar S. Akbari, PhD

Abstract: Female mosquitoes are the sole blood-feeding culprits responsible for transmitting dangerous human pathogens. Hence, the imperative task of eliminating female mosquitoes precedes any genetic biocontrol interventions. In this study, we introduce a highly reliable method called SEPARATOR (Sexing Element Produced by Alternative RNA-Splicing of A Transgenic Observable Reporter) designed to harness sex-specific alternative splicing of a benign reporter gene. This innovative approach ensures the exclusive and dominant expression of the reporter gene in males.Our research demonstrates the effectiveness of SEPARATOR for sex selection at both the larval and pupal stages of Aedes aegypti mosquitoes. We leverage a Complex Object Parametric Analyzer and Sorter (COPAS®) to showcase the scalability of high-throughput sex selection, particularly in first instar larvae. Furthermore, we employ SEPARATOR to unravel the transcriptomes of early larval males and females, unveiling several genes that exhibit sex-specific expression in males.Building on these findings, we integrate SEPARATOR into a molecular genetic control system known as the precision-guided sterile insect technique (pgSIT). This integration enhances the precision and efficiency of sex sorting, paving the way for the development of the next-generation sterile insect technique tailored for mosquito control in Aedes aegypti populations.SEPARATOR holds the promise of streamlining the large-scale production of male

mosquitoes for release programs and boasts adaptability across various species, rendering it an invaluable tool for genetic biocontrol interventions.

234 **Collaborative efforts with Oxitec and Delta Mosquito and Vector Control District in the Central Valley of California**

Mustapha Debboun, PhD, mdebboun@deltamvcd.org

Abstract: The yellow fever mosquito, Aedes aegypti is an invasive species in California. Since 2013, Ae. aegypti has spread and become established in 26 counties and 300 cities and towns in California, posing unique challenges to mosquito control because its diel periodicity, proximity to people, climate change, and use of cryptic harborages and breeding sources. Delta Mosquito & Vector Control District (DMVCD) invited Oxitec to evaluate their self-limiting gene technology against Ae. aegypti within its District, pending state regulatory approval from California Department of Pesticide Regulation Office. This presentation will focus on the community and outreach efforts by DMVCD and Oxitec and the widespread, enthusiastic public support in the Central Valley for this cutting-edge innovative technology using self-limiting gene male mosquitoes from Oxitec.

235 **Scale-up of Oxitec's Sustainable, Self-Limiting Solution for Aedes aegypti**

Rajeev Vaidyanathan, Ph.D., zvuvhol@gmail.com

Abstract: The invasive mosquito Aedes aegypti is distributed across much of the world and, aided by climate change, continues to spread to new regions in the US. One novel solution for management of Ae. aegypti is the release of self-limiting male mosquitoes. These non-biting males find and mate with local female conspecifics, and the resulting female offspring cannot survive. The number of biting females in subsequent generations is reduced, thereby delivering targeted, species-specific biological control of Ae. aegypti. The deployment of self-limiting male mosquitoes has proven highly effective in reducing Ae. aegypti populations in densely populated urban communities in Brazil by more than 90%, relative to those in untreated neighborhoods. Now commercially approved in Brazil, Friendly™ Aedes aegypti egg devices are being purchased by city governments, households, and businesses. This same self-limiting technology has undergone three seasons of successful pilots in the Florida Keys, demonstrating its utility as a safe and effective vector control tool.

Latin American Symposium II

236 **Metagenomic bank for the control of Culicidae**

Gerardo Trujillo, Professor, entogerry36@gmail.com, Mariana Lizbeth Jimenez, Everardo Gonzalez, Professor, Iram P. Rodriguez-Sanchez, PhD

Abstract: The creation of a metagenomic bank is of vital importance for the study and control of vectors. The Molecular and Structural Physiology Laboratory performs different omics focused on the dengue-transmitting mosquito Aedes aegypti, generating information on the genome, mironome, metabolome, microbiome, among others. Although the science performed is essentially descriptive, it is of vital importance to have it in order to start generating experiments that benefit vector control, since the main impediment to carry out experimental science is the lack of focus.

237 **Mosquito (Diptera: Culicidae) survey during the construction of the Mayan train, southeastern Mexico**

Aldo I. Ortega-Morales, agrortega@hotmail.com, Jorge J. Rodríguez-Rojas, Ángel S. Gómez-Rivera, Pedro C. Mis-Ávila, Marco A. Domínguez-Galera, Rosa Maria M. Sanchez-Casas, Ildefonso Fernandez-Salas

Abstract: One of the main projects of the current government of Mexico (2018–2024) is the construction of a tourist train, named the ¨Mayan train". This train is built mainly in southwestern Mexico, including the states of Tabasco, Chiapas, and the Yucatan Peninsula, including the states of Campeche, Yucatan, and Quintana Roo. The train route passes through several conserved rainforests and tropical regions. Therefore, some rainforest has been deforested for the railway installation works. During these activities, diverse vector-borne diseases were reported among train workers. To document the species of mosquitoes present in a section of the Mayan train in the state of Quintana Roo, mosquito collection was conducted during the dry season of 2023, in conserved areas around the Mayan train track in the municipalities of Bacalar, Othon P. Blanco, and Chetumal. Mosquitoes were collected using CDC light traps, Shannon traps with protected human bait, approaching humans, and immature stages were collected from natural and artificial water bodies. Collected specimens were labeled and transported to the Center for Research and Development in Health Sciences, UANL in Monterrey, for mounting and identification. 19 species were collected, including two new records for Quintana Roo: Culex metempsytus Dyar and C. spissipes (Theobald).

238 **Effectiveness of Actellic 300 CS (Pirimiphos-methyl 28.9%) as alternative ULV formulation to control indoor and outdoor adult Aedes aegypti resting populations at Monterrey, Northeastern Mexico**

Ildefonso Fernandez-Salas, ildefonso.fernandezsl@uanl.edu.mx, Jorge J Rodriguez-Rojas, Rosa Maria M. Sanchez-Casas, Teresa Ambriz

Abstract: Increased reports of pyrethroid resistance in most Latin American countries are challenging Vector Control Programs to move either to newly developed insecticide groups or to safer and well-known organophosphate compounds. Actellic 300 CS is a capsule formulation designed to prolong residuality when used by contact indoor residual spraying (IRS) versus indoor resting mosquitoes. However, Actellic 300 CS studies focusing on its airborne action properties have been poorly documented. Considering some interesting facts, such as being an organophosphate product and presenting a very low dermal and oral toxicity, we conducted a small-scale ULV treatment on ten households in Monterrey City, NE, Mexico.

Female Aedes aegypti were placed in 15 x 10 x 30 cm cages and distributed in indoor of house rooms. Mosquito cages were also placed at outdoor house backyards. Two control houses were used concurrently. Actellic 300 CS was prepared by mixing an 833-ml bottle in 10 L of water to yield a 1 gr a. i./m2. The latter concentration is recommended for resting Anopheles in Africa, but because an indoor ULV dose is unavailable, we decided to use it as cold fogging. We aimed to explore the potential results of airborne activity of the capsule formulation. The flow rate was 150 ml/min, while the mean diameter of the microdroplet was 23.7 microns.

Results: Indoor and outdoor 24-hour mortality was 100% for both locations. Females Ae. Aegypti were knocked down one after spraying as high as 99.2% and 97.5%, indoor and outdoor, respectively. No complaints were noticed by house dwellers related to skin irritation or fuel odor. Results show an optimistic potential of recommending Actellic 300 CS as a house ULV treatment during severe Dengue outbreaks in Latin America.

239 **Datos Satelitales para Apoyar Herramientas de Pronóstico de Enfermedades Transmitidas por Vectores**

Helena Chapman, MD, MPH, PhD, helena.chapman@nasa.gov

Abstract: Según el reporte del Estado del Clima en América Latina y el Caribe 2022, los efectos perjudiciales del cambio climático sobre la salud en la región incluyen sequías, inundaciones, olas de calor y frío, peligros naturales, aumento del nivel del mar, el calentamiento de los océanos y cambios en el uso de la tierra. Estas alteraciones de los ecosistemas naturales, junto con el riesgo de resistencia a insecticidas, pueden presentar desafíos en el control de vectores y manejo clínico. Por lo tanto, las aplicaciones científicas novedosas que incorporan los datos satelitales para examinar los cambios del medio ambiente, pueden ofrecer herramientas clave para pronosticar áreas de alto riesgo de los criaderos de vectores a los Ministerios de Salud y a los actores interesados. En esta presentación, se presentará el programa de Salud y Calidad del Aire de la NASA, el cual promueve el concepto de Una Salud y el valor de colaboraciones multidisciplinarias para motivar el análisis crítico sobre las amenazas complejas en la salud ambiental. Se mostrarán ejemplos clave donde los investigadores integraron los datos satelitales, entomólogos y epidemiólogos para desarrollar herramientas de apoyo a la toma de decisiones para el control de vectores. Finalmente, se promoverán las oportunidades de aprendizaje por los cursos del Programa de Capacitación de Teledetección Aplicada (NASA ARSET) y por la participación en la comunidad de práctica de GEO Salud, con el fin de adquirir nuevas destrezas y contribuir los conocimientos en redes profesionales de diversas disciplinas.

240 **Parallel surveillance activity of Aedes aegypti using traps in the Wolbachia replacement project to control dengue in El Salvador.**

Julieanne Miranda Bermúdez, jmiranda@prvectorcontrol.org, Cristhian R. Sánchez-Rolón, MS, Berta Álvarez-Rodríguez, MS, Norma Padilla, PhD, Carlos Estupinian, MS, Omar Martinez, BS, Jose Eduardo romero, Ing, Grayson Brown

Abstract: In 2019, over 3 million dengue cases were reported in Latin America, including 27,500 in El Salvador. The municipalities of Santa Ana, Chalchuapa, and San Sebastian Salitrillo experienced the highest dengue burden from 2015-2019. A collaborative project between Puerto Rico Vector Control Unit (PRVCU), El Salvador's Ministry of Health, World Mosquito Program (WMP), and CDC Dengue Branch has been implemented to determine the successful establishment of Wolbachia replacement in three areas. The PRVCU and CDC are implementing a parallel surveillance to evaluate diverse factors to monitor the populations of Aedes aegypti, the presence of arbovirus in adult mosquitoes, and the replacement of the native Ae. aegypti population with Wolbachia-infected mosquitoes that would block dengue virus transmission in western El Salvador. WMP will conduct a control and monitoring program to evaluate the rate of mosquito population replacement using household aspirations during short periods of time during implementation and sporadically afterwards, within the five-year observational period of the project. This parallel surveillance intends to complement WMP's surveillance system and

extend surveillance for the project lifetime. The project will be developed in three stages: (1) evaluation of the efficacy in capturing Ae. albopictus and Ae. aegypti between Autocidal Gravid Ovitrap (AGO) traps and Bioagent Sentinel 2 (BG) traps to determine which trap is more efficient; (2) depending on the results of the first stage, either AGO or BG traps will be deployed and surveillance of adult mosquitoes in residential areas will begin; and (3) long-term monitoring after the establishment of Wolbachia in the release area. This longitudinal measurement will allow us to understand the factors that determine the longevity and sustainability of Wolbachia in an area. The proposed presentation will show this methodology in detail and the preliminary results.

241 **Situation of arbovirus transmission in Latin America and Brazil, post COVID19 pandemic and the consequences of global warming.**

Fabio Castelo Branco fontes Paes Njaime, PhD, fabiocastello@gmail.com

Abstract: What was the impact of the transmission of Dengue, Zika and Chikungunya, at the same time that the Pandemic began, with the transmission of the SARS-CoV-2 virus (COVID-19). We consider the “COVID Effect” to have an epidemiological impact on other diseases that is as important as the social and economic impact.

We can summarize the impact in 3 main cases: UNDERREPORTING of Arbovirus cases; THE INTERRUPTION OF ENTOMOLOGICAL SURVEILLANCE, home inspection for surveillance and control of the Aedes mosquito, due to the risk of contagion, both for the owner and the Health Agent; SEROLOGY AND DIAGNOSIS, the urgency of care caused by a pandemic of global magnitude, with risk of death, overloaded the health system, which consequently reduced the serological investigation of cases, including those of arboviruses. Why? due to initial symptoms very similar to those of Covid19, most of them, in the rapid and urgent diagnosis, were probably neglected, prioritizing symptomatic treatment and considering the case as suspected of Covid19.

At the beginning of 2022, with the arrival of vaccines and the commitment of world governments to vaccinate their population against Covid19, cases of the disease also decreased exponentially in both cases and cases with a risk of death. Generating pressure relief on health systems and allowing the resumption of routine services, including serological and primary diagnosis of Arboviruses. As a result, in the first two months of 2022, approximately 130,000 cases were reported with growth inversely proportional in speed to the reduction reported during the pandemic. In the capital of Brazil, for example, cities that saw a decrease of 70% in 2021 experienced an increase of more than 1,200% in 2022.

The change in climate temperature with the increase in temperature and its variation changes the seasonality of mosquito infestation and transmission of arboviruses in cities, demonstrative graphs.

Social Media and Mosquito Control Symposium

242 **Mastering Multimedia: Social Media Storytelling**

Beth Ranson, beth.ranson@Valentbiosciences.com

Abstract: Social media has become a dynamic stage for storytelling, connecting people and ideas worldwide. To truly captivate and engage your audience, it's essential to master the art of multimedia content. This presentation will unveil the secrets behind crafting compelling narratives through the fusion of text, images, videos, and more - and will explore the strategic use of multimedia to create memorable, shareable content that resonates with your target audience.

243 **From Silence to the Sound of Social Media**

Michele Rehbein, PhD, C.E., michele@slcmad.org

Abstract: Sharing education and outreach information can be tricky, including social media platforms. In June 2023, the Salt Lake City Mosquito Abatement District (SLCMAD) put social media into high gear and became more active on social media platforms. This presentation will discuss the ways SLCMAD attempts to connect with its local community and on a wider scale through social media. Hear suggestions of how to get more creative with your content, developing a consistent schedule for posting and sharing content, and not being afraid to go outside of your comfort zone when it comes to content sharing. Examples and suggestions of content SLCMAD has used will be also be shown and discussed.

244 **Backyard Bug Hunt - Mosquito Edition**

Jason Fritz, MPH, jason.fritz@wilco.org, Mehgan Murray

Abstract: Since the late 1990s, National Mosquito Control Awareness Week (NMCAW) has been an annual campaign among many vector control districts. The rise of social media has allowed organizations to reach a larger and more diverse audience. In 2020, Williamson County and Cities Health District (WCCHD) first began to promote NMCAW.

WCCHD leverages the power of social media as a low-cost platform to educate residents of Williamson County, Texas, about its public health services, including mosquito surveillance and control. The 2023 NMCAW included four short videos created using two people, a cell phone, Canva Pro, and Adobe Premier Rush. The videos were published on WCCHD's social media pages throughout NMCAW.

WCCHD collaborated with an entomologist from Texas A&M AgriLife Extension to discuss mosquito habitat and control. The entomologist is known for their point of view (POV) videos on social media called "Backyard Bug Hunt." Both WCCHD and AgriLife wanted to collaborate on a "Backyard Bug Hunt- Mosquito Edition" to showcase mosquito control education. These videos featured WCCHD's vector control supervisor discussing mosquito habitats, mosquito traps used at WCCHD, proper repellent use, and protecting pets from heartworm disease. After filming, a WCCHD marketing specialist utilized Canva Pro and Adobe Premier Rush to edit and publish the videos.

This campaign empowered the community with knowledge and resources to protect themselves from mosquito-borne disease and bring awareness to local mosquito control, reaching nearly a million social media accounts across all sites. WCCHD hopes to maintain this momentum for its future educational campaigns.

245 **Leveraging Facebook in mosquito control communications**

Michael Mut, mmut@miamidade.gov

Abstract: This presentation will serve as a primer on how to leverage the social media giant Facebook to communicate with residents about mosquito control. It will cover the history of the platform, current functions and demographic information, instructions on how to create and best post content, and a look at the robust audience measurement and advertising capabilities. In addition, it will provide examples on how Miami-Dade uses the platform to deliver mosquito control tips, news, and spray treatment notices, and an example of how communicating with a resident through the Instant Messenger function led to a breakthrough on how the County provides treatment notifications. The goal will be to give both the novice and intermediate users of the platform detailed instructions and insight on how to optimize messaging and fully leverage the platform.

10 Annual AMCA Arthropod Vector Highlights Symposium

246 **Highlights of Vector Control Technology – 2023**

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Abstract: Dengue is one of the most concerning emerging viruses, being a threat to one-third of the human population globally. Recently in Bangladesh, over 700 people have died by, and more than 138,000 have been infected through September 2023. Based on historical data, 2023 has been the deadliest year since the first recorded dengue epidemic occurred in 2000 in Bangladesh.

Domestic inspections to eliminate habitats for container-inhabiting Aedes aegypti is labor intensive, especially when there is an ongoing outbreak of dengue. There is an urgent need to develop innovative mosquito control methods to integrate with current integrated mosquito management practices. This presentation will review recent published literature describing epidemiologic models, risk assessment, release of Wolbachia-infected mosquitoes, use of nanoparticles for larval control and more. By building experience and information from novel techniques we could have a better understanding of dengue epidemiology and effective control interventions for the global community.

247 **Highlights of Vector Biology**

Keira J. Lucas, PhD, klucas@cmcd.org

Abstract: Vector biology plays a pivotal role in understanding the transmission of vector-borne disease and the development of effective control strategies. This presentation summarizes the most significant advancements, discoveries, and breakthroughs in the field of vector biology in 2023. A Boolean search of the literature using bibliographic databases will identify and spotlight discoveries that are groundbreaking, distinct, or simply astonishing. Topics will include vector-pathogen interactions, genomic advances, gene-drive mechanisms, vector-borne diseases, vector distribution and more.

248 **Highlights: Recent outbreaks and/or introductions of vector species**

Paula Lado, Ph.D., pau.parasito@gmail.com

Abstract: Globalization, anthropogenic factors, and climate change are amongst the main drivers of recent VBD emergence, re-emergence, and outbreaks worldwide. Global warming allows the establishment of vector populations in new areas (i.e northern latitudes), or the expansion of their

historic geographic range, and with them the pathogens they carry. This has been observed for numerous diseases, including babesiosis and West Nile. Similarly, travel and animal movement has contributed to VBDs outbreaks or establishment in new areas, as it has been reported for theileriosis, malaria, and dengue, for example. VBDs control is challenging due to a plethora of reasons, and thus preparedness is key. Being prepared for vector / pathogens introductions, as well as outbreaks, can make a difference in the communities, especially those with limited resources. This talk will review the latest reports of VBDs outbreaks, emergence, re-emergence, and vector / pathogen introductions, based on peer-reviewed journal articles published in 2023. Online databases and internet sources will be used as search engines for relevant literature; and the selection of the articles to be presented will be based on citations, geographic areas, vectors, and effects on human and animal health. In addition to the 2023 published papers, this talk will include a brief summary of outbreaks and introductions for the first quarter of 2024, if any. This summary will be based off newspaper articles and health organizations reports, and its goal will be increasing audience awareness of very recent and ongoing events.

Adult Control III

249 **Exclusion of Ae. aegypti from yard drains reduces adult abundance in Madera, California**

Abraham Velazquez, B.S, avelazquez@maderamosq.com, Trinidad Reyes, Istvan Menyhay, Teresa Hamilton, Christopher M. Barker, PhD, Nicholas Aparicio Arrue

Abstract: The invasive mosquito, Aedes aegypti, poses health risks in urban areas due to its ability to transmit dengue and several other arboviruses, a preference for blood-feeding on humans, and prolific breeding in human-made containers found around homes. This study in Madera, California aimed to determine whether blocking mosquitoes' access to yard drains with both a cap and plastic matrix could reduce adult Ae. aegypti abundance in a single suburban neighborhood. The 10-week study follows a stepped-wedge design with three phases. Forty-five Biogents Sentinel traps were placed in the targeted area and monitored daily. For the first two weeks, monitoring occurred without any intervention to establish baseline data. Starting from week 3, houses in the northern wedge had their lawn drains capped, followed by the southern wedge in week 5 and the central wedge in week 7. Our findings reveal a substantial reduction in the Ae. aegypti population within the study area. This research highlights the practical importance of managing Ae. aegypti populations through source reduction in an urban community and its potential impact on public health.

250 **Mosquito Activity, Meteorological Conditions and the Effectiveness of Aerial Sprays**

Neil Vickers, PhD, n.vickers@utah.edu, Sarah McDonald, Nathaniel Byers, PhD, Ary Faraji, PhD

Abstract: Conditions in the lower atmosphere such as wind speed, turbulence, and temperature together with astronomical variables such as light levels play a role in the responses and ability of flying female mosquitoes to find their way into surveillance traps. Aerial sprays are frequently employed as a control intervention targeted towards flying mosquitoes. We recorded mosquito activity in response to CO2 surveillance traps during evenings when aerial sprays were conducted to determine if the atmospheric conditions and other variables were suitable for mosquito flight and thus relevant to the potential effectiveness of the spray. Similarly, trap activity was also monitored the following evening to evaluate the effects of the previous nights' aerial spray on the numbers of mosquitoes captured by the

trap. Our results may provide insights into the importance of timing aerial sprays to coincide with peak mosquito activity.

Funding support from the Pacific Southwest Regional Center of Excellence for Vector-Borne Diseases funded by the U.S. Centers for Disease Control and Prevention (Cooperative Agreement 1U01CK000516) (NV) and NSF-EAGER awards 2132726 (NJV)

251 **Mosquito Magnet Executive Trapping for Neighborhood protection from Mosquitoes – a 2-year study**

Aaron Lloyd, lloyd@lcmcd.org, Dan L. Kline, PhD, Karen McKenzie, PhD, David F. Hoel

Abstract: Commercial mosquito traps powered by electricity or propane are advertised to protect homeowners from biting insects. The Mosquito Magnet Executive (MME) trap claims to protect an acre of land from biting mosquitoes and is sold to homeowners for that purpose. The study was conducted on Sanibel Island off the west coast of Lee County in Southwest Florida, in the Gulf of Mexico. Aedes taeniorhynchus, the Black Saltmarsh Mosquito, breeds as heavily here as anywhere in the state including the Everglades. A 2-year study looking at the effect of placing 33 MME traps in a neighborhood on Sanibel Island, was started in early 2021 and continued into 2022. Testing was terminated early in 2022 due to Hurricane Ian that flooded the island and destroyed all of the traps that had been stored prior to the storm. Preliminary findings from both years of study will be presented.

252 **Report on the AMCA 2023 Insectide Resistance Workshop**

Jennifer R. Gordon, jennifer@buglessons.com, Daniel Markowski

Abstract: At the beginning of the 2023 AMCA Annual meeting in Reno, NV, AMCA condcucted an Insecticide Resistance Needs Assessment Workshop. AMCA developed an interactive, all-day workshop and invited attendees representing different areas of academic, governmental, and provate mosquito control instituitions to determine needs and gaps related to insecticide resistance testing at the mosquito control local level. To guide attendees and facilitators throughout the entirety of the daylong event, three pieces of collateral were created: a set of creative spaces in Mural to capture ideas generated throughout the workshop, a PowerPoint slide guide that moved facilitators and attendees throughout the day, and a master facilitator's guide containing detailed plans for every anticipated aspect of the day. At the end of the workshop, the attendees identified 6 categories of need: new pesticides to manage insecticide resistance, insecticide resistance data repository, national network of entomologists with insecticide resistance knowledge, training and guidance authority on insecticide resistance in mosquito control, external partnerships, and insecticide resistance related research. The final report of the workshop will be presented and each category of need discussed.

253 **Spatial repellents as protection points against mosquitoes in a Florida forest**

Barbie Bayer, MS, barbara.bayer@usda.gov, Robert L. Aldridge, PhD, Kenneth Linthicum, PhD, Seth Gibson, PhD, Jeff Bloomquist, PhD, Edmund Norris, PhD, Daniel Kline, PhD

Abstract: Insecticide resistance is a growing threat that continues to reduce our stockpile of available chemical controls against pestiferous and nuisance mosquitoes. Here we evaluate several potential candidates as spatial repellents against mosquitoes in the field and compare them to one another - identifying strengths and weaknesses against forest dwelling mosquito species.

254 **Statewide examination of insecticide resistance and mechanisms in Florida Culex quinquefasciatus**

Eva Buckner, PhD, eva.buckner@ufl.edu, TJ Fedirko, Alden S. Estep, Eric P. Caragata, Ana Romero-Weaver

Abstract: Culex quinquefasciatus serves as a primary vector of West Nile virus and St. Louis encephalitis viruses in Florida. Only limited insecticide resistance testing of Florida Cx. quinquefasciatus populations has been previously performed; therefore, we undertook a comprehensive, statewide evaluation of pyrethroid and organophosphate phenotypic insecticide resistance and the potential mechanisms responsible. We found that all Florida Cx. quinquefasciatus populations tested were resistant to pyrethroids but varied in susceptibility to organophosphates. While the L1014F conversion and kdr-associated resistance was identified in many Florida Cx. quinquefasciatus, detoxification enzyme-based resistance primarily mediated by beta-esterases appeared to play a more important role in the phenotypic resistance we observed in CDC bottle bioassays.

255 **Using action thresholds to escalate mosquito control interventions**

Sarah S. Wheeler, PhD, swheeler@fightthebite.net, Tony Hedley, Steve Ramos, Gary Goodman

Abstract: There are a wide range of strategies available for managing mosquito populations and reducing arbovirus transmission. Consistent surveillance data and metrics for human disease risk are critical for escalation of control interventions. In 2023 the Sacramento-Yolo Mosquito and Vector Control District had higher than normal levels of West Nile virus (WNV) transmission throughout their service area. A responsive trapping strategy was utilized to cover all service areas, and enhanced trapping was performed in response to WNV detections. Mosquito collections were tested for WNV, Saint Louis encephalitis and western equine encephalitis. The core surveillance metrics utilized were mosquito abundance, mosquito infection rate, and dead birds that drove further trapping. Vector index was closely monitored and was used to make escalating control interventions. The action thresholds used for control, escalation of mosquito control strategies, impact of control efforts, and the utility of vector index for driving control will be reviewed and discussed.

308 **Australia's National Border Vector Monitoring Program - current state and challenges.**

Kyran Staunton, kyran.staunton@aff.gov.au, Angus Sly

Australia’s National Vector Monitoring Program has been defending their border from exotic mosquito incursions for decades. The Australian federal Department of Agriculture, Fisheries and Forestry conducts surveillance at ~85 first point of entry locations, identifies ~300,000 mosquito samples annually and detects and responds to an average of 21 exotic mosquito detections per year in collaboration with a variety of stakeholders. Within the last decade there have been substantial increases in detections of exotic mosquitoes (predominantly Aedes species) at the border, involving breakbulk cargo, oversize tyres and likely Unit Load Devices. As the international risk increases, the program is presented with several challenges in both effectively managing responses as well as reducing receptivity of border environment. Despite such challenges, the Australian mainland remains free of establishment of many exotics of concern such as Aedes albopictus.

Disease & Vector Studies III/Larval Control I

256 **Not your grandma's West Nile: Transmission dynamics of West Nile virus in Richland County, SC do not follow traditional ecology or epidemiology**

Kyndall Dye-Braumuller, MS, PhD, kyndallb@email.sc.edu, Melissa S. Nolan, MPH, PhD

Abstract: As West Nile virus (WNV) infected naïve host populations and vectors in the United States (US) following its introduction into the country, WNV is thought to have mutated and new genotypes emerged until an equilibrium (endemicity) was established. Richland County, SC has become an annual hotspot of endemic WNV transmission, where human cases (and recently—deaths), positive mosquito pools, and positive birds are reported annually. Unfortunately, public health response is lacking in this county, as resources are severely limited. A 2022 survey among residents found no correlation between mosquito bites and traditional risk factors for WNV disease, suggesting alternative risk factors and/or biological aspects associated with contemporary transmission in this hotspot. To better understand this phenomenon, this study was initiated in May 2023. From June – November 2023, Culex quinquefasciatus mosquitoes were sampled and screened from the 6 highest risk communities in Richland County for presence of WNV, and environmental characteristics were collected. Additionally, pre- (June) and post-WNV season (November) blood spots to test for WNV IgG and IgM antibodies and seroconversion and a WNV knowledge survey were collected from 130 participants in the same neighborhoods. Univariate regression analyses examined WNV risk factors associated with seropositivity. Climate variables' variance and neighborhood characteristics were analyzed for associations to Culex spp. presence and WNV positivity. Residents' WNV combined seropositivity was 21.9%, significantly higher than the estimated state and national seroprevalence. Additionally, traditional WNV risk factors were not statistically associated with seropositivity. Culex quiquefasciatus mosquitoes were not collected ubiquitously throughout the high-risk neighborhoods, and a greater variance in climate variables was significantly associated with fewer Cx. quiquefasciatus mosquitoes collected. With these surprising results, next steps include investigating the lineage of WNV through next-generation sequencing. Has WNV lineage evolution over time led to novel transmission dynamics distinct from the original 1999 infecting lineage?

257 **The Impact of Various Doses of Roundup® on the Larval Development of the Southern House Mosquito, Culex quinquefasciatus (Diptera: Culicidae)**

Mahmood Nikbakhtzadeh, PhD, mahmood.nikbakhtzadeh@csusb.edu, Aboulaye Aziz Zerbo, Graduate student, Mayra Espinoza, Undergraduate student

Abstract: Roundup® stands as one the world's most extensively utilized herbicide. A fraction of herbicides applied in agriculture fail to reach their intended targets, resulting in notable levels of these herbicides extending beyond agricultural boundaries. Glyphosate, the active ingredient in the Roundup® formulation, likewise exits its target sites through surface runoff, often being detected in aquatic systems. Prior studies have demonstrated that glyphosate can elicit biochemical, physiological, and behavioral modifications in non-target species, including mosquitoes.

Through laboratory experiments, we investigated the effect of a series of Roundup® doses on the development and survival of Culex quinquefasciatus, the main vector of WNV and SLE in southern California. Our result indicated that 1st instar larvae exposed to the high doses of Roundup® (500 and

1000 mg/l) experienced a high percentage of mortality and only a small fraction could molt into pupae. None of the pupae could eventually emerge as adults (n=10). Exposure to the low doses of Roundup®, similar to the field realistic doses, (0.1 mg and 1 mg/l) prolonged the larval duration and also reduced the mean of the daily count of live larvae, however the number of emerged adults was not impacted when compared with the control (n= 10). When 1st instar larvae were exposed to intermediate doses of Roundup®, no impact was observed on the mean of daily count of larvae at 10 mg/l concentration, but a significant reduction at the concentration of 100 mg/l was noted. Exposure to the intermediate doses of Roundup® also caused the larval stage to be prolonged considerably (n= 10).

This research indicates that the herbicide Roundup®, depending on the dose, can induce various effects on the immature stages of Cx. quinquefasciatus, which varies from prolonging the larval stage and reduction of population density in lower doses to the mortality in higher doses.

258 **It Taste Like Chicken: The challenges of cannibalism among Sentinel chickens.**

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Abstract: Sentinel chicken program is the most common method of mosquito-borne virus surveillance in Florida that is being utilized by local health departments and mosquito control agencies to assess local arbovirus amplification and transmission in nature and reliably provide information on the risk to human health. The total number of flocks and number of chickens per flock varies among different programs based on budget, manpower, and experience. The chickens are placed in cages that are strategically located throughout the county where they can be exposed to mosquito bites. A separate flock of chickens are kept in a mosquito-proof building to replace chickens lost due to mortality or seroconversion.

However, chickens that are kept in enclosed communal areas are prone to pecking order and cannibalism. Cannibalism among sentinel chickens involves pecking, tearing, and consuming the skin, tissues, or organs of the flock mates. Because cannibalism can decimate a sentinel chicken flock, it is very important that cannibalism control is a part of flock health management. This presentation will discuss possible causes and some remedial steps taken at the Lee County Mosquito Control District to minimize cannibalism issues that plagued the sentinel chicken program.

259 **Sewage effluent changes sexual organs and limits survivorship and larval mosquito feeding rates of Gambusia affinis**

Kevin A. Caillouet, Ph.D., kcaillouet@stpmad.org, Emily Kane, Ph.D.

Abstract: Mosquitofish, Gambusia affinis, are eponymous larval mosquito predators. Other than being water-bound, mosquitofish's ability to survive low oxygen allow them to naturally manage larval mosquito populations in most ground pools where they are introduced. Effluent from onsite sewer disposal systems (OSDS, aka "septic systems") has been shown to limit the presence of fish predators, releasing Culex quinquefasciatus larvae from suppression. Mosquitofish were collected and body conditions were compared in sites with and without effluent discharge from OSDS. Using mosquitofish from clean water sites, lethal doses of sewage effluent and time to 50% mortality were determined. Finally, prey capture rates were compared across three concentrations of OSDS effluent. Fish from contaminated sites were proportionally heavier than control fish and females from contaminated populations were masculinized. Sewage effluent had an LD50 at 71% concentration over 4 days and a

LT50 of 25 hours at 90% concentration. In addition, mosquitofish generally stop feeding in high effluent concentration, though individual variation was observed. Effluent from OSDS reduces mosquitofish health, survival, and prey capture allowing West Nile virus vectors to thrive.

260 **Inhibition of emergence: Field validation of encapsulated methoprene**

Michael Riles, mriles@central.com

Abstract: Pre-treatment larval abundance (first and second instar larvae, third and fourth instar larvae, and pupae) should be recorded in both experimental and control sites. The sampling method should be appropriate to the type of breeding habitat, and the appropriate number of samples should be taken from each habitat based on the type and size of the habitat. Larval instars and pupae from each sample are counted and recorded. Post-treatment larval abundance (all stages) should be monitored 48 hours post application and then weekly using pupae collected from treated and untreated control areas. After the first 48 hours, begin collecting pupae and rearing them out for inhibition of emergence calculations. Inhibition of emergence begins at application, but waiting 48 hours after the initial treatment ensures that all pupae collected have developed in the presence of (S)-methoprene. Collection of pupae starts at 48 hours, 1 week, 2 week, 3 week, 4 week and 5 week post-treatment, if possible. Characterization of the habitats in terms of abiotic and biotic factors aids the interpretation of results. Rainfall and any change in water level or other parameters, such as algal bloom, water quality, outflow, temperature or predators in the habitats, should be recorded.

261 **Aligning data streams for (successful) entomological evaluations of larviciding for control of Culex mosquitoes in Minneapolis-St. Paul, Minnesota**

Joseph McMillan, PhD, josmcmil@ttu.edu, Scott Larson, PhD

Abstract: West Nile virus is the most prevalent mosquito-borne virus of public health concern in the United States. Tremendous surveillance, control, and research efforts are exerted nationwide to reduce WNV transmission in the enzootic cycle in hopes of preventing spillover of WNV into human populations. Despite these efforts, it is difficult to link results from mosquito control operations to results from WNV surveillance operations. One main issue limiting the success of studies evaluating entomological and epidemiological endpoints of mosquito control programs is that spatial and temporal replication of control and surveillance data sets are often short in duration and limited in spatial extent. Given the combined spatial and temporal extent of the Metropolitan Mosquito Control District's (MMCD) surveillance and control programs, we developed a series of spatiotemporal quantitative analyses to estimate population-level reductions in Culex pipiens mosquitoes stemming from mosquito control operations in catch basins and non-catch basins habitats. Our central hypothesis is that reductions in host-seeking Culex spp. mosquitoes are scale dependent, and that reductions in adult collections associated with larval control are likely detectable within one to three weeks of applied interventions and are proportional to the density of treated basins and the frequency of larvicide applications near a trapping location. To partially answer this hypothesis, we will present the challenges and solutions to aligning multiple data streams and identifying appropriate computational methodologies to link control of larval mosquitoes more effectively to reductions in adult collections.

262 **Preliminary evaluation of toxicity of essential oils to Aedes taeniorhynchus.**

Lawrence J. Hribar, BS, MS, PhD, PHE, lhribar@keysmosquito.org

Abstract: There are many studies published in the scientific literature reporting the results of trials of essential oils against larvae of Aedes aegypti. The potential of two essential oils, Melissa oil (Melissa officinalis L.) and Rosemary oil (Salvia rosmarinus Spenn), to kill larvae of Aedes taeniorhynchus was investigated. A stock solution of 0.05% Tween® 20 was prepared and used as a diluent for all tests. Tween® 20 is an emulsifying agent used to prepare stable oil-in-water emulsions. A range of dilutions (1% to 0.001%) was prepared for both oils. Distilled water and the stock Tween® 20 solution were used as negative controls; a 0.1% solution of naled was used as a positive control. Over 2/3 of larvae tested died at the lowest concentration of Melissa oil whereas none died at the same concentration of Rosemary oil. There was zero mortality in the distilled water and Tween® 20 negative controls and 100% mortality in the naled positive control. Based on limited trials, Melissa oil appears to be more toxic to Aedes taeniorhynchus larvae than is Rosemary oil. More trials are planned.

263 **Efficacy testing of a residual mosquito larvicide on flood irrigated ranches in Teton County, Wyoming**

Kelsey M. Mitchell, M.S., kmitchell@tcweed.org, Mikenna Smith, M.S.

Abstract: Flood irrigated ranch lands present unique challenges for mosquito management in western Wyoming given the overwhelming numbers of floodwater nuisance mosquitoes produced throughout the summer. In Teton County it is common practice for private ranches to flood large areas (400+ acres) of grassland throughout the season, creating ample, long-lasting, anthropogenic habitat for mosquito breeding. Not only can this extend the natural breeding season for floodwater species, but because they are often flooded all summer, breeding sites for semi-permanent and permanent mosquito species such as the West Nile Virus vector Culex tarsalis are created. The repeated flooding and continuous movement of water makes it difficult to know whether insecticides designed with long residual times remain efficacious throughout the season. We conducted 5-week efficacy tests to determine the duration of effective control achieved after treatment with a 42-day residual methoprene larvicide (MetaLarv). Control and treatment larval samples were collected weekly from five treatment and control polygons in the field and reared in the lab in triplicate. Daily observations of larval development and mortality rates were recorded for each sample. Analysis of results will be discussed and will inform a cost-benefit approach to product purchasing and management decisions among flood irrigated ranches for future mosquito seasons.

264 **Considerations for assessing methoprene bioefficacy in the lab and in the field**

Samer Elkashef, Ph.D., selkashef@central.com, Tony Hughes, PhD Entomology

Abstract: Insecticide resistance monitoring is crucial to the success of integrated vector management programs. Methoprene, as a biorational insect growth regulator has fulfilled a significant role in the management and control of mosquitoes for nearly half a century and continues to do so. The availability and flexibility of methoprene formulations coupled with wide-ranging larval habitats and delivery platforms necessitate sound methodology to assess bioefficacy and detect tolerance or resistance in a variety of mosquito species. Here, we present key considerations for the assessment of methoprene bioefficacy in the lab and in the field. We will discuss important aspects of laboratory-based bioassays for methoprene, to include appropriate materials, larval life-stages, and source of active ingredient. In addition, we will frame laboratory testing in the context of integrated measures of efficacy

which should include field validation methods such as assessing habitat, extraction of pupae and determining inhibition of adult emergence.

Equipment/New Product Trials

265 **A Standardized Protocol for Unmanned Droplet Characterization of Truck Amounted Cold Aerosol ULV Equipment Using ULV Diluent Oil**

Jacob Sublett, Master of Science in Biology, jsublett@toledomosquito.org, Jennifer Shimola, Doctorate in philosophy in Biology, Paul Buaman, Master of Science in Biology

Abstract: Confirming that cold aerosol ULV sprayers are calibrated correctly, through droplet characterization trials, is critical to help ensure optimum droplet size for successful applications and is a requirement for label adherence for many adult mosquito control products. Previous work has provided a wealth of detailed information on how to perform these trials; however, variations in these protocols do exist and no universal methodology has been adopted as an industry standard. Here we compare droplet characteristics from two different ULV insecticides, a ULV diluent oil, and two different probe placement methodologies (manned and unmanned). Trials of truck-mounted sprayers were conducted using a DC-IV hot-wire anemometer system where droplet number and size (Dv0.5 and Dv0.9) were recorded. On average, the unmanned method either collected more or very similar amounts of droplets. Furthermore, while differences in individual sprayers significantly affected Dv0.5, neither product type nor methodology had a significant impact on Dv0.5. As such, the use of ULV diluent and an unmanned probe placement methodology should be considered when performing droplet characterization, as it provides a standardized approach and necessitates less insecticide exposure.

266 **DIY: A modernized gravid trap design for mosquito surveillance**

Nathaniel Byers, PhD, nate@slcmad.org, Andrew Dewsnup, Thomas Widmer, Ella J. Branham, Ary Faraji, PhD, Gregory White, PhD, Christopher S. Bibbs, PhD

Abstract: Gravid traps have become a common, and frequently essential, surveillance tool for parous Culex spp. vectors of West Nile virus and other encephalitis-causing pathogens. The recent closing of BioQuip Products Inc., an entomological supply company, has jeopardized the commercial availability of gravid traps. The Salt Lake City Mosquito Abatement District presents a template for making your own gravid trap, but with some modernizations for quieter fans and longer lasting, light weight, lithium battery packs. At the time of writing, the materials cost for the fan ($14 USD), toolbox ($13), cables ($9), ABS pipe ($2.50), aluminum brackets ($10), catch container with lid ($9), trap net ($10), USB battery pack ($35) and the negligible amount of 3D-printed filament ($2), is approximately half the cost (not including labor) of the formerly available commercial model. Additionally, performance validation in the laboratory ($t_{4,9} = 0.1191$, $p = 0.91$) and within two field sites ($\chi 2 = 0.107$, $p = 0.74$) demonstrated no significant differences in collections of gravid Culex pipiens. We do not present an overhaul of the previous gravid trap blueprint, but the quality-of-life updates to the trap design, the feasibility of in-house manufacture, and the mirrored collection efficacy to the commercial model can allow improved maintenance of gravid trap surveillance networks without a commercial supplier.

267 **The H-Trap Is Not Just for Tabanidae**

Dan L. Kline, PhD, dan.kline@usda.gov

Abstract: The H-Trap (Bite-Lite LLC, Bethel, CT) is specifically designed to catch flies from the Tabanidae family. The company's instruction manual specifically states that the H-Trap will NOT catch other biting flies that bother horses. We have found that, if baited with dry ice, this trap will collect large numbers of several species of mosquitoes. In a recently completed study, utilizing traps baited with dry ice/octenol, we collected large numbers of Aedes spp., Anopheles spp, Culex spp. and some Psorophora spp. In addition to collecting mosquitoes we also collected several Culicoides spp, Lutzomyia spp. and large numbers of Corethrella appendiculata. Future studies will compare the efficacy of unbaited with baited traps for collecting these and other biting fly taxa.

268 **3D Printing Applications for Research and Surveillance at Pasco County Mosquito Control District**

Taylor Taylor, ttaylor@pasocmosquito.org, Agne Prasauskas

Abstract: With an increased focus on research and surveillance at Pasco County Mosquito Control District, there has been a growing need for new and improved equipment. We have found that custom-designed pieces can be printed in-house, producing cost-effective equipment tailored to our program's needs. The addition of a 3D printer has allowed us to design and manufacture parts for new granular swath characterization equipment for aerial operations, a mosquito blood-feeding apparatus for colony maintenance, and turn out a set of our own weathervanes designed by Clarke for field testing. Other programs and private companies within our industry have adopted and are creating novel 3D prints for numerous applications and are willing to share their ideas and renderings freely. We are eager to see how we can further utilize this device for the future growth of our program.

269 **The SLAM feeder as a cost effective option for blood feeding mosquitoes**

Gregory White, PhD, greg@slcmad.org, Christopher S. Bibbs, PhD, Nathaniel Byers, PhD, Ary Faraji, PhD

Abstract: The capability to rear mosquitoes can be a vital process to use mosquitoes for studies in control methods, disease transmission, surveillance techniques and other areas related to the biology and control of these vectors. One requirement to rear most mosquitoes is to provide them blood to feed on. Using artificial membrane systems to present blood offers many benefits over live blood sources, however, many of these membrane systems can be expensive. The Salt Lake City Mosquito Abatement District set out to create an artificial membrane blood feeder for mosquitoes that would be inexpensive and easy for others to build while also being user friendly and effective at feeding a variety of mosquito species. The result of this research is the Salt Lake City Mosquito Abatement District artificial membrane feeder (SLAM). We compared the effectiveness of the SLAM to a common commercially available membrane feeding system and had nearly identical results when looking at fecundity of mosquitoes as an outcome. The fabrication, cost, utility, features and feeding results will be discussed in this presentation with the goal that others interested in a cost effective blood feeding alternative can use these designs to enhance their own study of mosquitoes.

270 **Repelling and catching mosquitoes with electric fields using insulated electrical wires**

Krijn Paaijmans, PhD, kpaaijma@asu.edu, Ndey Bassin Jobe, Michael Erickson

Abstract: To control and prevent mosquito-borne diseases, insecticides are often our only option, but their excessive use has led to the rapid development and spread of insecticide resistance. Health experts have called for intensified efforts to find new approaches to reduce mosquito populations and human-mosquito contact. A new tool that is currently being piloted is the use of high-power electrical fields (EFs) that repel mosquitoes by creating an invisible mosquito barrier. The technology is being integrated into outdoor aluminum window blinds, but our aim is to make the technology more accessible and more widely implementable by using insulated electrical wires. We quantified the number of Aedes aegypti mosquitoes that are successfully repelled and/or captured by EFs that are generated using insulated electrical wires. Test voltages ranged from 0V (control) to 18kV/cm over 23h periods. Mosquitoes were released in a free-flight room, and lured into a BG-Pro trap that was baited with carbon dioxide. Mosquitoes had to pass through a window that contained our electric barrier: a single row of vertical wires with alternating polarity. EFs using insulated electrical wires prevented 60-80% of mosquitoes from flying through the window, at voltages >3kV/cm. Stronger EFs did not lead to a stronger repellent effect at this point in time (23h after release), but did increase the number of mosquitoes that were captured (i.e. got stuck to one of the wires). Detailed data will be presented at the conference, as we are conducting our experiments at the time of writing. Our data clearly show that sufficiently strong EFs can be generated with insulated electrical wires to both repel and capture host-seeking mosquitoes. This will reduce human-mosquito contact and as a result mosquito nuisance and disease transmission risk. We will discuss how EFs impact mosquito behaviors, as well as use-case scenarios.

271 **Can Low-Density In2Care Trap Deployment Manage Mosquito Populations?**

Timothy D. McNamara, Ph.D, t.mcnamara@ufl.edu, Estelle Martin, Ph.D, Cason Bartz, Dan L. Kline, PhD, Eva Buckner, PhD, Peter Jiang, PhD

Abstract: Management of mosquito populations through area-wide applications of insecticides has become increasingly difficult due to the limited number of modes of action available to professional, legislation of existing chemistries, and increasing rates of insecticide resistance in target populations. These challenges have led to an increasing number of alternative and supplemental tools to aid in mosquito management. One of these tools, the In2Care mosquito trap, has been shown to effectively control populations when used at the recommended 10 traps/acre. However, the cost of deployment in equipment and labor is often higher than other integrated approaches. To determine if treatment efficacy can be maintained, while reducing the cost of usage, we conducted 2 years of In2Care deployment in a Gainesville, FL neighborhood at 3 traps/acre. During the first year, we conducted In2Care trap deployment without the use of other integrated mosquito management practices, while in the second year the neighborhood was treated regularly using a Baccilus thuringiensis subspecies israelensis-based larvicide. During deployment, we surveilled the impacts of deployment on Aedes aegypti and Culex quinquefasciatus adult, larval, and egg abundance. We found no significant impact on either Aedes aegypti or Culex quinquefasciatus resulting from trap deployment, implying that high-density applications are necessary to induce population reductions.

272 **Field performance of novel spatial repellents against host seeking Stegomyia**

Barbie Bayer, MS, barbara.bayer@usda.gov, Robert L. Aldridge, PhD, Frances V. Golden, Seth Gibson, PhD, Jerome Hogsette, PhD, Edmund Norris, PhD, Jeff Bloomquist, PhD, Kenneth Linthicum, PhD

Abstract: Insecticide resistance is continually developing against the currently developed products available for mosquito control. In order to counteract it we must explore both novel chemistries and deployments of new insecticides. Here, novel spatial repellents (GMR-134 and GMR-189) were combined with the synergist TCA and applied to BG-sentinel2 traps to assess their effectiveness at repelling host seeking mosquitoes in a back yard environment. The traps were rotated over at least 6 days and we were able to show that the traps protected by GMR189+TCA and GMR-134+TCA collected fewer mosquitoes than the control traps. Furthermore, the number of (Stegomyia) Aedes albopictus was significantly less in traps protected by GMR-189+TCA and GMR-134+TCA than non-treated traps. These results demonstrate field performance of these spatial repellents and their potential to create a point of protection against host seeking mosquitoes.

273 **Applied Trials; Testing ReMoa Tri Adulticide and In2Care Mosquito Traps**

Daniel Tuzzolino, Bachelors Degree, tuzzolinod@stlucieco.org

Abstract: St. Lucie County Mosquito Control is constantly looking to improve its adult mosquito control treatments, and trialing products remains crucial to insuring that potential new products are safe and effective. In the summer of 2022, we conducted two separate trials on products designed to control adult mosquitoes: ReMoa Tri adulticide and In2Care Mosquito Traps. Our ReMoa Tri study utilized a fog truck to test the knockdown ability of ReMoa Tri on non-resistant populations of Aedes taeniorhynchus, and resistant populations of Culex quinquefasciatus after 48 hours. We also conducted droplet analysis to determine how the concentrations of our treatments influenced mortality. We compared these results to current products we use, such as Aqua Zenivex and Fyfanon EW. Our In2Care trial was a two-year study that monitored the populations of Aedes aegypti and Aedes albopictus at tire shops throughout the county before and after the introduction of In2Care traps. In addition to monitoring the population, we collected water samples from our In2Care traps and the surrounding environment to conduct larval bioassays to determine if the pyriproxyfen coated on the inside of the In2Care trap was being transferred to other sources of water by adult mosquitoes in sufficient quantity to kill larvae. We used lab reared susceptible Ae. aegypti mosquitoes to test this. Both studies showed promising results for adult control of a variety of different species of Ae. and Cx. mosquitoes.

Education & PR

274 **How to Design an Unforgettable Mosquito Education Experience**

Amy Lucas, amyllu@leeschools.net, Ian Sharp, Jason Burgess

Abstract: Education and outreach teams can elevate the public image of any mosquito control operation. Making your lessons valuable and memorable allows mosquito educators the opportunity to raise mosquito awareness as it relates to public health, while simultaneously boosting student achievement. Our approach embeds our Florida state science standards within each lesson in order to build the foundation for providing an exceptional educational experience that leaves all school district stakeholders wanting more. Documenting and sharing your classroom visits via social media makes your program even more exciting, memorable, and shareable so that your public education team can extend their reach beyond the walls of the classroom.

275 **Bytes, Bits, and Buzz: How Technology and Good Data Management Enhance Public Relations**

Andrea McKinney, amckinney@cmcd.org

Abstract: The Collier Mosquito Control District uses a scientific, integrated approach to controlling mosquitoes. This involves a large collection of data and information. Historically, this information was not available for people to access and communicate it to the public because it was bound up, essentially in paper format. This made it difficult for our outward facing communication specialists to convey certain information to the public efficiently and in a timely manner. 5 years ago, our Research team began developing a number of dashboards that have summarized these data, making it easier to communicate with the public. These dashboards provide real-time updates on our planned activities, monitoring actions, prior treatments, and other key metrics. These dashboards have a twofold purpose – they offer immediate access to vital information and successfully underline the importance of mosquito control. These communication tools help educate the community about our commitment to manage disease vectors and nuisance mosquitoes effectively. This presentation will shed light on how Collier Mosquito Control District has used its dashboards to improve its public facing communication, making it easier for the community to understand our work and strategy.

276 **Analysis of Perceived Risks and Benefits of Mosquito Abatement and Personal Protection Strategies in Northeast Communities**

Emily M. Mader, MPH MPP, emm367@cornell.edu, Nia Clements, BS, Aine Lehane, MPH, Scott Crans, MS, Chris Horton, Jody Gangloff-Kaufmann, PhD, Amelia Greiner Safi, PhD MS, Laura C. Harrington, PhD

Abstract: We investigated the perceptions and challenges individuals experience when making decisions about mosquito bite prevention through six focus groups and two interviews with individuals living in Massachusetts, New Jersey, and New York (n=35). Most participants were unfamiliar with public mosquito control services and felt they were not at high risk of exposure to any mosquito-borne diseases (MBDs) in their area. Participants across every focus group/interview expressed concerns over ecosystem health and long-term consequences of pesticide use for both larval and adult mosquito control. Notably, many participants commented on the lack of accountability surrounding the use of private pest control to treat properties for mosquitoes, expressing feelings of helplessness to change what they perceived as an overuse of pesticides. The extent of expressed concerns varied by community contexts of tourism and level of urban development. Participants in every focus group/interview referenced a risk assessment that weighed the risk of MBD exposure against the use of chemical control products; in most scenarios, participants were supportive of control actions when the risk of exposure to MBDs was elevated for humans and animals, but otherwise preferred chemical control be avoided and bite prevention be left in the realm of individual responsibility. Overall, participants were supportive of investment of public funds to support mosquito surveillance and control operations. However, participants across several focus groups expressed feelings of distrust that government programs were following best practices and that enhanced communication on decision making could alleviate many of their concerns. Participants felt communication from mosquito control agencies should be widely available, disseminated across multiple venues, and include instructions for the public during spray events, resources for individual bite prevention, and information on control products used (i.e., risks, duration, timing, and active ingredient). This project was supported through the 2023 AMCA Research Fund.

277 **Taking mosquito control education to the next level: Building an education center and science museum**

Richard Weaver, rweaver@amcdfl.org, Rui-De Xue

Abstract: Taking an idea of building a center that would educate the general public on disease vectors and the diseases that these vectors carry and building it.The education center focuses on the number one killer worldwide, mosquitoes, but also addresses other vectors, diseases, control methods, technology, entomology and history. The center was planned and developed to be an immersive experience based on how theme parks tell stories. The use of interactive displays, built for all ages, a classroom for lectures and laboratory demonstrations and a working insectary makes the 6,000 square foot center fun and engaging. Building this center took a great amount or research and planning and some very talented people to be able to develop and build these immersive displays, and incorporate them into a cohesive storyline. The construction of the project was started in February 2020 just before the covid lockdowns, adding to the difficulty of designing and building the center. A planed one year build time turned into four years with a final opening in the spring of 2024. A review of the development of the idea, of a next generation education experience, and the design of the center and it's displays, including the challenges of building a one-of-a-kind center are explored and explained and a description of the displays are presented.

278 **Wing Beats - AMCA/FMCA trade journal to highlight your program**

Dennis Moore, Editor-in-Chief, dmtrinity@outlook.com

Abstract: Wing Beats is an international publication for mosquito and vector control produced by the Florida Mosquito Control Association (FMCA) and is an official publication of the American Mosquito Control Association (AMCA). The publication is supported by advertisers and is mailed to nearly 4,000 individuals. Wing Beats is also available online on the AMCA and FMCA websites for members to view at no cost.

Wing Beats is published quarterly and is written and produced by those in various professions associated with mosquito control, research, and administration. Our goals are to keep interested parties informed on matters related to mosquito and vector control and disseminate information to educate and raise the level of the mosquito control profession.

Wing Beats seeks interesting technical and field-related articles about mosquitoes, mosquito control and other vector related topics. The articles need not be “scientific” in nature and vary in size from just a page or two, to multiple pages. Longer articles tend to be the most interesting and are encouraged if the additional space is warranted. We encourage the submission of manuscripts and provide guidance for authors. Author guidelines are available to help both authors and our editorial teams.

Wing Beats is your trade journal which gives you a chance to highlight the exciting things going on in your program. By sharing your information others can learn from your experience.

279 **Successfully Engaging the Community with Impactful Mosquito Control Outreach Practices**

Monique D. Spence, monique.spence@miamidade.gov

Abstract: Community engagement is crucial for the success of mosquito control outreach programs as it fosters awareness, participation, and sustainable behavior change. Traditional outreach methods often struggle to capture the attention and active involvement of community members, limiting their impact.

The strategies to be presented include:

1. Collaborative Partnerships: Establishing partnerships with local organizations, schools, and community groups to effectively reach a wider audience and leverage their expertise and resources. By collaborating with these stakeholders, mosquito control programs can tap into existing networks and engage community members through joint initiatives.

2. Education and Awareness Campaigns: Implementing educational campaigns that provide comprehensive information about mosquito biology, disease transmission, and prevention strategies. These campaigns utilize various mediums, such as workshops, seminars, and community events, to deliver engaging and interactive content that resonates with the target audience.

3. Volunteer Programs: Developing volunteer programs that allow community members to actively participate in mosquito control efforts. These programs provide training and resources to empower volunteers to conduct surveillance activities, distribute educational materials, and implement control measures. This approach not only increases community involvement but also promotes a sense of ownership and responsibility.

4. Community Feedback and Dialogue: Establishing platforms for community feedback and dialogue to address concerns, answer questions, and receive input from community members. This can be done through town hall meetings, online forums, or social media platforms, fostering a sense of inclusivity and promoting open communication.

5. Community Workshops and Training: Organizing workshops and training sessions to empower community members with the knowledge and tools necessary to actively contribute to mosquito control efforts. These interactive sessions facilitate two-way communication, allowing for the exchange of ideas, concerns, and best practices.

By embracing interactive and engaging outreach techniques, mosquito control programs can effectively educate, motivate and mobilize communities.

280 **Designing Tests for Formulated Larvicidal Products in Laboratory or Semi-Field Environments**

Mir Bear-Johnson, MS, mbearjohnson@central.com, Chris Holderman, PhD, Kevin Welzel, PhD

Abstract: Whether you're at a district, a university, or a company – if you're in the mosquito control business you're aware of the need to test, re-test, and confirm efficacy of products, from larvicides, to adulticides, to repellents on a semi-regular basis. It's equally important to make sure the testing is appropriate for the product and provides you the needed information. We are all aware that resistance to available public health chemicals is a problem, and testing field populations against formulated products is a useful way to discover possible issues early enough to prevent local resistance from becoming a larger problem. Testing larvicide products in the lab can seem near impossible requiring space, time, staff, resources, or equipment beyond what is feasible. However, as districts are aware, testing products in the field can be challenging as well. Often, districts cannot leave untreated areas, and

therefore cannot have a control group. Since the focus of a district is on protecting the public health and not treating known mosquito production area would go directly against that mission. Some districts have pool sized tanks or other equipment to assist their ability to test without endangering their population, but not all districts have this capacity. There are ways that districts, universities, or companies, can test products without putting populations at risk. These methods will be discussed in brief as well as the questions to ask as you design a test to ensure a reliable test which provides the needed data.

281 **A brief history of Methoprene, product development, and commercialized products for various use patterns both within and outside of mosquito control.**

Chris Holderman, PhD, cholderman@central.com, Mir Bear-Johnson, MS

Abstract: Methoprene has been used in insect control since initial commercialization in the mid 1970's. The path for commercial development and use began in mosquito control, but use has extended to other pest targets such as horn flies (Haematobia irritans), fleas (Siphonaptera), stored product pests (various Coleoptera families and Lepidoptera families), and ants (Formicidae). A short overview of the history of methoprene and related JH mimics will be presented. How pesticides are regulated in the USA will be discussed, with specific emphasis on methoprene, toxicology profile, and various use patterns ranging from feed-through products, on-animal products, commodity treatments, and of course, mosquito control. Formulation of a product relates directly to product effectiveness, examples of this relationship will be used to illustrate how methoprene can be formulated for such disparate use patterns as boluses, briquettes, carpet sprays, and granular commodity treatments.

282 **Infrastructure to Evaluate Community Engagement Efforts for an Integrated Vector Management Program**

Rafael Saavedra-Hernandez, MPH, rsaavedra@prvectorcontrol.org, Julieanne Miranda Bermúdez, Grayson Brown

Abstract: This study assesses the effectiveness of community engagement (CE) strategies in reducing vector-borne diseases, with a specific focus on Aedes aegypti mosquitoes in Toa Baja, Puerto Rico. We examine cost-effectiveness and risk communication to the community by comparing traditional CE methods like door-to-door visits and loudspeakers with innovative approaches such as text messages and mobile applications. Fifteen clusters were chosen using two-stage cluster sampling, with traditional, innovative, or control interventions assigned proportionally. Evaluation tools, including KAP surveys, larval indices, and AGO traps, were employed to gauge behavioral changes and mosquito population impact before and after interventions.

Of 451 attempts, 259 houses were visited, ultimately reaching 150 participants across 15 clusters. The interviewed residents consisted mostly of women (67%), with an average age of 57, and 47.3% had an income below $24,999. Before educational interventions, a significant knowledge gap existed between traditional and innovative interventions (p-value: 0.002), but not between traditional control and innovative control. There were no significant differences in attitudes and practices between the intervention groups. In the yard inspections 2,414 artificial containers were identified, with 28% containing water and 11% of those water-containing containers harboring immatures, half of which were pupae. No significant difference (p-value: 0.865) was observed in the number of positive containers between intervention groups. Regarding adult mosquito surveillance, the average number of mosquitoes

per trap per week was 13.75 in control clusters, 15.49 in traditional, and 6.38 in innovative, showing a significant difference (< 0.01). Interventions commenced in August 2023, involving 353 houses in the first cycle (144 traditional, 209 innovative). The second cycle targeted only houses in the traditional cluster, impacting 158 houses. The interventions are anticipated to conclude in October, after which KAP and house inspections will be finalized, and entomological data will be analyzed to assess the post-intervention impact.

GIS/GPS/Management

283 **Enhanced Routing Methods for Truck Mounted Applications in Urban Environments**

Ruben S. Rosas, rrosas@fightthebite.net

Abstract: Ruben RosasSacramento-Yolo Mosquito and Vector Control DistrictUnited Statesrrosas@fightthebite.net916-416-12432024 AMCA AbstractTitle: Enhanced Routing Methods for Truck Mounted Applications in Urban Environments The Sacramento-Yolo Mosquito and Vector Control District (District) uses truck mounted ULV fogging and wide area larvicide applications as an essential tool targeting areas with invasive mosquito species and with high West Nile Virus activity. Mapping and routing in urban environments for effective truck applications has become a fundamental component for successful adult and larval control. By using Google MyMaps, Google Drive and a navigation app called InRoute, the District has developed a systematic approach for creating routes and providing seamless navigation in the field. Utilizing these low-cost platforms, the District is able to create routes that can be shared amongst staff and can be used to accurately calculate the needed material prior to visiting the site. These navigation tools allow applicators to receive turn by turn directions, identify overlapping treatment areas and provide audible and visual instructions to the applicator during treatment. The presentation will demonstrate how to use these tools and will focus on the benefits of integrating these platforms for control operations.

284 **Making Use of Your Data: Decision Making and Reporting Using VectorSurv**

Lincoln Wells, MS, MPH, lcwells@ucdavis.edu

Abstract: VectorSurv is a data management, analysis, and reporting software used widely across 20 states and territories and over 220 vector control and public health agencies that enables users to make real-time, data-driven control decisions and customized reports. VectorSurv's built-in tools incorporate GIS capabilities to allow users to calculate abundance anomalies, pool infection rates, vector index, West Nile virus risk, and insecticide resistance over user-defined spatial regions. Recently, VectorSurv released the VectorSurv API, enabling users to access VectorSurv data programmatically through widely used protocols. The VectorSurv API enhances customization in decision-making and reporting by providing access to VectorSurv data within popular software tools like Tableau, Power BI, Python, and R. This presentation will review the decision making and reporting capabilities available to VectorSurv users that drive data-based vector control decisions and limit the spread of vector-borne diseases.

285 **The Deviations in GIS Strategies during Recent Mosquito Control Hurricane Responses in Florida.**

Jessica L. Ber, M.S., Jessica.Ber@FDACS.gov

Abstract: GIS tools are essential during many facets of emergency response following a hurricane. The same was true for the FDACS Mosquito Control Incident Response Team (MCIRT) during the recent responses to Hurricane Ian and Hurricane Idalia in Florida. GIS tools create the foundation of mosquito control response through proper rendering of designated spray zones for treating the most affected, populated areas while avoiding protected lands. The requests for GIS also include trapping locations, acreage/mileage verification, and final mapping for reports. Though these tools remain a necessity for each hurricane, how they are used may vary greatly due to the location of impact and the characteristics of the storm. This flexibility was imperative for both Hurricane Ian and Hurricane Idalia. In 2023, Hurricane Idalia required a major shift in GIS strategies that had been carefully crafted during Hurricane Ian in 2022. When comparing these two strategies, one can see how essential flexibility is during hurricane response, especially for GIS.

286 **A Day in the Life of a Service Request**

Chad Minteer, chad@frontierprecision.com

Abstract: Learn how a customer service request or complaint is handled operationally by various organizations using ArcGIS Online and FieldSeeker GIS. When service requests are managed in GIS, there are many options for collection, management, routing, assignment, notification, and automatic closing. We'll consider a few examples, touch on Web GIS, and overview recent updates to our FieldSeeker Core software (with workflows for Larviciding with storm drain treatments, Surveillance, and Service Request) and our FieldSeeker ULV Adulticiding system.

287 **Spinosad ovicidal activity: Another tool to control Aedes aegypti - dengue vector mosquito**

Maria Alice V. Melo-Santos, Phd, maria.varjal@fiocruz.br, Constância Ayres, Phd, Kathyanne Barbosa

Abstract: The Aedes aegypti mosquito is widely distributed throughout the world, with great epidemiological importance in areas where arboviruses are transmitted. Behavior such as skip oviposition associated with survival through egg quiescence has increased the complexity of its control, especially in environments with precarious sanitary conditions. Strategies for using larvicidal and adulticidal insecticides have been carried out in Brazil since 1996 to eliminate Ae. aegypti, presenting unsatisfactory results so far. Concerning issues for this discussion are the low coverage of the species' breeding sites and the absence of insecticides capables of eliminating the mosquito in its embryonic phase. In this context, the present study evaluated the ovicidal potential of spinosad, based on some empirical field observations. Bioassays with eggs of Ae. aegypti RecL, a Laboratory colony, were carried out with concentrations (20, 30, 50, 70 and 100 mg/L) of NATULAR®NT technical powder, containing 93% of the spinosins A and D, against groups of recently laid eggs or with 24, 48 and 72 h after the start of embryogenesis. The results revealed that immediate contact with spinosad led to the unviability of the majority of eggs (80%) and that contact after 24 hours of embryogenesis dropped to < 60% even with the highest concentrations of the compound. This percentage was even lower (< 20%) when eggs were already 48 or 72 hours after oviposition. When NATULAR®EC20 was used in dosages of 10, 30 and 50 ml/10L, embryo mortality was 95% to 100% for newly laid eggs and > 90% for those at an advanced stage of embryogenesis, even at lower concentration. These responses confirm the ovicidal action of spinosad and indicate that the EC20 formulation enhanced this effect. Furthermore, the product also eliminated around 60% of females that had contact with it during oviposition, in laboratory tests.

288 **Insecticide resistance management for Aedes aegypti and deltamethrin comparing low-dose, high-dose, and high-dose-refugee treatments**

Brook Jensen, B.S., bmjense4@asu.edu, Alden S. Estep, Shelby Blach, NA, Eliana Cheroske, NA, Sophia Koutsogiannis, NA, Roman Lombardo, NA, Noureen Nakshbandi, NA, Axel Pintor, NA, Jack Reihing, NA, Ethan Smith, NA, Silvie Huijben, PhD

Abstract: The primary method for reducing mosquito-borne disease burden involves the use of insecticides for mosquito population control and reduction. However, overreliance and overuse of insecticides have led to the emergence and spread of insecticide resistance, such as knockdown resistance, thwarting traditional control efforts. This situation calls for strategic insecticide resistance management, including innovative approaches such as low-dose application or designated refugee areas free from insecticide exposure. These tactics aim to reduce insecticide resistance emergence and spread. A loftier goal is to restore the efficacy of current insecticides in the future, which would be especially helpful due to the costly and slow development of new insecticides. To investigate the efficacy of several insecticide application practices, we established 12 replicate Aedes aegypti mosquito populations consisting of a mixture of the knockdown resistant mutations V1016I and F1534C. Populations are exposed to one of four insecticidal applications each generation for ten generations: low-dose exposure, high-dose exposure, high-dose-refugee (50% exposure, 50% untreated), and untreated control. Mosquitoes are exposed to deltamethrin using a modified (enlarged) bottle bioassay. The resistance allele frequency for V1016I and F1534C is assessed across generations. The experiment is currently at generation three to six. Initial allele frequencies suggest the high-dose treatment results in the strongest increase in the V1016I mutation, and that the high-dose-refugee treatment results in a greater increase in the V1016I mutation than the low-dose treatment. This research holds significant promise toward identifying resistance management strategies effective (or not effective) at reducing selective pressure for insecticide resistance, which is necessary for informed mosquito control and mosquito-borne disease reduction via insecticides.

289 **Tick Management Strategies in a Northeastern Park**

Daniel Markowski, amca.ta@mosquito.org, Broox Boze, PhD

Abstract: The number of reported human cases of tick-borne pathogens has increased dramatically in recent years. And although the number of pathogens recently found to be transmitted by ticks has increased, Borrelia burgdorferi is still the primary tick-borne pathogen transmitted in the United States. It has been reported that there may be as many as 300,000 people per year diagnosed with Lyme disease. However, most districts and health departments throughout the U.S. struggle to find a proper strategy to manage the tick populations most responsible for causing this rise in tick-borne diseases. Even though the methods for managing ticks are largely the same as they were 20 years ago, large scale management programs are rarely attempted or successful. In a small northeastern park, there has been a highly successful program in place since 2015. Prior to instituting the tick management program, visitors reported tick-bites daily during the active tick season. Since management operations began, tick bite reports have declined significantly and surveillance data demonstrate a dramatic decrease in questing Ixodes scapularis. The various components of this program will be presented and discussed as a template for other programs to follow.

290 **A Novel and Innovative Mycelial Approach to Mosquito Control and Management**

Glen Babcock, glen@gardencityfungi.com

Abstract: This is a water movement system and method configured to eradicate and/or control mosquito populations that lay eggs in stagnant water environments. The system is comprised of a water pump configured to function in cooperation with an underwater mosquito attractant device. The mosquito attractant device is suitably constructed to generate carbon dioxide for attracting mosquitoes to a water extermination zone or trap. The underwater mosquito attractant device contains organisms such as mushroom mycelium for generating the carbon dioxide. Mosquitoes are attracted by the carbon dioxide generation device to reproduce in the water extermination zone, using the CO2 enriched water to lay eggs, and grow larvae and pupae for the subject mosquitoes. A solar-powered water pump device with auxiliary power backup is configured to direct the flow of water from the water extermination zone toward filters of the water pump device to trap and kill mosquito progeny including eggs, larvae, and pupae. The system can be initially set up and left unattended for extended periods of time and will eradicate mosquito progeny on a daily basis. It is an environmental friendly and effective solution to incorporate into any integrated pest management program.

307 **Is Africa ready for American style mosquito control?**

Siriman Samake, samakesiriman1@gmail.com, Mohamed M. Traore, Anounou Sissoko, Dick Loomis, Gunter C. Muller, PhD, Alexey M. Prozorov, Edita E. Revay, Rui-De Xue, Ary Faraji, PhD,

In Mali, Malaria is the leading cause of morbidity (34%) and mortality (33%) according to the Local Health Information System (DHIS2 2021) data. Children under the age of 5 and pregnant women are most affected. Vector control in Mali is solely based on ITN distribution, which gives protection to people only when they sleep under it. Therefore, Malaria reduction remains a significant challenge in the country. Ouelessebougou Alliance, a Utah based NGO working in Mali for over 2 decades, teamed up with Salt Lake City Mosquito Abatement District, Anastasia Mosquito Control District, and the University Clinical Research Center in Bamako, to implement integrated vector management as conducted in the USA. In July 2023, eight villages were selected in Ouelessebougou area, randomized between control (4) and intervention (4) for the first pilot study of true IVM in Mali. Adult vector surveillance is conducted monthly with 6 Dynatrap DT160 at fixed locations, spray catch in ten sleeping rooms. ULV treatment is carried out once a week, at midnight, in each intervention village with deltamethrin. Larval surveillance is conducted and larviciding is done in positive breeding sites once a week in the intervention villages with BTi.

We are expecting significantly lower vector density, and lower entomological inoculation rates in intervention versus control arm.

Larval Control II

291 **4-Ethylphenol as oviposition cue for Aedes aegypti**

Lucia ME Ibarra Bouzada, PhD, Lucia_IbarraBouzada@baylor.edu, Jason Pitts

Abstract: Aedes aegypti is the mosquito vector of multiple arbovirus that cause disease, affecting hundreds of millions of people globally. Females must locate suitable places to lay eggs, which is critical

for survivorship of their progeny. 4-ethylphenol is a volatile odor compound (VOC) present in Bermuda Grass and has been reported to attract Culex quinquefasciatus, but hasn't been evaluated for other mosquito species. In the present study, we evaluated the role of 4-ethylphenol as a potential oviposition cue in A. aegypti. Gravid wild type females were used three days after feeding on fresh defibrinated sheep blood, in two-choice assays under controlled conditions (27°C, 70% humidity, 12:12 light cycle). One female was introduced into a cubical cage where two water sources were offered: 50 mL of water with 4-ethylphenol [10-3M] or [10-7M], and 50 mL of distilled water (control). Each cup contained a small piece of Whatman filter paper as an egg-laying substrate. Following an overnight assay, eggs deposited in each cup were counted using a stereomicroscope, and an Oviposition Assay Index (OAI) was calculated as a metric to determine preference, where OAI= (#eggs odor – # eggs control/ total eggs). Data were analyzed using the Wilcoxon rank test to assess statistical significance. It was produced an OAI of -0.85 ± 0.38 (p=9.28-8, n=21), -0.21 ± 0.49 (p=0.2368, n=11) for [10-3M] or [10-7M], respectively. This indicate that 4-ethylphenol is highly deterrent for A. aegypti oviposition at higher concentration, under these conditions. Future assays will examine additional concentrations of 4-ethylphenol to determine potential concentration effects. Preliminary results suggest 4-ethylphenol may be useful as an oviposition deterrent at higher concentrations. We hypothesize this odor will produce attractive responses at lower concentrations and can be used with other compounds for either push or pull strategies as a component of vector surveillance and/or integrated management programs

292 **Invasive Anopheles stephensi and Aedes aegypti Larval Mosquito Surveillance Using the Environmental DNA**

Chloe Wang, MS, PhD, xiaomiw1@uci.edu, Yan Sun, PhD, Guiyun Yan, PhD

Abstract: Anopheles stephensi is a major malaria vector species in South Asia, the Middle East and the Arabian Peninsula. This vector species has been expanded to several African countries during the past decade since its first detection in Djibouti in 2012. Anopheles stephensi invasion to Africa has posed a significant health risk to the fast-growing urban Africa as its population thrives very well in urban environment. In parallel, the recent infiltration of Aedes aegypti into California and other western U.S. states has sparked substantial public health concerns. To effectively control the spread of invasive mosquito vectors, sensitive surveillance methods enabling early detection are very valuable. Environment DNA (eDNA) method that detects genetic material in aquatic habitats and has found useful in identifying invasive species across various aquatic organisms, including mosquitoes using qPCR. The goal of this study was to determine the sensitivity of the novel eDNA technique for detecting An. stephensi and Ae. Aegypti in aquatic habitats in laboratory conditions. Additionally, we evaluated the utility of eDNA for mosquito surveillance under field conditions. Several experiments were conducted to ascertain the sensitivity and persistence of mosquito eDNAs under varying larval densities, water volumes and rearing conditions, including the presence of other Anopheline and Culicidae larvae. Furthermore, the eDNA technique was applied to two field sites in Ethiopia, which had recently experienced an invasion of An. stephensi. We are currently analyzing the data to determine whether the novel eDNA technique is a valuable tool for monitoring the distribution and spread of invasive mosquito vector species.

293 **Black fly management at Greater Los Angeles County Vector Control District: A Game of Leapfrog**

Rande M. Gallant, MBA, BS - Zoology, rgallant@glamosquito.org

Abstract: As a result of a severe Black fly Simulium spp. infestation along the Los Angeles River corridor, the Greater Los Angeles County Vector Control District (GLACVCD) created its first Black fly Control Program in 1996. Augmented by a special assessment for properties along the Los Angeles River and tributaries, these areas have been continuously monitored and treated to reduce Black fly presence.

Beginning in early spring, personnel from the Science-Technical Services department (Sci-Tech) commence surveillance activities, which continue throughout the season. Presence, and ranked abundance levels are reported to Operations for treatment.

Since inception of the program, Black fly abundance has not approached pre-program levels of activity, as evidenced by the lack of visible adult activity in the air, and lack of complaints. This presentation will discuss our current program's status and how it has evolved.

294 **Lethal and nonlethal effects of insect growth regulator and predation on Aedes aegypti mosquitoes**

Abdullah Alomar, a.alomar@irmosquito2.org, Barry W. Alto

Abstract: Insect growth regulator (IGR) pyriproxyfen mainly prevents adult emergence by mimicking juvenile hormone, whereas the larval stage is not targeted. The use of IGR can therefore act in conjunction with natural aquatic predators that target the larval stage to affect population of prey. In this study, we assessed the invasive mosquito prey Aedes aegypti responses to lethal and nonlethal effects of a combination of IGR and predatory mosquito larvae of Toxorhynchites rutilus. The combination of IGR and Tx. rutilus heavily lowered Ae. aegypti emergence to adulthood more than the independent effects of IGR or Tx. rutilus. Exposing Ae. aegypti larvae to the combination shortened lifespan of adults. Our results show strong lethal and nonlethal outcomes of the combination on Ae. aegypti. These findings suggest an additional benefit, decreases adult lifespan, of the use of an IGR when combined with a natural predator of mosquitoes that may be exploited to improve mosquito control strategies to reduce the risk of disease transmission.

295 **Attack of the Zoospores! Discovery of a new Pythium species infecting mosquito larvae in Lee County**

Constance Darrisaw, darrisaw@lcmcd.org

Abstract: At the Lee County Mosquito Control District in Lehigh Acres, FL samples of wild larval populations are routinely brought into the Field Validation department to rear for insecticide resistance testing. In the fall of 2021, while inspecting a larva under a dissecting microscope, an oddity was found growing on its cuticle. One year later, in the fall of 2022, we finally got an answer. A novel species of water mold in the genus Pythium was infecting, and in the case of Psorophora columbiae killing, wild larvae around Lee County. Through collaborative work with the University of Florida Microbiology department, we are working to learn more about this pathogen and will soon publish our earliest findings.

296 **Assessing Methoprene Resistance in Aedes taeniorhynchus Mosquitoes from Indian River County, Florida**

Peter Jiang, PhD, p.jiang@irmosquito2.org, Sherry Burroughs

Abstract: Methoprene has been employed to manage salt marsh mosquitoes Aedes taeniorhynchus in our district since the mid-1970s. Initially, it demonstrated outstanding efficacy, achieving mortality rates of 95-100% based on field pupal collection over a 20-year period. However, starting in 1993, its effectiveness began to decline, with some sites experiencing a decrease to approximately 70% mortality, despite no observed resistance. Around a decade later, signs of Ae. taeniorhynchus resistance to methoprene started to manifest, as indicated by testing conducted by our district scientists. The presence of resistance became prevalent in our Ae. taeniorhynchus populations. Consequently, in 2009, a decision was made to transition to different larvicides.

In the last decade, methoprene has not been utilized in our district for Ae. taeniorhynchus control. Due to the limited availability of larvicide products, discussions have ensued regarding the potential reintroduction of methoprene for Ae. taeniorhynchus control, primarily due to its cost-effectiveness and formulation, Altosand. However, prior to implementing methoprene for mosquito control, it is imperative to conduct testing to confirm the resistant status of Ae. taeniorhynchus to methoprene throughout the district.

The resistant status of Ae. taeniorhynchus to methoprene was assessed through laboratory bioassays utilizing field-collected larvae. A susceptible Ae. taeniorhynchus colony from the USDA-ARS lab was used as a control for comparison. The bioassay tests involved exposing late 4th instar larvae of Ae. taeniorhynchus (USDA) and field-collected specimens to methoprene technical material. The results indicated varying levels of resistance to methoprene in field populations of Ae. taeniorhynchus. Our findings confirm the existence of methoprene resistance in Ae. taeniorhynchus.

297 **Mansonia mosquitoes, water weeds, and insectary intricacies**

Mollie Davies, mdimise@stpmad.org, Shannon M. Cawthon, Kevin A. Caillouet, Ph.D.

Abstract: St. Tammany Mosquito Abatement (Slidell, Louisiana) has over 40 miles of coastal swamps along Lake Pontchartrain capable of producing Mansonia species. These populations peak in the fall and become the primary nuisance mosquito in the southern, highly-populated portion of St. Tammany. Adulticiding has thus far been our main solution for swelling populations, but recent research and new technologies allow for a more diversified strategy. Larval Mansonia species have been found on a narrow range of invasive aquatic weeds, and we have recently begun herbiciding as a means of source reduction. An up-and-coming Mansonia insectary colony, coupled with resistance trials and host plant reduction, will hopefully lead to improved control of these species in coming years. While still nascent, we hope to curb the annual infestation of a major nuisance mosquito while simultaneously reducing invasions of some major aquatic weeds.

298 **Reduced susceptibility of S-methoprene in Culex pipiens throughout the Chicago area**

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Abstract: Insect growth regulators, like S-methoprene and pyriproxyfen, are heavily relied upon for larval mosquito control due to their target specificity and long-lasting effects. Despite decades of use in the Chicago area to control West Nile virus vectors in catch basins, resistance to these active ingredients has not yet been evaluated. To determine susceptibility of field-collected Culex pipiens to S-methoprene, mosquitoes were evaluated from 16 locations throughout the Chicago area in collaboration

with the North Shore MAD, Northwest MAD, Des Plaines Valley MAD, South Cook County MAD, and the City of Chicago. To compare to areas without S-methoprene pressure, Cx. pipiens from Madison WI, Milwaukee WI, and a susceptible colony were also evaluated. Reduced susceptibility to S-methoprene was detected from all locations in the Chicago area, but was not detected in Madison or Milwaukee. This provides evidence that resistance or tolerance to S-methoprene will form with enough selection pressure over an extended period of time, and highlights the recommendation of product rotation.

Using NASA Satellite Data to Enhance Understanding of Vector Habitats and Disease Transmission Symposium

303 **Incorporating NASA Earth Science Applications to Monitor Infectious Disease Hotspots**

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Global ecosystems offer a delicate balance of living organisms, where changes in climate, weather or agricultural practices can influence vector habitat suitability and hence disease transmission. Through intersectoral and intrasectoral collaborations coupled with stakeholder engagement, leaders can identify practice gaps, leverage scientific expertise among diverse disciplines, and develop innovative solutions to reduce vector and disease exposure. To complement these activities, Earth-observing satellites collect temporal and special information on environmental parameters that can influence vector habitats, such as humidity, land surface temperature, precipitation, and vegetation. Ultimately, this information can be integrated with on-the-ground mosquito and laboratory data into robust models and algorithms for disease early warning systems. This presentation will highlight selected projects that integrate environmental observations from NASA satellites and sensors and on-the-ground fieldwork data to enhance public health surveillance and reporting measures. It will also share key findings from the AmeriGEO Week 2023, where researchers shared robust vector-borne disease applications to help monitor vector hotspots and risk of disease transmission. Audience members will gain insight on NASA program's activities and training opportunities, including the Applied Remote Sensing Training Program (ARSET), the GEO Health Community of Practice network, and the interagency-supported hybrid Earth Information Center.

304 **Climate Change and Vector-borne Diseases – A National and Global Perspective**

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Human influence has resulted in climate warming at a rate that is unprecedented in at least the last 2,000 years. Climate strongly influences the distribution and occurrence of environmentally sensitive diseases. Changes in climate lead to changes in the environment, which result in changes in the ecology, incidence, and distribution of vector-borne diseases. The number of reported cases of these diseases have more than doubled over the last 20 years in the United States, driven by multiple social and environmental factors. In the United States, enhancement of vector-borne disease diagnosis, prevention and control capacity are seen as a high priority for resiliency against these public health threats that are influenced in part by climate change. On a global basis, however, climate change is expected to result in significant environmental change, leading to migration of large numbers of people away from areas that are no longer habitable, into crowded urban settings. In these settings, vector-borne diseases, such as dengue and malaria, transmitted by highly adapted urban vectors like Aedes aegypti and Anopheles stephensi, pose a significant challenge for global public health, compounded by over-crowding, poverty

and poor sanitation that are also likely outcomes. Effective prevention and control will likely be complicated by increasing environmental and social change, with the burden of health impacts borne in tropical regions of Africa, Asia, and South America where limited resources often complicate the capacity to respond with effective prevention and control efforts. For these reasons, on an international scale, climate change poses existential threat to global health.

305 **VectorSurv: Toward Web-based Forecasting of West Nile Virus Disease Risk**

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VectorSurv is dedicated to providing a cutting-edge web-based platform designed to streamline the management, visualization, and analysis of data pertaining to vector surveillance and control. Its primary objective is to enhance the usability of data for key stakeholders within the public health community, spanning various agencies at the local, state, and national levels. Currently, VectorSurv is actively utilized by vector control agencies and public health organizations in over 20 U.S. states and territories, underscoring its scalability for nationwide implementation.

The system's core functionality centers on data management and decision-support tools, including "nowcasts" that translate surveillance data into real-time assessments of entomological or epidemiological risks for arboviral diseases. This significantly enhances assessment of arboviral disease threats by standardizing data collection and ensuring public accessibility. Alongside its hosting of vector surveillance data, the web-based VectorSurv platform constantly updates and hosts climate and other environmental data essential for modeling vector distributions and pathogen transmission.

VectorSurv is engaged in ongoing efforts to create short-term forecasting models. These models will seamlessly integrate real-time vector surveillance data with NASA's Earth observations and other complementary environmental data sources. The transition to a web-based format for these models is aimed at democratizing access to predictive tools, catering to a wide range of users and needs, including vector control professionals, public health officials, and researchers.

VectorSurv is committed to establishing a direct connection between predictive models and the extensive underlying database. This integration is expected to catalyze collaborations between modelers and decision-makers. By bridging this long-standing divide, we aim to create a synergy where scientific evidence can swiftly inform strategic actions, ultimately resulting in more effective vector control measures and proactive public health responses.

306 **Mapping Urban Mosquito Microhabitats and Malaria Risk Using Satellite Earth Observations**

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Anopheles stephensi is associated with urban habitats and is an important malaria vector throughout its native range in South and West Asia. This species is currently spreading into Africa, raising concerns that it could establish new foci of urban malaria transmission throughout the continent. Better neighborhood-level maps of mosquito habitat suitability and malaria transmission risk are needed to inform vector control and malaria elimination in cities. Satellite Earth observations can support these efforts by providing high-resolution maps of buildings, vegetation, and water as well as direct measurements of land surface temperature. We used satellite data to analyze urban heat and moisture island effects in Ahmedabad and Surat, two malaria-endemic cities in western India. Land surface

temperature data were obtained from the ECOSTRESS instrument, and land cover data were generated through time series analysis of Landsat data. In situ temperature and humidity data were collected using microclimate sensors located indoors and outdoors at 93 dwellings in the two cities. Outdoor temperature and relative humidity were generally higher in the urban core than at the periphery, but these patterns were weaker for indoor locations. Microclimate patterns were associated with land cover and land surface temperature, particularly concentrations of impervious surfaces and areas of irrigated agriculture. Predictions of Anopheles stephensi vectorial capacity exhibited strong spatial variation, and hot spots of high malaria transmission potential shifted throughout the season. These results demonstrate how combining satellite Earth observations with ground-based microclimate measurements can provide valuable data to support urban malaria control programs.

306 **Designing a Global Surveillance and Forecasting System for Selected Vector-borne Diseases**

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Vector-borne disease emergence and spread have the potential to result in outbreaks and epidemics across the world threatening global health security and US national security. Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700,000 deaths annually. They can be caused by either parasites, bacteria or viruses. The incidence of vector-borne diseases is increasing everywhere globally due to a highly variable and changing climate. Illustrations include the emergence of chikungunya and Zika viruses in the western hemisphere in 2013 and 2015 and chikungunya in Mediterranean Europe since 2006. The epidemiology of many vector-borne pathogens is driven by climate and environmental conditions that critically influence vector survival, reproduction, biting rates, feeding patterns, pathogen incubation and replication periods, and the efficiency of pathogen transmission among multiple hosts. While specific shifts in patterns of climate and weather anomalies are known to precede certain vector-borne disease outbreaks (e.g. dengue, chikungunya, Rift Valley fever, Zika, hantavirus), there has not been a comprehensive estimation of driving environmental and climatic thresholds, temporal persistence of the anomalies, as well as generalization of these metrics at a global scale. We are utilizing various global satellite remote sensing and climate data sets, in combination with disease outbreak data sets, to use machine learning techniques to globally map current and forecast the risk of selected vector-borne disease activity.

Legislative and Regulatory Symposium II

Legislative and Regulatory Symposium II

Nina M. Dacko, MS, nmdacko@gmail.com

As legislative and regulatory gridlock dominates at the federal level, many states and localities have taken it upon themselves to address issues pertinent to mosquito control. From concerns over backyard mosquito control treatments, to pollinator protection, to anti-pesticide activism, every mosquito control entity in the country faces a unique regulatory and legislative landscape. This symposium will focus on the issues that are shaping the future of mosquito control and pesticide regulation at the local and state levels. In response to the evolving challenges faced by practitioners and policymakers, this roundtable discussion aims to foster in-depth discussions and collaborations at the grassroots level.

Poster Session

Adult Control

P 1 Testing a combined IIT-SIT to control Aedes-borne viral diseases at scale in Yucatan, Mexico

Abdiel Martín-Park, ampark27@gmail.com, Yamili Contreras-Perera, Silvia Pérez-Carrillo, Azael Che-Mendoza, Henry Puerta-Guardo, Norma Pavía-Ruz, Doctor, Jorge Palacio-Vargas, Biologist, Co-Author, Zhiyong Xi, Gonzalo M. Vazquez-Prokopec, PhD., Pablo Manrique-Saide

Abstract: The incompatible insect technique through Wolbachia-induced incompatibility combined with the sterile insect technique using radiation (IIT-SIT) to suppress Ae. aegypti populations has been tested in a recent successful pilot trial in a suburban area of Yucatán Mexico. As part of an ongoing collaboration between the UADY and the Government of Yucatan and CENAPRECE - supported by CONACYT and USAID - the combined use of IIT-SIT will be scaled-up in urban areas to suppress Ae. aegypti populations and control the Aedes borne diseases. The Laboratory for Biological Control of Aedes aegypti (LCB-UADY) has the capacity to produce on a large scale (up to 5 million) male Aedes mosquitoes with Wolbachia and SIT. An Integrated Management Plan for Aedes aegypti Control will be developed in coordination with the Vector Control Program of the MoH of Yucatan incorporating IIT-SIT with "traditional" vector control for population suppression and reduce the risk of dengue transmission in urban areas of Merida Yucatan. This integrated control plan includes a package of interventions structured in three phases: (i) preparation phase, (ii) attack phase and (iii) suppression phase during two transmission seasons. The mass-release of male Aedes aegypti will be carried out at two sites known to be historical foci of arbovirus transmission, and two other sites will serve as controls. This is the first study implementing IIT-SIT for population suppression of Aedes aegypti in urban areas of Mexico.

Adult Control

P 2 Dose determination and survivorship of X-ray irradiated sterile Aedes aegypti mosquitoes: preparation for SIT in West Valley region of San Bernardino County, California

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Abstract: The success of a Sterile Insect technique depends on the survivorship and fitness of sterile mosquitoes in the environment. Here we conducted experiments to determine X-ray radiation dosage and the survivorship of X-ray irradiated male Aedes aegypti in the laboratory conditions. A cohort of newly emerged male Ae. aegypti mosquitoes were X-ray irradiated with a dose of 42 Gy, 45 Gy, 47 Gy, 50 Gy, 52 Gy, 58 Gy and 60 Gy. Triplicate cages, each containing freshly emerged 45 mosquitoes (male to female ratio of 1:2), were set after males were subjected to X-ray treatment. Daily mortality was recorded for 50 days. Similarly, non-sterile mosquito cohorts with similar number as treated cages were used as control. Following blood feeding, eggs were collected from each cage and counted. All eggs harvested from the experimental cages were hatched after drying for few days. Hatching success was considered as a proxy to determine the viability of eggs. The number of eggs laid and their hatching success were compared among the cohorts. The results and their implications for SIT work are explained.

Adult Control

P 3 Selection Pressure for Insecticide Resistance in Major Mosquito Vectors of the Salt River Valley

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Abstract: Resistance to insecticides is a growing global issue in mosquito populations. It is caused by selective pressures from increasing overuse and untargeted use of insecticidal chemicals to decrease the prevalence of vector-borne diseases and of other pesticidal chemicals to hinder crop destruction and kill nuisance arthropods. Populations of Aedes aegypti in the Salt River Valley in metropolitan Phoenix, AZ, have been shown to have high levels of target-site resistance mutations at the 410, 1016, and 1534 loci of the kdr gene. However, the status of insecticide resistance in Culex spp. in the Valley is largely unknown, a quite concerning issue due to the genus's role as the West Nile Virus vector. Insecticide resistance in Cx. spp. is thought to be primarily controlled by metabolic enzyme pathways. Here, we will present our ongoing work to determine the level and spatial distribution of pyrethroid resistance in Cx. spp. in the highly populated urban areas of the Salt River Valley. Phenotypic resistance is determined by establishing dose-response curves using topical application bioassays. Mosquitoes are further genotyped using melt-curve analysis for common kdr target-site mutations, and metabolic resistance is assessed using colorimetric enzyme activity assays. Levels of resistance will be correlated with past fogging frequency from the public health vector control program. However, public health insecticide use may not be the main driver of resistance. We will be assessing the insecticide exposure to mosquitoes from fogging in both semi-field and operational field studies to estimate the evolutionary pressures exerted by programmatic fogging.

Adult Control

P 4 Role of container periphyton as oviposition attractant to female Aedes aegypti

Luisa M. Otero Lopez, nrs4@cdc.gov, Roberto Barrera, Eric P. Caragata, , , , , , , ,

Abstract: Aedes aegypti females use different chemosensory cues to select oviposition sites. These cues are thought to give Ae. aegypti females information on food availability, presence of pathogens, competitors, and risk of predation among other factors. Most research on stimuli attracting female Ae. aegypti to oviposit in natural or artificial containers have focused on the properties of the vessel and contained water, such as size (perimeter, volume), color, water quality, and the concentration of dissolved organic matter and microorganisms in the form of plant infusions. One component of the aquatic habitat that has not been studied is the community of microorganisms that grow on inner walls of containers where Ae. aegypti gravid females stand to lay eggs, usually right above the water line. Depending on sun exposure algae can grow on the submerged wall surfaces, and other micro-organisms such as bacteria and fungi can grow as organic matter accumulates. These micro-organisms form the periphyton community which Ae. aegypti larvae feed on by browsing on submerged surfaces. The question of interest is whether Ae. aegypti females are attracted to periphyton stimuli and what factors facilitate the attraction. To answer this question, we conducted behavioral experiments where we: 1- Compared Ae. aegypti oviposition rates between containers with periphyton, and similar containers whose inner walls were periphyton free, and 2- Characterized the periphyton community richness and diversity. We found significantly higher oviposition rates in containers with periphyton compared to containers without, and we found the periphyton community in our experiments was mostly composed of Bacteria, followed by Archaea, Viridiplantae, Eukaryota and Fungi. Understanding how periphyton

mediates oviposition behavior and what variables make periphyton attractive can help us in the formulation of new attractants directed for mosquito control.

Adult Control

P 5 Stability of Wolbachia wAlbB strain infection through sequential generations of mass-reared Aedes aegypti mosquitoes

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Abstract: The incompatible insect technique (IIT), in which males carrying Wolbachia strains are released to induce incompatible mating in wild Wolbachia-free female mosquitoes, is one of the currently implemented innovative method for suppression and control of Aedes aegypti populations. Quality control of the mass-reared production and field-release of Wolbachia infected mosquitoes is critical to ensure the success of the interventions using IIT. Here, we determine the presence and frequency of Wolbachia infection in male and female Ae. aegypti mosquitoes through several generations (F28-F33) under a mass-rearing system established at the Laboratory for Biological Control of Aedes aegypti of the Autonomous University of Yucatan (LCB-UADY). A total of 360 individuals Ae. aegypti mosquitoes divided in 180 males and 180 females were analyzed for the presence of Wolbachia wAlbB strain infection by end-point PCR using Wolbachia B strain specific primers. Our results showed that the Wolbachia wAlbB strain was stably maintained (100% Wolbachia genome positivity) along six generations (F28-F33) of both male and female Ae. aegypti mosquitoes reared under laboratory conditions. Further molecular analyses to determine the density of Wolbachia infection as well as DNA sequencing of the wsp gene to identify the potential variability of the Wolbachia wAlbB strain infecting Ae. aegypti through different generations will be performed. These results together will provide important information concerning the robustness and stability of Wolbachia wAlbB infection of Ae. aegypti maintained under mass-rearing conditions which is critical requirement for the potential establishment and implementation of biocontrol strategies (IIT or combined IIT-SIT) against Aedes-borne diseases such as dengue, Zika, and chikungunya.

Adult Control

P 6 Establishment and stability of Wolbachia (wAlbB strain) in Aedes aegypti populations from the Yucatan Peninsula, México

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Abstract: Aedes-borne diseases (ABDs) such as dengue, Zika and chikungunya pose an enormous burden to the public health systems worldwide. As no effective vaccines or therapy are available, vector control programs remain as one of the main strategies to defeat these diseases. In Mexico, the Ministry of Health is interested in incorporating the incompatible insect technique (IIT) using Wolbachia-induced cytoplasmic incompatibility to suppress the populations of Aedes aegypti and reduce the incidence of ABDs. In the Laboratory for Biological Control of Aedes aegypti of the University of Yucatan (LCB-UADY) - a reference insectarium for national and local vector programs - we are establishing and mass-rearing

local Wolbachia-free and Wolbachia-infected Ae. aegypti lines from two different areas of Mexico, Quintana Roo (QROO) and Campeche (CAMP) states. Briefly, emerging females (F0) from ovitrap-collected eggs were maintained for oviposition, offsprings were reared under laboratory conditions for two generations (F2), and then screened for Wolbachia infection by qPCR (Zhang et al. 1998; Puerta-Guardo et al. 2020). Wolbachia-free males (wild-type ♂ receptor line (F2), n=30) from both states were selected for outcross breeding with females carrying Wolbachia wAlbB strain (wMID♀ donor line (F35), n=30) (Liang et al., 2022) from the Yucatan state. After three crossing generations (G3), two new Ae. aegypti lines carrying Wolbachia (wAlbB) from Campeche and Quintana Roo, hereafter designated as wCAMP and wQROO, were successfully established (100%) as confirmed by qPCR. Further analyses to evaluate life-history traits such as fecundity, fertility, longevity, cytoplasmic incompatibility, and male mating competitiveness as well as Wolbachia infection through sequential generations of the two new Wolbachia infected lines, wCAMP and wQRO, were performed to compare to the wild type populations. These results provide significant insights regarding the future implementation of Wolbachia-based strategies for vector control not only at local but national levels.

Adult Control

P 7 How do socio-economic factors impact mosquito abundance and diversity in Suburban Neighborhoods?

Timothy D. McNamara, Ph.D, t.mcnamara@ufl.edu, Estelle Martin, Ph.D

Abstract: Income has been shown to significantly impact the abundance of both Aedes and Culex mosquito populations, with lower-income communities experiencing higher mosquito abundance than high-income communities. Unfortunately, these low-income communities have also been shown to have higher rates of West Nile virus infection the mosquitoes present than higher-income communities. This difference in mosquito burden is thought to be the result of a higher abundance in breeding sites in low-income areas due to the presence of more breeding sites. However, much of this research has focused on the impacts to urban systems, meaning that the impacts of poverty on mosquito burden in smaller communities is poorly understood. To bridge this gap, we are conducting a survey of mosquito abundance and diversity in 6 neighborhoods in Gainesville, FL of varying income. We are also conducting a Knowledge, Attitude and Practices (KAP) survey of the neighborhood residents to determine their perceived mosquito burden, knowledge of mosquito management practices, and to measure how education impacts practices to control mosquitoes in their area. Preliminary results indicate that Winter and early season (December to May) Aedes and Culex mosquito abundance did not vary by income.

Disease/Vector Studies

P 8 THE EFFECTS OF SUBLETHAL DOSES OF PYRIPROXYFEN ON MALE AND FEMALE AEDES ALBOPICTUS REPRODUCTIVE FITNESS

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Abstract: Autodissemination approaches for insect control are based on the self-delivery of pesticides by insects. The advantage autodissemination approaches are that small amounts highly effective insect growth regulators compared to conventional spraying techniques are delivered to cryptic mosquito larval habitats. Pyriproxyfen is an IGR that acts similarly as a natural juvenile hormone (JH) in

insects. In general, JH and 20 hydroxyecdysone (20E) act antagonistically by interfering with the metamorphosis of the immature stage to the adult stage by retaining the juvenile characters in insects and inhibiting important physiological processes including reproduction and development. With the application of autodissemination approaches, adult male and female mosquitoes can be exposed to sub-lethal doses of PPF. While autodissemination approaches have been shown to impact mosquito populations there is little known about the effects of pyriproxyfen on adult male and female mosquitoes when exposed to non-lethal doses. In this study, we performed experiments to examine the effects of non-lethal doses of PPF on the fecundity, blood feeding rates, egg hatch rates, and fertility of PPF-treated Ae. albopictus. In addition, the gene expression patterns of EcR (ecdysone receptor), HR3 (hormone receptor), USP (ultraspiracle), and Vg (vitellogenin) and their impact on ovary maturation and development were examined. The results are discussed in the context of the unintended impacts of PPF on male and female mosquitoes in reference to the use of autodissemination approaches.

Disease/Vector Studies

P 9 The Impact of Aromatic Plants on BG Sentinel II Trap Efficacy

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Abstract: Aromatic plants such as lavender (Lavandula sp.) and geranium (Geranium sp.) are frequently found in residential front yards. Their prevalence can be attributed to their remarkable drought tolerance, a highly sought-after trait in the arid Mediterranean climate of Fresno County, California. These aromatic plants are known to emit volatile compounds when agitated. This study aimed to determine whether aromatic plants in residential landscaping deter mosquitoes, resulting in decreased mosquito activity on the property.

The study was conducted in Clovis, California using BG-Sentinel (II) traps to sample the mosquito population. Traps were set weekly next to lavender, geranium, or a non-aromatic control plant. There was no significant difference in the number of mosquitoes collected adjacent to aromatic plants when compared to the control group of non-aromatic plants. Although there were slightly more mosquitoes collected overall at the control sites, this difference was not statistically significant.

Disease/Vector Studies

P 10 Impact of native and invasive grasses on the behavior of Aedes aegypti, vector of dengue and yellow fever virus

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Abstract: Invasive plants alter the structure and function of ecosystems and can influence native species populations. Invasive plants are known to alter the distribution and abundance of arthropods of disease vectors of humans and livestock by modifying habitats and resource availability. In Texas rangelands, several invasive grasses are known to displace native grasses and shrubs that can potentially influence the prevalence of vector borne diseases. We analyzed the impact of native and invasive grasses on the oviposition behavior of mosquito species Aedes aegypti, the vector of dengue and yellow fever

virus. We used oviposition and gravid traps to assess behavioral response. Preliminary results show no statistical difference in oviposition and flight behavior of Ae. aegypti in response to native grass infusions, invasive grass infusions, or tap water. This study was limited by an extremely hot and dry summer which reduced the overall mosquito collections. We aim to repeat sampling at different times of the year when there is increased mosquito activity. A four-port bioassay experiment is planned to examine the attraction and repellency of the grasses on adult mosquitoes. The results will help in understanding the synergy between invasive plants and mosquitoes and assist in planning comprehensive management for invasive plants.

Disease/Vector Studies

P 11 Elucidating the effects of temperature change on oviposition and progeny viability of Aedes aegypti and Culex tarsalis mosquitoes

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Abstract: Temperature is known to affect the transmission efficiency of mosquito-borne viruses, particularly those spread by Aedes aegypti and Culex tarsalis mosquitoes. With the rising issue of climate change, investigating how environmental changes impact mosquito fecundity will inform future action for vector control. Our preliminary data has shown impaired egg deposition when Rift Valley fever virus infected adult Ae. aegypti mosquitoes were exposed to temperatures varying from typical environmental conditions. This study will further investigate the relationship between altered temperatures, oviposition rates, and progeny viability within uninfected blood-fed Ae. aegypti and Cx. tarsalis mosquitoes. We hypothesize that temperature variation will negatively impact egg viability and deposition rates, along with subsequent offspring development and survivorship. Blood-fed female mosquitoes (n=50) will be housed individually at lower (18°C) or higher (32°C) than standard (28°C) rearing temperatures. Egg production will be assessed by quantifying deposited eggs in comparison to retained eggs, obtained by dissection. Deposited egg hatch rates will be recorded to determine offspring viability. Data collection is ongoing. Understanding the relationship between mosquito fecundity and temperature is of great importance for anticipating infectious disease dynamics in a complex and shifting global environment.

Disease/Vector Studies

P 13 The Use of Sentinel Chickens Throughout the United States

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Abstract: Mosquito-borne viruses continue to be a public health concern on a global scale. The control of arboviral activity is most effectively accomplished through the management of vector species. The use of sentinel chickens is a powerful tool to aid in the arboviral surveillance efforts of mosquito control programs and the results from this type of surveillance help guide abatement efforts for vector species. To better understand how sentinel chickens are used throughout the United State, a survey was developed and distributed to mosquito control programs. Fifty-three responses were received representing districts from Arizona, California, Delaware, Florida, Georgia, and Texas. Ideally, results of this survey will help programs learn ways to improve their current sentinel operations, boost the efficiency of their program, and save on operational costs.

Disease/Vector Studies

P 14 Inter-annual climate variability and its impact on local weather, Aedes aegypti dynamics and control, and arbovirus transmission in southern Puerto Rico

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Abstract: We monitored the population dynamics of gravid females of Aedes aegypti in two managed (area-wide mass-trapping) and two unmanaged communities in southern Puerto Rico for several years (2013-2019) to understand how inter-annual climate variability influenced local weather and its effects on mosquito and arbovirus populations. During this study we observed drought periods associated with the emergence of El Niño Southern Oscillation events (ENSO), and wetter conditions during La Niña events. Also, during that period, we observed outbreaks of dengue, chikungunya, and Zika viruses. Mosquito populations were more abundant during the warmer and wetter part of the seasonal cycle, corresponding with periods of maximum transmission of arboviruses. Other than these weather factors, the main factor explaining differences in Ae. aegypti abundance among study sites was mass-trapping. Populations of Ae. aegypti were not directly affected by a severe drought that coincided with a strong El Niño event. Since there is a lag between the occurrence of climatic conditions promoting transmission and the subsequent outbreak, we analyzed lagged values of El Niño Index and arbovirus cases and found they were positively correlated. Arbovirus cases were positively correlated with lagged values (5-12 months) of El Niño Index, droughts, and abundance of Ae. aegypti. The results suggest that the onset of strong ENSO conditions in Puerto Rico could potentially be used as an early warning signal for arbovirus outbreaks in areas where Ae. aegypti populations exceed the density threshold value.

Disease/Vector Studies

P 15 Establishing a target for vector control programs to prevent dengue virus transmission in Puerto Rico

Veronica Acevedo-Soto, gra3@cdc.gov, Jose Ruiz-Valcarcel, Luisa Otero-Lopez, Rafael Saavedra-Hernandez, MPH, Joanelis Medina, Julieanne Miranda Bermúdez, Grayson Brown, Co-Author, Gabriela Paz-Bailey, Roberto Barrera,

Abstract: The advent of efficient traps to capture gravid females of Aedes aegypti provides an opportunity to determine what is the number of mosquitoes per trap (mosquito density threshold) that prevents or reduces dengue virus transmission. This information can be then used by Vector Control Programs to evaluate the effectiveness of their operations. Using a cluster randomized study, we investigated if controlling the population of Ae. aegypti at various levels was associated with low or no local transmission of dengue viruses. Area-wide control was done by mass-trapping gravid females with Autocidal Gravid Ovitraps (AGO traps). There were 4 intervention levels with 3 replicate clusters per level and 300 houses per cluster: no trapping (control), one trap/house, two traps/house, and three traps/house in most houses (>75% of houses in the clusters). We monitored the density of Ae. aegypti every week since May 2021 and collected pools of female mosquito that were analyzed by RT-PCR to detect the presence of dengue viruses. The results showed significant differences in the average number of female mosquitoes per treatment, where the density decreased from untreated clusters to clusters with three traps/home. Mean densities were 9.16, 5.85, 4.47, and 2.99 female mosquitoes/trap/week in

clusters with no control, one, two, and three traps/home, respectively. There were reductions of 41 (25.7-53.1; 95% C. I.), 58 (46.1 – 66.3), and 77 (70.5 – 81.4) % in treatments with one, two, and three traps/home, respectively. The expected numbers of infected mosquitoes per one thousand mosquitoes were 2.8, 2.6, 0.6, and 0.8 in clusters with zero, one, two, and three traps/house. Our findings suggest that a threshold density of 4 or less Ae. aegypti/trap/week reduces dengue transmission.

Disease/Vector Studies

P 17 Vector competence of mosquitoes from Texas to Madariaga virus

Danilo Carvalho, PhD, da.decarvalholeandro@ag.tamu.edu, Tereza Magalhaes

Abstract: Madariaga virus (MADV) is a lesser-known member of the eastern equine encephalitis virus complex, prevalent in Latin America. Several MADV equine epizootics have been reported, with case fatality rates exceeding 90% in certain instances. In humans, MADV infection has been associated with severe cases of encephalitis, some of them fatal, but the full impact on human health remains poorly understood. Other key aspects of the virus, including its vertebrate hosts and vectors, remain unknown. Nonetheless, some evidence suggests that non-volant mammals like rodents may serve as the amplifying hosts, while Culex spp. may act as enzootic vectors. Field studies also point to Aedes spp. as epizootic or bridge vectors. Given the potential expansion of MADV's geographical range, it is possible that the virus could reach the United States (U.S.) in the future, posing a health threat to local animal and human populations. As an initial effort to evaluate different mosquito species from the U.S. for their ability to transmit MADV, this study aims to test the potential of Culex spp. mosquitoes collected in College Station, East-Central Texas, to transmit MADV. For that, mosquitoes of early filial generations (F2-F5) will be orally exposed to MADV, and mosquito body, legs and saliva will be collected at different time points after exposure to determine infection, dissemination, and transmission rates, respectively. Data on the potential ability of local mosquito species to transmit this important pathogen is essential to plan prevention and control strategies in the event of MADV introduction to the country.

Disease/Vector Studies

P 18 Incriminating vectors of deer malaria (Plasmodium odocoilei) in a Florida deer farm

Morgan N. Rockwell, B.A., morganrockwell@ufl.edu

Abstract: Plasmodium odocoilei, is a hemoparasite that infects wild and farmed white-tailed deer (WTD) in the United States and is the causative agent for deer malaria. Co-infection with deer malaria and epizootic hemorrhagic disease virus can cause high mortality and morbidity in WTD. Determining the vector(s) of deer malaria permits development of integrated pest management strategies that can ultimately reduce WTD mortality and morbidity at Florida deer farms, where WTD are an economically important species.

Disease/Vector Studies

P 19 Analysis of pollen quantity on flower visiting mosquitoes.

Nalany Richardson, nr15837@uga.edu, Danica Shannon, B.Sc, Daniel Peach, PhD

Abstract: Mosquitoes visit flowers in search of nectar, which they consume as a primary source of energy. However, very little is known about the role mosquitoes play in pollinating flowers and, subsequently, their ability to carry pollen. Here we report the amount of pollen found on mosquitoes from flowers on the Savannah River Site, outside of Aiken, South Carolina.

Disease/Vector Studies

P 20 Mosquito-flower interactions in the Southeast.

Danica Shannon, B.Sc, danica.shannon@uga.edu, Nalany Richardson, Daniel Peach, PhD

Abstract: Mosquito interactions with humans are well documented with known broader public health impacts, however the ecological consequences of their interactions with flowers are a less understood topic. In addition to female mosquitoes of certain species requiring nutrients in blood to produce their eggs, both male and female mosquitoes of all species feed on plant sugar such as nectar to fulfill their energy demands. Although it is the sugar in flower nectar that is the main resource they are after, multiple additional interactions take place, which we currently have limited knowledge of. Processes like pollination, microbial exchange, and the uptake of secondary metabolites are all things that are yet to be well characterized in the literature, and could help us better understand mosquito ecology as a whole. To begin this investigation, we first need to document what particular interactions are occurring between which mosquito and plant species. To answer this question on a local scale, we carried out field work and molecular analysis to provide evidence of mosquito-flower visitation at the Savannah River Site near Aiken, South Carolina. By attempting to elucidate which species are involved, we can begin to lay the groundwork for exploring interactions that we do not yet fully comprehend.

Disease/Vector Studies

P 21 Defining Internal Cut Off Values for Operational Use with the Co-Diagnostics, Inc. Vector Smart™ North American Mosquito West (NAM-w) Multiplex RT-qPCR Assay

Heather Ward, M.S., hward@2cmad.org

Abstract: In 2023, the Canyon County Mosquito Abatement District in south-western Idaho, established in house RT-qPCR testing for West Nile virus (WNV), St. Louis encephalitis virus (SLEV), and western equine encephalitis virus (WEEV). When deciding on purchases to augment the laboratory as approved by the Board of Commissioners, the Co-Diagnostics Vector Smart™ North American Mosquito West (NAM-w) was selected instead of developing our own triplex RT-qPCR to begin testing as soon as equipment was delivered. The NAM-w kit included positive controls for WNV, SLEV, and WEEV, as well an extraction control, has been validated and used by other districts, and had a simple workflow and interpretation for results. The goal was to save time in getting up and running in contrast to developing, testing, and validating a new protocol, or one adapted from a different laboratory. To increase our testing capacity, we purchased a Rotor-Gene Q thermocycler capable of concurrently running 100 samples per run instead of the Co-Dx Box™ which would have limited us to 24 samples per run using the NAM-w assay. Because we purchased equipment that Co-Diagnostics hadn't validated for running the NAM-w assay, we did encounter issues that were resolved through validation steps, protocol refinements, and modifying our internal definitions of positive results for use in our operational decisions.

Larval Control

P 22 Laboratory evaluation of efficacy of the larvicide spinosad against Anopheles stephensi in Jigjiga, Ethiopia

Gabriela Gonzalez-Olvera, PhD, gabygzzo@gmail.com, Solomon Yared, PhD, Esayas Aklilu, PhD, Araya Gebresilassie, PhD, Wilberth Bibiano-Marin, Biologist, Azael Che-Mendoza, Oscar David Kirstein, PhD, Co-Author, Gonzalo M. Vazquez-Prokopec, PhD.

Abstract: We report the efficacy of a commercial formulation of the insecticide spinosad against larvae of Anopheles stephensi from populations found in the city of Jijiga, Somali Region, Eastern Ethiopia. Batches of 25 larvae (late III to early IV instar) collected from large water storage reservoirs associated with construction sites (the primary An. stephensi larval site in the dry season) were tested under laboratory conditions against each insecticide at a dose recommended by the manufacturer (Natular® G30, 0.02 gr/5L) following WHO guidelines. Mortality at 24-48 h post-exposure was 100%. Results show that Spinosad is effective against An. stephensi larvae and suggest that it may be a useful tool as part of larval source management plans aimed at controlling this invasive malaria vector in Ethiopia.

New Product Trials

P 23 Efficacy evaluation of Natular® DT larvicide in the eastern Amazon region of Brazil

Josiane N. Müller, jnmuller@outlook.com, Allan Kardec Galardo, Ana Paula Corrêa, Wellington Santos, Tatiane Barbosa, Márcio Cláudio Nunes, Kilder Vidal, Co-Author

Abstract: The Aedes aegypti mosquito is associated to important arboviruses including Dengue, Zika and Chikungunya. Mosquito control is a goal of most countries present in the species' distribution range, given the public health problems caused to the population. In Brazil, biolarvicides' evalution is important to increase control alternatives existing and used in the country. This study evaluated the effectiveness of the Natular® DT product in field simulation tests and directly in the field, in the city of Macapá, Amapá, Brazil. The field simulation was conducted in plastic tanks containing 40 liters of water in shaded and exposed to the sun areas, with 60% water exchange weekly and using Ae. aegypti larvae from Rockefeller lineage and a local population. For the field evaluation, a neighborhood area of Macapá was selected and the product was used following the municipality vector control program methodology. In this area, the treated deposits were labeled and identified to track positivity. Another area was maintained in the program routine using pyriproxyfen and considered a control area. Two intervention cycles were used, lasting two months each, with evaluation of methodologies using ovitrap types. In the field simulation, mortality above 80% was observed for up to 42 days, and larvae was detected in the treated and labeled deposits after 42 days of treatment. Areas where the Natular DT was used, the ovitraps showed that the density of Aedes eggs was reduced during the study period but increased at the end of the assessment. The residuality presented by Natular® DT may vary depending on the location where the product is used, due to the complexity of breeders in each location. The results showed that this product can be applied in control actions but highlights the importance of mechanical control and health education activities to the population.

Latin American Poster Session

Adult Control

P 24 Residual efficacy of deltamethrin, bendiocarb and pirimiphos-methyl formulations against Triatoma dimidiata (Latreille, 1811) applied on substrates typically used in premises of Yucatán, Mexico.

Carlos Arisqueta-Chablé, PhD, c.arisqueta@gmail.com, Wilberth Bibiano-Marin, Biologist, Anuar Medina-Barreiro, Biologist, Juan Adolfo Ortiz Rivera, Biologist, Jorge Palacio-Vargas, Biologist, Gabriela Gonzalez-Olvera, PhD, Azael Che-Mendoza, Co-Author, Gonzalo M. Vazquez-Prokopec, PhD., Pablo Manrique-Saide,

Abstract: The national program for the control and elimination of Chagas disease in Mexico recommends the residual spraying of insecticides. In addition to traditional indoor spraying, the program has introduced targeted outdoor residual of spraying of structures and objects that are potential refuges for T. dimidita in the peridomicile. However, the residual effect of different currently available insecticide molecules and formulations against Triatoma dimidiata is insufficient. Here we report the residual efficacy of different insecticide formulations applied on wood and nude concrete block, which are the most common types of materials used to build structures found in the peridomicile of premises in rural areas of Mexico. Field doses of commercial residual formulations of deltamethrin (0.025 g/m2), bendiocarb (0.4 g/m2) and pirimiphos-methyl (1 g/m2) were applied to wood and nude concrete block substrates. Cone bioassays were done (24hrs up to 6-months) exposing nymphs of T. dimidiata for 72hrs to substrates and recording the mortality at 1-3-5 days post-exposure. All the formulations showed high efficacies on all substrates at 24hrs after treatment. After 30 days, mortality rates on wood ranged from 87% (deltamethrin) to 100% (bendiocarb and pirimiphos-methyl), and from < 48% (deltamethrin and bendiocarb) to 87% (pirimiphos-methyl) on nude concrete block. After 60 days, bendiocarb and pirimiphos-methyl showed a good performance (100%) on wood, while deltamethrin performance decreased on all substrates (32-55%). Only pirimiphos-methyl continue performing good (>90% mortality) on nude concrete. After 6 months the performance on wood with bendiocarb and pirimiphos-methyl remained good (96%-100%) and intermediate (»50%) with deltamethrin. For nude concrete block, only the performance of pirimiphos-methyl was still good (>90%).

Adult Control

P 25 Frequency of resistance to pyrethroids and organophosphates in Aedes aegypti populations in the department of Cordoba, Colombia

Ronald Maestre-Serrano, ronald.maestre@unisimon.edu.co, Maria Claudia Atencia-Pineda, Yerson Javier García-Leal, Diana Díaz-Ortiz, Richard Hoyos-López, Alfonso Calderón-Rangel, Paula Pareja-Loaiza, Co-Author, Pedro Fragoso-Castilla, Adriana E. Flores, D.Sc,

Abstract: The use of insecticides is the main tool for controlling insect vectors of diseases of public health interest, such as dengue, chikungunya, and Zika. For this reason, it is necessary to monitor the susceptibility of Aedes aegypti populations to the insecticides used for vector control. The main objective of the study was to establish the state of susceptibility to insecticides in Ae. aegypti in the department of Cordoba. The study was carried out in fourteen municipalities of the department that recorded the highest incidence of dengue from 2015 to 2020. The insecticides permethrin, deltamethrin, and lambda-cyhalothrin were evaluated using the methodologies of the World Health Organization

(WHO) and the Centers for Disease Control and Prevention (CDC). The larvicide temephos was assessed with the WHO methodology, and the organophosphates malathion, fenitrothion, and pirimiphos-methyl were evaluated with the CDC-impregnated bottle methodology. All populations were resistant to the three pyrethroids evaluated and to fenitrothion. Resistance to pirimiphos-methyl was also observed in 3 of the 14 populations; meanwhile, all populations showed susceptibility to temephos and malathion. Finally, the kdr mutations F1534C, V1016I, and V410L were identified with variations in allelic and genotypic frequencies in the analyzed populations.

Adult Control

P 26 Successful control of Triatoma dimidiata with residual application of a microencapsulated formulation of pirimiphos-methyl (Actellic 300cs) in southeast Mexico.

Carlos Arisqueta-Chablé, PhD, c.arisqueta@gmail.com, Wilberth Bibiano-Marin, Biologist, Azael Che-Mendoza, Guillermo Chan-Perez, Biologist, Anuar Medina-Barreiro, Biologist, Norma Pavía-Ruz, Doctor, Juan Adolfo Ortiz Rivera, Biologist, Co-Author, Fabian Correa-Morales, PhD, Hugo Delfín-González, PhD, Gabriela Gonzalez-Olvera, PhD

Abstract: Triatoma dimidiata, the main vector of Trypanosoma cruzi throughout south Mexico and Central America, infest domiciles and peridomestic ecotopes of rural communities. This study reports the effect of the residual application of the organophosphate pirimiphos-methyl, in a microencapsulated formulation (Actellic 300cs®) for the control of intradomiciliary and peridomestic T. dimidiata in the rural community of Tekik de Regil in Yucatan, Southeast Mexico. A two-arm entomological randomized trial was carried out between March and October 2022. Timed Manual Collections (TMC) characterized house and peridomicile infestation by T. dimidiata prior (baseline) and monthly after spraying for up 6 months. A total of 122 premises surveyed at baseline (61 positive and 61 negatives to T. dimidiata) were randomly allocated 1:1 to treatment and control groups. Monthly post-spraying entomological surveys (May-Oct) with TMC were carried-out in a random sample of ten houses (5 positive & 5 negative) from each arm. Post-treatment domestic infestations were only detected in the control group (2/60 houses, 3.3%). Cumulative (across all post-spraying surveys) peridomestic infestation was significantly higher in the control arm (31.7%; 19/60) compared to the treatment arm (11.7%; 7/60) ($X2=0.007$, $p< 0.01$). The for a cumulative 6-month estimated efficacy of the intervention (% reduction in treatment versus control arm) was 65% (95% CI: 21%-86%). A single application of Actellic 300cs reduced T. dimidiata infestations by more than 60% for up to 6 months post treatment and is an alternative formulation for the control of triatomines in Mexico.

Adult Control

P 27 Lethal doses of insecticides used in vector control programs against Triatoma dimidiate (Hemiptera: Reduviidae) using impregnated papers.

Guillermo Chan-Perez, Biologist, guillermochanperez@gmail.com, Gabriela Gonzalez-Olvera, PhD, Carlos Arisqueta-Chablé, PhD, Anuar Medina-Barreiro, Biologist, Azael Che-Mendoza, Gonzalo M. Vazquez-Prokopec, PhD., Pablo Manrique-Saide

Abstract: Triatoma dimidiata (T. dimidata) is the main vector of Chagas disease in South Mexico. The use of insecticides has been the most effective strategy for vector control in Latin America and it is necessary to have doses and methods for monitoring susceptibility to insecticides commonly used to

control T. dimidiata populations. We calculated the lethal doses (LD50 and LD99) of three active ingredients (deltamethrin, bendiocarb and pirimiphos-methyl) in nymphs I and V of T. dimidiata population 5 generations isolated and reared under insectary conditions. The LD50 and LD99 were obtained by PROBIT analysis. Lethal doses of deltamethrin, bendiocarb and pirimiphos-methyl against T. dimidita (nynphs I) were as follows: LD50= 2.8, 26.62, 2.75 µg/cm²; LD99= 24.90, 65.23, 4.36 µg/cm² respectively, while for nymphs V: DL50= 41.79, 19.83, 6.00 µg/cm²; LD99= 237.69, 72.23, 16.74 µg/cm². The values of LD50 and LD99 obtained could be considered for monitoring the susceptibility of populations of T. dimidiata to these active ingredients under operational conditions.

Adult Control

P 28 Evaluation of Novaluron 0.2 G against Aedes aegypti in an urban area of Antioquia, Colombia

Guillermo Rua-Uribe, guillermo.rua@udea.edu.co, Marcela Quimbayo, Juan David Amaya

Abstract: Dengue, Zika and chikungunya are serious public health problem in tropical and subtropical countries, including Colombia. There, dengue epidemics are periodic (more than 70 thousand cases in 2022), and Antioquia is one of the departments with the highest number of cases. These arboviral diseases are transmitted to humans by bites of Aedes mosquitoes, mainly Ae. aegypti, and in the absence of a vaccine, health entities focus mainly on vector control using insecticides, including Insect Growth Regulators (IGR). Novaluron, a kind of IGR, has proven to be effective in vector control. In order to determine the optimal application dose of Novaluron 0.2G on the emergence of Ae. aegypti in an urban area endemic for dengue of Antioquia (Carepa, Urabá region) this study was done. Twenty-one dwellings were randomly selected, where three 250-L tanks were located, two corresponded to treatments and one to control, evaluating three concentrations (treatments), randomly selected for each dwelling. The study was carried out for 18 weeks: seven weeks of pre-treatment, one week of product application and ten weeks of post-treatment. For this, the pupae of Ae. aegypti were collected, allowing the emergence of adult mosquito under controlled conditions, in order to estimate the weekly inhibition of the emergence. The results indicated that a reduction in the emergence of Ae. aegypti of close to 100% was achieved with the highest concentration evaluated (0.584 mg/L). For the other concentrations (0.292 and 0.146 mg/L), the percent inhibition of emergence for week two was 79% and 45%, respectively. These results are very useful to support vector control in dengue endemic cities.

Disease/Vector Studies

P 29 Habitat disturbance of Phlebotominae sandfly: Impact on microbiota and Leishmania composition.

Anayansi Valderrama Cumbrera, avalderrama@gorgas.gob.pa, Luisa Collado, Brigitte Henriquez

Abstract: The microbiota found in sand flies, a subfamily known as Phlebotominae, constitutes a complex system situated at the intersection of ecology, parasitology, and immunology. However, it is crucial to consider the impact of anthropogenic disturbance when analyzing how environmental alterations can influence the composition of the biological communities in which these flies interact, potentially affecting their microbiota. To address this issue, we conducted collections of sand flies by placing light traps in both undisturbed and anthropogenically disturbed areas. Subsequently, we sequenced the bacteria and Leishmania present in each species of sand fly with the aim of establishing their microcosms in different environments. Our specific objectives were as follows: 1. Characterize the

bacterial diversity present in these sand flies. 2. Evaluate the presence of Leishmania in sand fly populations. 3. Compare the microcosm structure in different environments. To achieve this, we calculated alpha and beta diversity indices to determine differences based on the collection areas. In total, our study involved the collection and analysis of a total of 549 individuals distributed across 20 species, along with three unidentified specimens. The results revealed the presence of Leishmania in 10% of the specimens analyzed, Wolbachia in 7%, and a significant diversity of bacteria in 54% of cases. In conclusion, our findings underscore the importance of understanding sand fly microbiota in the context of environmental disturbance. The bipartite analysis in this study is useful for comprehending the complexity of interactions between different species in an ecosystem and may have significant applications in biodiversity conservation. This information can be pivotal for ecosystem management, conservation efforts, and addressing potential implications for public health.

Disease/Vector Studies

P 30 First report of Aedes albopictus (Skuse, 1894) in the Córdoba department, northern Colombia

Paula Pareja-Loaiza, paula.pareja@unisimon.edu.co, Maria Claudia Atencia-Pineda, Alfonso Calderón-Rangel, Richard Hoyos-López, Yerson Javier García-Leal, Rafael Bolaños, Ronald Maestre-Serrano

Abstract: Aedes albopictus is a potential vector of arboviruses in the Americas. In Colombia, its presence has been reported in 54 localities in 14 departments of the country; however, in the department of Córdoba there were no reports of the presence of this vector. During collections of immature stages of Aedes aegypti in urban areas of the department of Córdoba from June to November 2022, larvae and pupae of the species Ae. albopictus were found cohabiting with Ae. aegypti in the municipalities of Ayapel, Pueblo Nuevo, Planeta Rica, Montelíbano and Puerto Libertador. The types of breeding sites where entomological material was found were tires, plastic tanks, cement tanks, bottles and abandoned toilets containing rainwater. A total of 389 females and 269 males were obtained from the larvae and pupae collected.

This finding corresponds to the first record of Ae. albopictus in the Caribbean region of northern Colombia.

Disease/Vector Studies

P 31 Spatial stratification of entomological risk for dengue transmission in neighborhoods of Asuncion, Paraguay

Guillermo Rua-Uribe, guillermo.rua@udea.edu.co, Rodrigo Burgos, Natalia Alvarez

Abstract: Dengue is one of the most important vectors borne disease and a serious public health issue in tropical and subtropical regions, and Paraguay is no stranger to this problem. This country experiences periodic dengue epidemics, and Asunción (its capital) is one of the most affected cities. For instance, in 2020 more than 220,000 cases were reported, a country with 7.5 million inhabitants. The disease is caused by Dengue virus and is transmitted to humans by bites of Aedes mosquitoes, mainly Ae. aegypti. This mosquito oviposits in containers inside homes, and this makes it possible to design entomological indicators to calculate the risk of transmission. The availability of entomological information related to the spatial distribution of dengue risk help us build heat maps, which is a very

useful information for the authorities and the stakeholders to design prevention and control strategies. In order to stratify the entomological risk for dengue transmission in the neighborhoods of Asunción, a retrospective observational and analytical study was done. In this study we use the survey of Rapid Aedes Index (LIRA: Levantamiento de Índices Rápidos para Aedes by its acronym in Spanish), from 2014 to 2018, to stratify high- and low-risk neighborhoods, according to p75 and p25 percentiles, respectively. It was observed that 14 high entomological risk neighborhoods, 17 low risk neighborhoods, 33 medium risk neighborhoods and 3 neighborhoods with scores for both groups were identified. According to results, the spatial analysis of LIRA allows stratification of the risk of dengue transmission in Asunción, which provides valuable information for targeting surveillance and control of dengue disease.

Adult Control

P 33 Mapping trends of pyrethroid resistance in Aedes aegypti from Mexico.

Kevin A. Ontiveros-Zapata, kevinontiveroz@gmail.com, Magaly Romero-Villarreal, Alan E. Juache-Villagrana, Selene M. Gutierrez-Rodriguez, M.C., Jesus A. Davila-Barboza, D.Sc, Beatriz Lopez-Monroy, PhD, Iram P. Rodriguez-Sanchez, PhD, Co-Author, Adriana E. Flores, D.Sc

Abstract: Current strategies to suppress arbovirus outbreaks in Mexico include eliminating larval breeding sites and insecticide treatment against larval and adult mosquito populations. The control of Aedes aegypti by insecticides is challenging due to a rapid increase in knockdown resistance (kdr) to pyrethroid insecticides. In this study, we located the focal points for kdr resistance in 45 populations of Ae aegypti from Mexico and with diagnostic dose (DD) bioassays in bottle bioassays with permethrin (10 mg) and deltamethrin (15 mg) in the same populations, a reliable geographical extrapolation was generated on the distribution of resistance to pyrethroid insecticides. Additionally, we evaluated the activity of enzymes associated with resistance, such as α-esterases, ß-esterases, mixed function oxidases (MFO), and glutathione S-transferases (GST). All populations of Ae. aegypti were found to have a high frequency of resistance to permethrin, with hotspots in the states of Veracruz and Tabasco in the southeast and Guerrero and Sinaloa in the Pacific. A high frequency of resistance to deltamethrin was obtained in 40% of the populations, 28% were moderately resistant, and 32% were susceptible, with the greatest focus of resistance in populations from Tabasco in the southeast. The most frequent genotype was VL/VI/CC, followed by the triple resistant LL/II/CC. The foci of greatest resistance to permethrin were significantly associated with the triple resistant genotype (LL/II/CC); however, for deltamethrin, the most frequent genotypes were the triple resistant (LL/II/CC) and double heterozygous for 410 and 1016 and resistant for 1534 (VL/VI/CC). CyP450 oxidases were altered in 72% of the populations and, to a lesser extent, the a-esterases with 41%; b-esterases and GST were altered in only 13% and 23% of the populations, respectively. The spatial identification of pyrethroid resistance foci provides a feasible tool to focus insecticide selection actions based on high-resistance risk areas identified as focal sites in Mexico.

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AMCA AWARDS

HONORARY MEMBERS

1937	Leland O. Howard (USDA)	1970	Robert L. Vannote (NJ)	1998	Eugene J. Gerberg (MD)
1938	C. C. Adams (NY)	1971	Richard W. Fay (USPHS)		Glen C. Collett (UT)
1944	Thomas J. Headlee (NJ)	1972	Christian T. Williamson (NY)	1999	Donald R. Johnson (GA)
	William B. Herms (CA)		Alan R. Stone (MD)	2001	Fred W. Knapp (KY)
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	Robert Matheson (NY)	1983	William R. Horsfall (IL)	2013	Henry Rupp (NJ)
1955	Harold F. Gray (CA)		Anthony W. A. Brown (WHO)	2017	Sammie Dickson
1958	Louis A. Stearns (DE)	1991	Kenneth L. Knight (NC)		
1964	George H. Bradley (USPHS/USDA)	1994	Harold C. Chapman (LA)		
1965	Arthur W. Lindquist (KS)		Lewis T. Nielsen (UT)		
1967	Fred L. Stutz (FL)				

HAROLD FARNSWORTH GRAY MEMORIAL CITATION
MERITORIOUS SERVICE TO MOSQUITO CONTROL AWARD

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

1964 Fred C. Bishopp (DC)

DR. THOMAS J. HEADLEE MEMORIAL AWARD

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

. 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

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	William R. Horsfall (IL)	1986	James R. Caton (CA)	2008	David A. Dame (FL)
1973	Don M. Rees (UT)	1987	Jay E. Graham (UT)	2009	Dan Ariaz (NV)
	Thomas D. Mulhern (CA)	1988	Lewis T. Nielsen (UT)		Gary Breeden (VA)
1974	Anthony W. A. Brown (WHO)	1989	Andrew J. Spielman (MA)	2010	Mir S. Mulla (CA)
	Donald L. Collins (NY)	1990	Glen C. Collett (UT)	2011	Dave Brown (CA)
1975	Daniel M. Jobbins (NJ)	1991	Harold C. Chapman (LA)	2012	Sammie L. Dickson (UT)
	Arthur W. Lindquist (USDA)	1992	D. Bruce Francy (CO)	2013	Wayne Crans (NJ)
1976	Austin W. Morrill, Jr. (CA)	1993	Gilbert L. Challet (CA)	2014	Chester G. Moore (CO)
	Carroll N. Smith (USDA)	1994	Ronald A. Ward (MD)	2015	Jorge Arias
1978	James B. Kitzmiller (FL)	1995	T. Wayne Miller (FL)	2016	Graham White (FL)
	William D. Murray (CA)	1996	Marshall Laird (New	2017	Randy Gaugler (NJ)
1979	Richard F. Peters (CA)	1997	Robert K. Washino (CA)		Allan Inman (CA)
1980	William E. Bickley (MD)	1998	John D. Edman (MA)	2018	Bill Meredith (DE)
	John N. Belkin (CA)	1999	Bruce F. Eldridge (CA)		Roger Nasci (IL)
1981	Stanley J. Carpenter (CA)	2000	Judy A. Hansen (NJ)	2020	Joe Conlon (FL)
	Roland E. Dorer (VA)	2001	Gary G. Clark (USPHS)	2021	Steve Mulligan (CA)
1982	Kenneth L. Knight (NC)	2002	Lucas G. Terracina (LA)	2022	Rui-de Xue (FL)
	William C. Reeves (CA)	2003	Robert J. Novak (IL)	2023	Ken Linthicum (FL)
1983	Harry D. Pratt (GA)	2004	James D. Long (TX)		Janet McAllister (CO)
	John A. Mulrennan, Sr. (FL)	2005	James W. Robinson (FL)	2024	Roxanne Connelly
1984	George T. Carmichael (LA)	2006	John L. Clark Jr. (IL)		Dan Kline

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)	1981	A. Ralph Barr (CA)	2002	Thomas G. Floore (FL)
	Donald L. Collins (NY)		Gilbert L. Challet (CA)		Sherry McLaughlin (TX)
	Theodore G. Raley (CA)		Edgar A. Smith (VA)	2003	Wayne L. Kramer (NE)
1973	Francis P. Creadon (CA)	1982	Hugo A. Jamnback (NY)		John L. Clarke, Jr. (IL)
	Vernon Conant (NJ)		Donald R. Johnson (GA)	2004	Yadira N. Rangel (Venezuela)
	Austin W. Morrill, Jr. (CA)		Harold D. Newsome (MI)		James W. Robinson (FL)
1974	Leslie D. Beadle (USPHS)		James V. Smith (GA)	2005	Major S. Dhillon (CA)
	John H. Brawley (CA)	1983	Richard F. Darsie (CO)		William H. Meredith (DE)
	John W. Kilpatrick (GA)		Ronald A. Ward (DC)	2006	William J. Sames (WA)
	T. Oscar Fultz (GA)	1984	Samuel G. Breeland (FL)	2007	Henry R. Rupp (NJ)
	Howard R. Greenfield (CA)		Donald J. Sutherland (NJ)	2008	Allan Inman (CA)
	Paul J. Hunt (FL)	1985	John C. Kuschke (NJ)		Manuel Lluberas (FL)
	William C. McDuffie (USDA)		James R. Caton (CA)	2009	Joe Conlon (FL)
	Donald R. Johnson (GA)	1986	C. Lamar Meek (LA)	2010	Norbert Becker (Germany)
	Helen Sollers-Riedel (DC)	1987	John C. Combs (CA)	2011	Harry Savage (CO)
1975	Lewis E. Fronk (UT)	1988	Chester G. Moore (CO)		L.A. Williams (SC)
	Joseph G. McWilliams (USN)		Margaret Parsons (OH)	2012	Lal S. Mian (CA)
	Lewis J. Ogden (USPHS)	1989	John S. Billodeaux (LA)		Edsel M. Fussell (FL)
	Rajindar M. Pal (WHO)		Edgar S. Bordes, Jr. (LA)	2013	Kenneth J. Linthicum (FL)
	Kenneth D. Quarterman (USPHS)	1990	Richard D. Morton (WA)	2014	Diann Crane (MN)
	Herbert F. Schoof (USPHS)		Lucas G. Terracina (LA)		Daniel Kline (FL)
1976	Robert A. Armstrong (MA)	1991	David A. Dame (FL)	2015	Mark Latham (FL)
	Osmond P. Breland (TX)	1992	Jerry Mix (TX)	2016	Rui-de Xue (FL)
	George B. Craig, Jr. (IN)	1993	William E. Hazeltine (CA)		William Reisen (CA)
	Claude M. Gjullin (USDA)	1994	Sally A. Wagner (MI)	2017	Michael Turell (MD)
	T. Wayne Miller (FL)	1995	Frederick W. Wagner (KY)	2018	Gary Goodman (CA)
1976	Donald J. Pletsch (Mexico)	1996	Donald J. Sutherland (NJ)	2019	Angela Beehler (WA)
	Glenn M. Stokes (LA)		Ronald A. Ward (MD)	2020	Michael Riles (FL)
	Luis M. Vargas (Mexico)	1997	Roger S. Nasci (CO)	2021	Mustapha Debboun (CA)
1978	Richard C. Axtell (NC)	1997	Thomas J. Zavortink (CA)	2024	Michelle Brown
1979	Marco. E. C. Giglioli (BWI)	1998	James D. Long (TX)		
1980	James D. Gorman (FL)	1999	Hilton B. Munns (CA)		
1980	Donald E. Weidhaas (FL)	2000	Leroy J. Bohn (VA)		
	E. John Beidler (FL)		Dreda McCreary (VA)		
	Eugene J. Gerberg (MD)	2001	Charles T. Palmisano (LA)		

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)	1997	Charles T. Palmisano (LA)	2012	Truc Dever (CA)
	Leslie E. Fronk (UT)		George J. Wichterman (FL)	2013	Robert Peterson (MT)
	Jesse B. Leslie (NJ)	1998	Douglas B. Carlson (FL)	2014	Salvador Rico (TX)
1981	Linda G. Raiche (CA)	1999	Charles Beesley (CA)	2015	Kristy Burkhalter (CO)
	Margaret S. Slater (NY)		Donald R. Johnson (GA)		Elizabeth Cline (CA)
1982	K. G. Nolan (NY)	2000	Peter B. Ghormley (CA)	2016	Angela Beehler (WA)
	Charles F. Scheel (IL)		David A. Brown (CA)		John Biedler
1983	Coyle E. Knowles (NY)	2001	Donald Menard (LA)	2017	Peter Connelly (FL)
1984	Ray Treichler (DC)		Joel Margalit (Israel)		Larry Smith (GA)
1985	Lawrence T. Cowper	2002	Dennis Moore (FL)	2018	Stephen Sickerman (FL)
	Janice B. Wells (NY)		Henry R. Rupp (NJ)		Isik Unlu (NJ)
1986	T. Oscar Fultz (GA)	2003	James R. McNelly (NJ)	2019	Brian Byrd
1987	Sharon A. Colvin (IL)		Robert Bonnett (MN)		Rui-de Xue
1988	Daniel D. Sprenger (TX)	200	James R. Brown (FL)	2020	Levy Sun (CA)
1989	Fred C. Roberts (CA)	2005	Mark Newberg (IL)		Harry Savage (CO)
1990	Leonard E. Munsterman (IN)		Susan Maggy (CA)	2021	Gary Hatch (CA)
1991	James D. Long (TX)	2006	Teung Chin		Kristen Healy (LA)
1992	Charlie D. Morris (FL)	2007	Karl Malamud-Roam (CA)	2022	Catalina Alfonso-Parra (Columbia)
1993	Robert J. Novak (IL)	2008	Wiliam H. Meredeth (DE)		Tianyun Steven Su (CA)
1994	James W. Robinson (FL)	2009	Rep. Dennis Cardoza (CA)	2023	Jennifer Gordon (CO)
	Dan L. Ariaz (NV)	2010	Gordon Patterson (FL)		Ary Faraji (UT)
1995	Sally Kuzenski (LA)		Gary Clark (FL)	2024	Mark Clifton
1996	Carl R. Tanner (IL)		Yasmin Rubio-Palis (Venezuela)		Priscilla Matton
	Sammie L. Dickson (UT)	2011	Angela Beehler (WA)		
			Roxanne Connelly (FL)		

JOHN N. BELKIN AWARD

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

1981	Botha de Meillon (PA)	2003	Richard C. Wilkerson (MD)
1982	Lloyd E. Rozeboom (IL)	2004	Kazua Tanaka (Japan)
1983	Kenneth L. Knight (NC)	2005	Ronald A. Ward (MD)
1984	Thomas J. Zavortink (CA)	2006	William K. Reisen (CA)
1985	Stanley J. Carpenter (CA)	2008	Maria-Anice Sallum (Brazil)
1986	Elizabeth P. Marks & John Reid (Australia)	2010	Daniel Strickman (MD)
1987	James B. Kitzmiller (FL)	2011	Rampa Rattanarithikul, Ph.D. (Thailand)
1988	Allan R Stone (MD)	2012	Maureen Coetzee, Ph. D. (South Africa)
1989	Pedro Galindo (Panama)	2013	John F. Anderson (CT)
1990	Peter F. Mattingly (UK)	2014	Graham White (FL)
1991	Jose P. Duret (Argentina)	2015	Elena B. Vinogradova (Russia)
1992	Bruce A. Harrison (NC)	2016	
1993	Edward L. Peyton (DC)	2017	George F. O'Meara (FL)
1994	Theodore H. G. Aitken (CT)	2018	Dr. L. Philip Lounibos (FL)
1995	Oswaldo P. Forattini (Brazil)	2019	Norbert Becker
1996	A. Ralph Barr (CA)	2020	Jan Conn

	Michael W. Service (UK)	2021	Ken Linthicum
1997	Christine J. Dahl (Sweden)	2022	Chet Moore (CO)
1998	Ralph E. Harbach (UK)	2023	John Edman (SC)
1999	Yiau-Min Huang (DC)		Bruce Eldridge (CA)
2000	Lewis T. Nielsen (UT)	2024	William Bradshaw (CA)
2001	John F. Reinert (FL)		Christina Holzapfel (CA)
2002	Richard F. Darsie (FL)		

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.	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 & La Crosse 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.
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
2003	Kenneth L. Knight	Ralph E. Harbach	Mosquito systematics: From organism to molecules—A tribute to Kenneth L. Knight
2004	Donald J. Pletsch	David A. Dame	Six Decades of International Commitment
2005	William E. Hazeltine	Bruce F. Eldridge	William E. Hazeltine: Rebel with a cause
2006	William C. Reeves	Grant R. Campbell	
2007	Norman G. Gratz	Graham B. White	Remembering Norman Gratz (1925-2005) – Doyen of Vector Control
2008	Andrew Spielman	John D. Edman	
2009	Lamar Meek	Roxanne Connelly	
2010	Harold C. Chapman	Tokuo Fukuda	
2011	H.G. Dyar	Terry Klein	
2012	James D. Long	John Welch	
2013	Thomas Mulhern	Randy Gaugler	
2014	Founding Mothers of Mosquito Control	Gordon Patterson	

2015	Dr. Richard F. Darsie, Jr.	Dr. Jonathan F. Day
2016	Oscar Fultz	Joe Conlon
2017	Jimmy Olson	Bill Sames
2018	Fred Knapp	Steve Presley
2019	William Opp	Gordon Patterson
2020	Lucas Terracina	Scott Willis
2021	Lew Nielsen	Sam Dickson Mark Blackmore
2022	Gary Clark	Dan Kline Kenneth Linthicum
2023	Dan Strickman	Mustapha Debboun
2024	Mir Mulla	Tianyun Steven Su

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)	2012	Stephanie Whitman (WY)
1998	William German (FL)	2013	Larry Erickson (IL)
1999	Gary A. Mount (FL)	2014	Gerry Hutney (FL)
	Daniel F. Boyd (GA)	2015	Joe Strickhouser (NC)
	David W. Waldron (GA)	2016	Terry Couch (FL)
	J. David Waldron (GA)	2017	Clark Wood (IL)
2002	Robert E. Richard (TX)		Malcom Williams (AR)
2003	Allen W. Wooldridge (FL)	2018	Larry Smith (FL)
2004	John L. Clarke, Jr. (IL)	2019	Peter DeChant
2005	Ernest Danka (IL)	2020	Martin Geier
2006	Willie N. Cox (IL)	2021	Bill Reynolds
2007	Bob Bonnett (MN)	2022	Mark Newberg
2009	Clarke Hudson (IL)	2023	John Neberz
	Bill Strange (ID)	2024	Janice Stroud
2010	Peter Connelly (FL)		
2011	David Sullivan (MT)		

GRASSROOTS AWARD

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

2005	Omar S. Akbari	Reno Washoe Country, Nevada
	Christopher Trapp	Multnomah County Vector Control, Oregon
2006	John Phelps	Mercer County, New Jersey
2008	Chris Frame	Cape May County, New Jersey
2009	Jason Craig Hardman	Salt Lake City MAD, Utah
2010	Jessica Fales	Midland County MC, Michigan
	Gary Hillsdale	Metropolitan MCD, Minnesota
	Elizabeth Vice	Buttle County MVCD, California
2011	David Bruget	Kings MAD, California
	Russell Eck	Washoe County Health District, Nevada
	Phillip Henry	Butte County MVCD, California
	Levi Zahn	Williston VCD, North Dakota
2012	Mike Smith	Anastasia MCD, Florida
2013	Arturo Gutierrez	Coachella Valley MVCD, California
2013	Michael Martinez	Coachella Valley MVCD, California
2013	David Lopez	Greater Los Angeles County VCD, California
2013	Martin Serrano	Greater Los Angeles County VCD, California
2014	Dell Boyd	Butte County MVCD, California

	John McCready	Jackson County VCD, Oregon
	Gaby Perezchica-Harvey	Coachella Valley MVCD, California
	Geneva Ginn	Coachella Valley MVCD, California
2015	Kevin Hill	Pasco County MCD, California
	Richard Ortiz	Coachella Valley MVCD, California
	Terry Sanderson	Lake County MVCD, California
	Melissa Snelling	Coachella Valley, MVCD, Californa
2016	Patrick Morgan	Indian River MVCD, Florida
	Janet Nelson	Northwest MVCD, California
	Richard Weaver	Anastasia MVCD, Florida
2017	Hailey Bastian	Shasta MVCD, California
	Gregorio Alvarado	Coachella Valley MVCD, California
	Aaron Lumsden	Butte County MVCD, California
	Danny Ray Hood	Beach MVCD, Floriday
2018	Jessica Dieckmann	County of San Diego VCP, California
	James Wynn	Anastasia MVCD, Florida
	Stefan Sielsch	El Dorado County MVCD, California
	Kyle Yager	Hillsborough County MVCD, Floriday
2019	James Binnall	North Shore MAD, Illinois
	Corey Boyer	Shasta MVCD, California
	David Delgado	Virgin Islands DH
	Aubrey Drummond	Virgin Islands DH
	Gerald Michael Hart	Indian River MCD, Florida
2020	Chad Kirkley	St. Tammany Parish MAD, Louisiana
	Trinidad Haro	Coachella Valley MVCD, California
2021	Reynaldo Morales	Puerto Rico VCU
	Rafael Saavedra-Hernandez	Puerto Rico VCU
	Marc Kensington	Coachella Valley MVCD, California
	Andrew Dewsnup	Salt Lake City MAD, Utah
2022	Bryan Ruiz	Delta MVCD, California
	Charles Rodriguez	Coachella MVCD, California
	Travis Edwards	Lee CMCD, Florida
	Greg Mercado	Greater LA CVCD, California
2023	Gonzalo Valadez	Coachella MVCD
	Cristhian Sánchez Rolón	Puerto Rico VCU
	Noemí Martinez-Tull	Puerto Rico VCU
	Yanet Chiong	Miami Dade County MCD
2024	Marla Garcia Perez	Puerto Rico VCU
	Mathew Garfin	Northwest MVCD (CA)
	Gerald Chuzel	Coachella MVCD

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.
1990	Andrea Brown	Peru State Coll.
1991	John Paul Mutebi	Notre Dame U.
1992	Rosmarie Kelly	U. Massachusetts
1993	Merry L. Holliday-	U. California, Davis
1994	John E. Gimnig	U. California, Davis
	Alice Shaeffer*	U. Mainz, Germany
1995	Glen Scoles	Notre Dame U.
	Jittawadee Rochaeroen*	U. California, Riverside
1996	Esther Chow Schaeffer	U. Maryland
1997	Lynn Cooper	U. Maryland
1998	C. Roxanne Rutledge	Louisiana State U.
	Emmalee Kennedy*	U. Illinois
	Timothy Schaub*	U. Illinois
1999	Laura Harrington	U. Massachusetts
	Adam S. Jones*	U. Massachusetts
2009	Alexandra	University of Florida
	Stephanie Larick*	University of Florida
201	Sarah Wheeler	University of California, Davis
	Kimmy Mains*	University of Kentucky
	Holly Tuten*	Clemson University
2011	Logan Minter	University of Kentucky
	Kristen Meckel-	San Diego County Vector Control
201	Jerome Schleier	Montana State University
	Elizabeth Andrews*	University of Kentucky
	Jennifer Gordon*	University of Kentucky
	Joseph Iberg*	University of Georgia
2013	Brian Johnson	Rutgers University
	Andrea Egizi	Rutgers University
	Brittany Nelms	U. California, Davis - CVEC
2014	James Ricci**	University of California
	Eva Bickner***	University of Florida

STUDENT PAPER COMPETITION AWARDS

	Hillary Reno*	U. Illinois
2000	Jason L. Rasgon	U. California, Davis
	Hope Q. Liu*	Virginia Polytechnic
2001	No competition	
2002	Laura B. Goddard	U. California, Davis
	Sharon L. Minnick*	U. California, Davis
	Margaret Sherriffs*	Yale U.
2003	Sarah Yaremych	U. Illinois
	Laura Goddard*	U. California
	Jason L. Rasgon*	U. California, Davis
2004	Gregory M. Williams	U. Delaware
	Stephen Aspen*	Colorado State U.
	Christian Kaufmann*	U. Zurich
2005	Wesley Rubio	San Diego State U.
	Whitney Qualls*	Auburn University
	Rebecca Trout*	University of Kentucky
2006	Robert D. Anderson	University of
	Linda O'Connor**	University of
	Joshua R. Ogawa*	Oregon State
	Matthew Eaton*	Concordia College
	Linda M. Styer*	U. California, Davis
2007	Jennifer Armistead	University of Florida
	Robert D. Anderson*	University of
	Thomas M. Mascari*	Louisiana State U.
2008	Jerome Schleier	Montana State
	Christopher Barker*	U. California, Davis
	Lisa Reimer*	U. California, Davis
	Allison Gardner***	U of IL Urbana -
2015	Maria Carrasquilla**	University of Florida
	Casey Parker***	University of Florida
2016	Sydney Crawley***	University of Kentucky
	Lin Zhu***	University of Miami
	Cassandra Urquhart**	University of
2017	Adena Why**	University of California
	Evlyn Pless **	University of California
	Edmund Norris***	Iowa State University
201	Annie Rich***	University of Georgia
	Katelyn Haydett***	University of Georgia
	Jay Brown*	University of Georgia
	Christopher Bibbs*	Anastasia Mosquito Control Dist.
	Shiloh Judd**	Louisiana State University
201	Casey Parker*	University of Florida
	Ed Norris**	University of Florida
	Meredith Beaulieu***	North Carolina State University
	Raji Joshua***	Florida International University
	Christopher Bibbs***	Anastasia Mosquito Control District
2021	Timothy McNamara*	Louisiana State University
	Corey Day**	University of Tennessee Knoxville
	Lindsay Baxter***	Cornell University
	Bob Aldridge***	USDA-ARS-CMAVE
	Olayinka David***	Florida International University
2022	Kristina Lopez**	University of Wisconsin - Madison
	Nicole Foley	Cornell University
	Kristin Sloyer***	University of Florida
	Antonio Alvarado***	Cornell University
2023	Olivia Winokur**	UC Davis
	Abdulla Alomar	Florida Medical Entomology Laboratory, University of Florida
	Kai Blore***	Anastasia Mosquito Control District

* $500 cash award presented to winner ** Gerald Hollandsworth Prize *** Honorable mention

AMCA OFFICERS, EXECUTIVE DIRECTORS AND EDITORS

AMCA PRESIDENTS

1935-1939	Thomas J. Headlee*	1972-1973	Glen C. Collett	2003-2004	Fred W. Knapp
1939-1940	Christian T. Williams*	1973-1974	Kenneth L. Knight	2004-2005	Roger S. Nasci
1940-1942	Louis A. Stearns*	1974-1975	Robert M. Altman	2005-2006	William R. Opp
1942-1944	Robert C. Botsford*	1975-1976	Harold C. Chapman	2006-2007	Joseph F. Sanzone
1944-1945	Robert L. Vannote	1976-1977	D. Bruce Francy	2007-2008	Gene R. Payne
1945-1946	Perry W. Ruth	1977-1978	Lewis T. Nielsen	2008-2009	Major S. Dhillon
1946-1947	Harry H. Stage	1978-1979	Paul J. Hunt	2009-2010	Doug Carlson
1947-1949	H. Duke Peters	1979-1980	Glen M. Stokes	2010-2011	Janet McAllister
1949-1950	Harold F. Gray	1980-1981	Robert K. Washino	2011-2012	William H. Meredith
1950-1951	Lester W. Smith	1981-1982	Claude H. Schmidt	2012-2013	Thomas R. Wilmot
1951-1952	Don M. Rees	1982-1983	Richard C. Axtell	2013-2014	Roxanne Connelly
1952-1953	Cecil R. Twinn	1983-1984	Jimmy K. Olson	2014-2015	Steve Mulligan
1953-1954	Fred C. Bishopp	1984-1985	Gilbert L. Challet	2015-2016	Ken Linthicum
1954-1955	Roland E. Dorer	1985-1986	T. Oscar Fultz	2016-2017	Stan Cope
1955-1956	Richard F. Peters	1986-1987	Donald J. Sutherland	2017-2018	T. Wayne Gale
1956-1957	Fred L. Stutz	1987-1988	George B. Craig, Jr.	2018-2019	William Walton
1957-1958	Arthur W. Lindquist	1988-1989	Bruce F. Eldridge	2019-2020	Jason Kinley
1958-1959	John M. Hirst	1989-1990	Judy A. Hansen	2020-2021	Ary Faraji
1959-1960	Archie D. Hess	1990-1991	Robert C. Sjogren	2021-2022	Mark Breidenbaugh
1960-1961	Daniel M. Jobbins	1991-1992	Matthew Yates	2022-2023	Dennis Wallette

1961-1962	William E. Bickley	1992-1993	Cyrus R. Lesser	2023 – 2024	Kristen Healey
1962-1963	Arthur W. Geib	1993-1994	John A. Mulrennan, Jr.		
1963-1964	Don W. Micks	1994-1995	Chester G. Moore		
1964-1965	John A. Mulrennan,	1995-1996	John D. Edman		
1965-1966	Anthony W. A. Brown	1996-1997	Robert J. Novak		
1966-1967	Jay E. Graham	1997-1998	Gary G. Clark		
1967-1968	Harry D. Pratt	1998-1999	Dan L. Ariaz		
1968-1969	Thomas D. Mulhern	1999-2000	William J. Zawicki		
1969-1970	George T. Carmichael	2000-2001	David A. Dame		
1970-1971	Albert W. Buzicky	2001-2002	Sammie L. Dickson		
1971-1972	Andrew J. Rogers	2002-2003	David A. Brown		

* - Eastern Association of Mosquito Control Workers

AMCA TREASURERS

1935-1943	Thomas D. Mulhern *	1994-2000	Charles T. Palmisano
1944-1950	Thomas D. Mulhern	2000-2011	Allan D. Inman
1950-1953	Roland E. Dorer	2011-2023	Gary Hatch
1954-1964	Lester W. Smith	2023 – present	Gary Goodman
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		

* - Eastern Association of Mosquito Control Workers

SECRETARY, EXECUTIVE SECRETARY, EXECUTIVE DIRECTOR

1935-1943	Thomas D. Mulhern*	Secretary	1992-1993	Harold C. Chapman	Executive Director
1944-1950	Thomas D. Mulhern	Secretary	1993-1994	Lucas G. Terracina	Acting Executive Dir.
1950-1952	Thomas D. Mulhern	Executive Secretary	1994-1995	Robert T. Graham	Executive Director
1953-1973	Theodore G. Raley	Executive Secretary	2006-2015	Sarah B. Gazi	Executive Director
1973	Theodore G. Raley	Executive Director	2015-2016	Lori Jensen	Executive Director
1974-1978	Thomas D. Mulhern	Executive Director	2016-2017	Bill Schankel	Executive Director
1979-1980	William D. Murray	Executive Director	2017-2019	Heather Gosciniak	Executive Director
1980-1985	Thomas D. Mulhern	Executive Director	2019-2020	David Butler	Executive Director
1985-1986	James R Caton	Interim Executive	2020 -present	Megan MacNee	Executive Director
1986-1991	Harold C. Chapman	Executive Director			
1991	Lucas G. Terracina	Acting Executive Dir.			
1992	Mark Vinsand	Executive Director			

* - Eastern Association of Mosquito Control Workers

BUSINESS MANAGER

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

TECHNICAL ADVISOR

2000-2020	Joseph M. Conlon
2020-2022	David Brown
2022 - present	Dan Markowski

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