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2019 AMCA PRESIDENTIAL ADDRESS: THE TIMES THEY ARE A-CHANGIN'

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INTRODUCTORY REMARKS

Good morning. I welcome everyone to the 85th annual meeting of the American Mosquito Control Association in beautiful Orlando. This is likely to be among the largest, if not the largest, meeting of the AMCA, with around 1,200 attendees.

I want to thank Ary Faraji, vice president of the AMCA and Program Committee chair, for organizing what should be an exciting and educational meeting for all participants. Special recognition goes to the Local Arrangements Committee, chaired by Rudy Xue and Aaron Lloyd, and the many volunteers from the Florida Mosquito Control Association and other regional organizations, who are assisting by staffing booths and helping attendees in a number of ways.

Thanks go to Chris Lesser for organizing Field Day; Brian Byrd for organizing the Student Competition; Jennifer Henke for organizing the poster session; Lee Cohnstaedt and Catalina Alfonso-Parra for organizing the Latin American Symposia; and Kristy Burkhalter and Edmund Norris for coordinating the activities of AMCA's Young Professionals (YP). A special thanks to Heather Gosciniak, Brittany Noll, Jeana Hoffman, and Arlene George at Association Headquarters for their assistance with all aspects of the scientific program and the meeting's activities.

I want to thank the sponsors for their very generous support. Please take time to visit the booths displaying the products and services offered by the vendors and thank our sponsors and exhibitors for their support of the AMCA.

YEAR IN REVIEW

I begin by expressing my gratitude to the AMCA membership for giving me the opportunity to serve as its president. It has been a rewarding and challenging experience. You will be hard pressed to find more dedicated members than the people who serve on AMCA's Board of Directors, who serve as committee chairs, subcommittee chairs, and who volunteer their time as members of the 14 AMCA committees. I would be remiss not to include our technical advisor in this group. These people are dedicated to making the AMCA a better organization and to serve your needs and those of the public that you protect from vector-borne diseases and improve quality of life.

I have had the opportunity to visit with state and regional organizations, perhaps not as many as I had hoped, but I thank you for your warm hospitality and

the dedication and professionalism with which you carry out your work in mosquito and vector control.

This past year, we have had many accomplishments, had a few disappointments, but strove to keep the AMCA at the forefront as *the* organization providing leadership, information, and education on issues related to mosquito control. I reflect on these matters and some of the exciting developments in mosquito control. The times, they are a-changin'!

At the national level, the AMCA provides leadership by delivering information and testimony having impacts on policy decisions. Some of the current issues include the Clean Water Act/National Pollutant Discharge Elimination System (NPDES) permit issue on the Farm Bill, Federal Funding for West Nile virus control through the Strengthening Mosquito Abatement for Safety and Health (SMASH H.R.1310/S.849) Act, Endangered Species Act considerations commenting on biological opinions (BiOps) issued by federal agencies, and review and comments on the US Fish & Wildlife Service's National Mosquito Management Policy on National Wildlife Refuges.

Unfortunately, the riders that eliminated duplicative regulations posed by the requirement that mosquito control practitioners file NPDES permits for the application of public health pesticides registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) were not maintained as part of the Farm Bill. Despite bipartisan support for the elimination of NPDES permits for vector control, whether the change in the political composition of the legislature that resulted from the recent midterm

elections or that riders related to the application of public health pesticides were not a good fit for a bill focusing on agriculture and might have been used as a bargaining chip for other agriculturally related measures in the bill, riders related to the application of public health pesticides were dropped from the final version of the Farm Bill.

With 1,500 members, the AMCA is a small fish in the federal lobbying pool. It is not uncommon for agricultural associations and commodity groups to have tens of thousands of members. A group that opposed riders related to the application of public health pesticides may have upwards of a million sponsors. This is why the messages of Public Information Officers and outreach coordinators are so important to let the members of Congress and the general public know what we do, why we do what we do, and how it benefits them. When Angela Beehler, Chairwoman of the Legislative and Regulatory (L&R) Committee, asks for your assistance to contact your members of Congress, please help with the efforts to get our messages across. The elimination of a requirement for filing NPDES permits for vector control operations has been reintroduced by Representative Gibbs (D, Ohio) and may find a more appropriate home in a public works bill. We have been knocked down, but not knocked out. You can hear more about this topic in a presentation by Gary Goodman in the L&R symposium.

The SMASH Act was approved in late 2018, but approval does not mean appropriation. If funded, a large part of this funding is dedicated for local vector control operations. The AMCA is reaching out to other groups that are involved with this bill, specifically the Association of State and Territorial Health Officers (ASTHO), the National Environmental Health Association (NEHA), the Association of Public Health Laboratories (APHL), and the Council of State and Territorial Epidemiologists (CSTE), to coordinate our messages to move toward funding. Depending on the version of the bill, funding is likely to be in the range of $40M–$180M/year for 5 years and should supplement existing Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases (ELC) funding. Appropriations requests will need to be filled out before the end March 2019, so time is short.

The AMCA continued to respond to biological opinions (BiOps) covering the ongoing registration of pesticides containing malathion, chlorpyrifos, and diazinon recently issued by the National Marine Fisheries Service (NMFS). The US Fish and Wildlife Service (USFWS) is unlikely to issue its BiOps in the foreseeable future because of ongoing litigation. Distinct biological evaluations (BE) were published by the US Environmental Protection Agency (EPA) at the end of 2016 for each of the 3 organophosphate (OP) compounds. The EPA concluded that the continuing registration of the active ingredients was "Likely to Adversely Affect" (LAA) some 97% of the listed species. NMFS concluded that the OPs posed "jeopardy" to about half of the evaluated species. The AMCA contends that the Reasonable and Prudent Alternatives (RPAs), Reasonable and Prudent Measures (RPMs), and Biological Evaluations (BEs) are overly stringent and are not based on real-world application, deposition, and degradation rates of public health pesticides. Karl Malamud-Roam is the chair of the Chemical Control Subcommittee (within the L&R Committee) and is spearheading AMCA's efforts on this front.

The AMCA commented on the US Fish & Wildlife Service's National Mosquito Management Policy on National Wildlife Refuges that was finally released in September 2018. The USFWS solicited comments from Bill Meredith and a group of AMCA members in 2017. While the AMCA is appreciative of the cordial and frank dialog with the USFWS about the document, we still have some reservations about the version of the document released recently.

One concern relates to the production of pestiferous mosquitoes from refuges. The document focuses on the control of mosquitoes that vector pathogens. Mosquito control is not just stemming vector-borne diseases, it is about improving quality of life … the other public health. At times during the year without mosquito control, natural wetlands like those found on refuges can produce significant numbers of mosquitoes. The following quotes illustrate the consequences of such production.

> the musquetoes were so excessively troublesome this evening that we were obliged to kindle large fires for our horses these insects tortured them in such manner untill they placed themselves in the smoke of the fires that I realy thought they would become frantic. (Meriwether Lewis, Thursday, July 3, 1806, near the Clark Fork River in western Montana)[1]

> a butifull Breeze from the N W. this evening which would have been verry agreeable, had the Misquiters been tolerably Pacifick, but thy were rageing all night, Some about the Sise of house flais [flies] … found the Misquitors So thik & troublesom that it was disagreeable and painfull to Continue … (William Clark, Friday, July 27, 1804, near the Platte River in Nebraska)[1]

While these guys clearly did not win many spelling bees, these and other entries in their diaries as they explored the land included in the Louisiana Purchase illustrate the potential of natural wetlands

[1] University of Nebraska Press/University of Nebraska-Lincoln Libraries-Electronic Text Center, *The Journals of the Lewis and Clark Expedition*, http://lewisandclarkjournals.unl.edu.

to produce large populations of pestiferous mosquitoes.

Here are a couple quotes from Gordon Patterson's book *The Mosquito Crusades*. This is a delightful book, and I recommend it to you if you are interested in the history of mosquito control in the United States and the history of the AMCA.

> By the fall of 1902 Smith recognized his error. He announced that he had conclusive evidence that the white-banded salt marsh mosquito had a flight range of forty or more miles. The common belief that mosquitoes do not fly far was dead wrong. Two-thirds of New Jersey fell within the flight range of salt marsh mosquitoes. (Patterson 2009, 25)

You could substitute the Delmarva Peninsula, Delaware, eastern Maryland, and the coastal region of any state from Virginia to Florida for New Jersey.

The Mosquito and Vector Control Association of California (MVCAC) held its annual meeting in Burlingame several weeks ago. Here is quote from someone who visited Burlingame in the early 1900s.

> In walking along the roads in the vicinity of the hills, mosquitoes would gather so abundantly on one's clothes that sometimes the color of the suit was obscured beneath the general affect [*sic*] of the light brown produced by the mosquitoes, an observer declared. (Patterson 2009, 37)

The following are the 4 issues raised by the AMCA about the USFW Handbook. First, the Handbook does not appear to recognize the need to control refuge-produced mosquitoes when their sheer numbers can adversely affect human or animal populations. Control measures could be implemented under a public health emergency or when pathogens are detected in mosquito vectors. This has the potential to change mosquito control from being proactive to reactive, which is not a good thing. Second, the Handbook is equivocal about the use of adulticides on a refuge. Were I a new refuge manager possessing no familiarity with integrated mosquito management, I might not allow the application of adulticides. Third, the Handbook indicates that local Mosquito Control Districts that participate in a spray program on refuge may be required to conduct or support postspraying studies. Such studies are costly and labor intensive. In my opinion, they are not justified for the routine application of products that have been approved by the EPA under FIFRA. Last, the Handbook appears to create a "hierarchy" among larviciding products. This hierarchy might not be amenable to vector control operations depending on the mosquito species and habitat, the relative cost of the control agents, and resistance management strategies being employed. Bill Meredith will discuss these issues in greater detail in a presentation in the L&R symposium.

If you are concerned about these and other issues, and would like to discuss them with your federal representatives, Washington Day will be held May 14–15. To accommodate Mother's Day, the schedule is changed to Tuesday–Wednesday for preparation and meetings on the Hill. Travel stipends are again being graciously provided by Central Life Sciences.

During the past year, the AMCA continued to strengthen linkages with other public health organizations. Some examples include our Technical Advisor, Joe Conlon, working with the National Environmental Health Association (NEHA); Truc Dever working with National Association of County and City Health Officials (NACCHO); Stan Cope working with the National Pest Management Association (NPMA) … talk about leadership (Cope 2017)! The AMCA signed a Memorandum of Understanding with the Entomological Society of America to develop a joint certification program in public health entomology (Associate Certified Entomologist–Public Health [ACE-PH]). Ary Faraji, Michelle Brown, and Mustapha Debboun led our efforts at the Kansas City meeting last year. A panel of experts from the AMCA has been assembled and is working on the certification program. The projected rollout for the ACE-PH is autumn 2019.

The AMCA completed very successful training and certificate programs for mosquito surveillance and control funded by the Centers for Disease Control and Prevention (CDC). Four of the milestones included (1) revising the existing *Best Management Practices for Integrated Mosquito Management* (AMCA 2009, 2017) and translating into Spanish; (2) developing and delivering 14 Train-the-Trainer workshops at 10 training hubs that resulted in more than 400 certifications in 31 states; (3) developing and delivering comprehensive web-based training materials and certification including 4 e-Learning modules with more than 1,000 engagements in 43 states and territories, and in 9 countries—Puerto Rico had the greatest number of user engagements; (4) translating the program into additional training sessions with other public health organizations (e.g., NACCHO, NPMA).

This past year, funding for the AMCA Research Foundation increased 3-fold. While the total amount of funding for the program remains small, we hope to grow the program. We thank these organizations, companies, and individuals that provided funding last year. During this year's funding cycle**,** 22 grant preproposals were received requesting $913,166. Ten full proposals were submitted requesting $396,152. The 2 projects that were funded are "Rapid Identification and Characterization Techniques for Mosquitoes of Public Health Importance," Brian Byrd, PhD, of Western Carolina University, and "Automated Real-Time Collection and High-Fidelity Identification of Vectors," Nathan Burkett-Cadena, PhD, of the University of Florida. Thanks go to the

Fig. 1. A mosquito control conference circa 1905 (left; ©AMCA) and the Young Professionals and advisors at the 2016 AMCA annual meeting in Savannah, GA (right; Photo credit: Peter Connelly).

Science and Technology Committee and to Craig Stoops for coordinating the review of the proposals.

We revitalized AMCA's social media efforts. Levy Sun of the San Gabriel Valley Mosquito and Vector Control District, and a former YP, is our Social Media Coordinator and has been doing an outstanding job. Besides tweeting and being a super hero, Levy meets with important people (Ronald McDonald) as shown here. The AMCA's Facebook handle is "AmericanMosquitoControl"; our Twitter handle is @AMCATweets, and the hashtag for this meeting is #AMCA2019.

Is this really AMCA's image (Fig. 1, left panel)? Doug Carlson (2010) in his 2010 presidential address said the following:

> . . . one of our astute members summarized it [a survey by the AMCA] by observing that the AMCA is "largely a group of aging, white, well-educated males . . . who like to kill things." Let's try and make certain that in the year 2020, as we celebrate our 85th anniversary, that a similar survey will show that the AMCA is "a large and growing group of young, ethnically diverse, well-educated women and men who like to punish the pests . . . while nurturing the nontargets."

Well folks, this is the 85th annual meeting. This picture of the YPs at our annual meeting in Savannah (Fig. 1, right panel) represents the AMCA that I know and love, with a diverse membership. The AMCA is committed to training and advancing the professional careers of the next generation of mosquito practitioners regardless of what aspect of modern mosquito control they enter, be it vector control technician, public health officer, military medical entomologist, industry representative, or academician. Nearly 500 individuals have participated in the YP program since its inception in 2010, and about 100 of the YPs are now members of the AMCA. There are 13 YPs participating the Industry Shadowing Program (ISP) this year. I thank the companies listed here for providing travel stipends to individuals in the ISP.

Another change that we made this year was to make the annual meeting more friendly for members attending with families. We have taken the suggestions of members to heart. Heather Gosciniak has worked with the venue and exhibitors to bring the suggestions to fruition. I look forward to more changes to promote diversity in the future.

THE CHANGING TIMES

What will mosquito control look like 10 years from now? I wrap up my address using invasive *Aedes* mosquitoes in California as an allegory to answer this question.

Three mosquitoes with container-dwelling larvae recently invaded California. The Asian tiger mosquito, *Aedes albopictus*, invaded in 2011. The Australian backyard mosquito, *Ae. notoscriptus,* was first detected in southern California in 2013. The yellow fever mosquito, *Ae. aegypti*, was found in the Central Valley of California in 2013 and in southern California in 2014. They were probably transported to California through commerce via shipping containers, used tires, and/or via desiccation-resistant eggs on plants. They are spreading across the landscape (Linthicum 2016) presumably via transportation in vehicles and the translocation of plants/nursery stock. At the recent MVCAC meeting, Marco Metzger of the California Department of Public Health presented data showing that *Ae. notoscriptus* has spread to 32 cities and provided circumstantial evidence that its movement from Los Angeles to San Diego was probably facilitated by the movement of tank bromeliads. *Aedes albopictus* was detected in 2001, and the current infestation might have persisted from that initial invasion. How could we miss these mosquitoes (Fig. 2)? How can we control them? Can we eliminate them and, if so, how much would it cost?

Let's take a look at some successful mosquito eradication programs. A successful mosquito erad-

Fig. 2. A display for National Mosquito Control Awareness Week in Chicago, IL (©Central Life Sciences). How could we miss these invading mosquitoes?

ication program that is often cited is the elimination of the African malaria vector, *Anopheles gambiae*, from northeastern Brazil. Fred Soper from the Rockefeller Foundation (Fig. 3a), in conjunction with the Brazilian government, carried out a military-style campaign that focused on larval mosquito control, but also included fumigation of vehicles, trains, cars, and structures as well as prophylaxis with anti-malarial drugs (Soper 1966). In some villages of Ceará in 1938, 100% of the population was infected with the malaria parasite (Soper 1966). This was a 10-year campaign that had the most intense efforts carried out during 2 years: 1939–1940. It cost somewhere between $905,000 and $1,080,000 in 1940 dollars[2] (Killeen et al. 2002, Griffing et al. 2015), which would be about $16.3 to

[2] The Brazilian government supplied $250,000 in 1938 and $500,000 in 1939. The Rockefeller Foundation provided $100,000 in 1939 and $230,000 in 1940. $175,000 in supplies were returned to Brazil in 1940. Expenditures prior to 1938 were not mentioned by Killeen et al. and Griffing et al. and not included in the calculation.

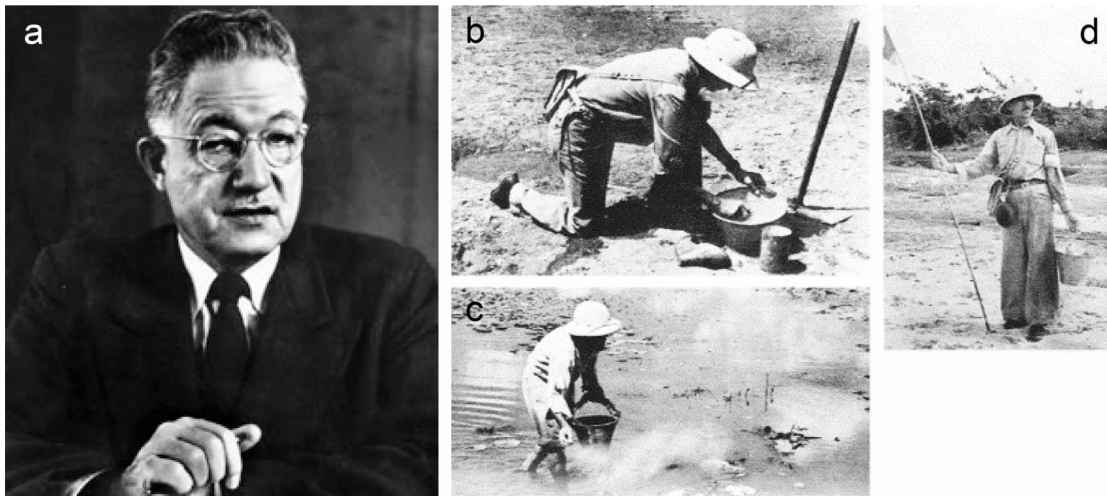

Fig. 3. Fred Soper, DrPH, MPH (a; ©Johns Hopkins Bloomberg School of Public Health). The equipment and daily activities of a typical larval inspector during the campaign that eradicated *An. gambiae* from 54,000 km^2 in northeast Brazil between 1939 and 1940. (b, c, d; ©Elsevier Ltd.: Killeen et al. [2002] reproduced from Soper FL, Wilson DB. 1943. *Anopheles gambiae* in Brazil: 1930 to 1940. New York: Rockefeller Foundation).

19.5 million in 2019. The program was successfully transitioned to Egypt during World War II to eliminate *An. gambiae* from near the Nile River in 3 years' time (Soper 1966).

Larval inspectors were assigned particular zones and set out on foot. The typical equipment used by larval inspectors is shown in Fig. 3b. The larval mosquito control agent was mixed on site with dust, sand, or dirt and then spread by hand across the sunlit pools inhabited by *An. gambiae* larvae (Fig. 3c). Blowers (dust guns) were not used because they were heavy. The fuel for the blower also was heavy, and the blowers were clogged readily by the sand or soil incorporated into the larvicidal mixture. A larval inspector with the appropriate personal protective equipment of the day… also known as skin … is shown (Fig. 3c). Each larval inspector carried 2 flags (Fig. 3d). One marked the place where the inspector left the road. I am not altogether clear on the use of the second flag. Besides indicating the current location of the inspector, it was probably used to mark where the body could be found. There were approximately 600 poisonings and 3 deaths of larval inspectors (Killeen et al. 2002). For those of you unfamiliar with Paris Green, it is copper acetoarsenite … a double whammy of a mixture of a heavy metal and arsenic. We no longer use this active ingredient for mosquito control. While Soper and his gang successfully eliminated *An. gambiae* (*An. arabiensis*?, Killeen et al. 2002) from northeastern Brazil, they did not eliminate the malaria parasite.

A second more recent mosquito eradication program that used a much more environmentally friendly larval mosquito control agent, the insect growth regulator S-methoprene, eliminated the Australian southern saltmarsh mosquito, *Ae. camptorhynchus*, from the North and South islands of New Zealand (Kay and Russell 2013). *Aedes camptorhynchus* is both a significant pest and a vector of Ross River and Barmah Forest viruses in Australia. This was a 12-year program (1998–2010) costing NZ$70 million (~$49 million US dollars in 2019). The treatment regime at the 11 primary introduction sites required a long-term commitment of 3 to 6 years; most sites required 3–4 years of treatment. The eradication metric was the absence of any life cycle stage during active surveillance following at least 3 inundation events over 2 years. Follow up surveillance for delayed egg hatching or reintroduction was carried out: *Ae. camptoryhnchus* was not found.

Would eradication be possible for *Aedes* introduced into California? *Aedes aegypti* was eliminated from a large portion of its geographic distribution in Central and South America through the use of dichlorodiphenyltrichloroethane (DDT) and other insecticides in the 20 or so years following World War II (Soper 1963, Hotez 2016). The development of resistance to insecticides in the mosquito populations and lack of political will and funding to continue eradication programs resulted in *Ae. aegypti*, along with diseases that result from the pathogens transmitted by the vector, reestablishing (Soper 1963). A regimented campaign of inspections, source reduction, and code enforcement was effective at eliminating *Ae. aegypti* from Brisbane following World War II (Trewin et al. 2017).

Current attitudes within the general public render such approaches untenable in modern day California. The 3 invasive *Aedes* species are found in densely populated urban/suburban habitats in California (Fig. 4) and, in the absence of a public health emergency, proactive control of these mosquitoes is challenging. The larvae of container-associated *Aedes* are not found in distinct sunlit pools and saltmarshes. The widespread use of insecticides via traditional application methods is unlikely to be accepted by the general public; although, peri-focal application of residual insecticides might offer a viable alternative approach (Reiter 2016). Source reduction of larval mosquito developmental sites is labor intensive and costly. The cryptic nature of larval mosquito developmental sites complicates such efforts (Fig. 4). Moreover, and I say this with my tongue firmly planted in my cheek, a paper inspection notice does not cover bullets in the rock-paper-scissors of backyard inspections. Some residents will not allow their yards to be inspected; larval mosquito developmental sites in a single backyard (Fig. 4) could defeat efforts to eliminate container-using *Aedes* from a neighborhood. Regimented campaigns that focus on *Aedes* eradication would exceed the budgets of vector control organizations and would presumably have low acceptance among the populace. "Eradication is neither easy nor cheap" (Soper 1963).

The latest methods for vector control take advantage of the biology and ecology of mosquito vectors, and through the genetic manipulation of mosquito populations and understanding mosquito behavior, use the mosquitoes to control their populations. Such techniques would seem applicable in urban and suburban habitats where access to mosquito developmental sites is inadequate. Clustered regularly interspaced short palindromic repeats (CRISPR)-Cas9, a technique for precise gene editing, was discovered in 2012. It has great potential applications in many areas of biology, such as the development of totipotent stem cells to create organs that will not be rejected following transplantation. CRISPR technology has broad potential applications in agriculture and, not surprisingly, for vector control. This week a gene drive system developed using CRISPR technology is undergoing evaluation for eliminating mosquito populations in high-security cages in Italy. While there are technical and ethical issues that need to be resolved, gene drives might be an addition to the vector control toolbox in the near future. Other techniques that might be incorporated into vector control include Oxitec's release of insects with dominant lethal genes (RIDL) technology, sterile insect releases using irradiation and other approaches, autodissemination of control agents, and

Fig. 4. A satellite image of eastern Los Angeles County (Google) and examples of *Aedes* developmental sites (upper right, water-holding plant; lower right, a backyard containing various types of water-holding containers. Photo credit: Greater Los Angeles County Vector Control District).

the release of *Wolbachia*-infected mosquitoes … birth control for mosquitoes.

The results from the release of *Wolbachia*-infected mosquitoes are quite promising. The results and technological advances made through an ongoing collaboration (Debug Fresno) among the Consolidated Mosquito Abatement District (MAD), Verily, and MosquitoMate in Fresno were recently summarized by Jacob Crawford of Verily in a presentation to the MVCAC. Releases of about 78,400 *Wolbachia*-

Table 1. Number of arboviruses isolated by year and virus type by Moore et al. (1975). Reproduced from Moore's table III.

Virus	1964	1965	1966	1967	1968	1969	1970	Total
Group A								
Chikungunya	1					54	1	56
Igbo-Ora			2			1		3
Group B								
Dengue 1				1	18	7	1	27
Dengue 2	1		10		3	10	6	30
Yellow fever						14	2	16
Zika					3			3
Bunyamwera						3	1	4
Bwamba								
Bwamba	6					2		8
Ganjam								
Dugbe		1	1	1		1		4
Simbu								
Shuni			1					1
Ug MP 359								
IbH 11306			1		1			2
IbH 13019			1				1	2
Ungrouped								
Lebombo					1			1
Tataguine			3		5	1		9
Thogoto			2					2
?								
Unidentified						1	2	3
Total	8	1	21	2	31	94	14	171

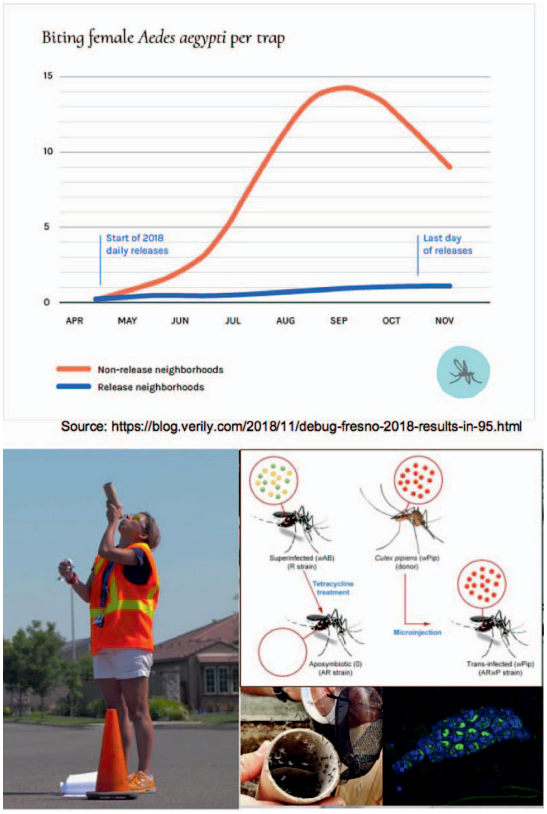

Fig. 5. Adult *Ae. aegypti* collected in neighborhoods without or with releases of *Wolbachia*-infected male mosquitoes near Fresno, CA during 2018 (Source: Verily https://blog.verily.com/2018/11/debug-fresno-2018-results-in-95.html). Releasing *Wolbachia*-infected male mosquitoes on the streets of Clovis, CA (lower left (NYTimes.com) and bottom middle). *Wolbachia*-infection strategy (middle right: www.enea.it); *Wolbachia* (green) in a mosquito ovary sterilizes mosquito vectors (bottom right: eliminatedengue.com).

infected male mosquitoes per day resulted in a 95% reduction of *Ae. aegypti* in trap counts from 3 neighborhoods where releases occurred in 2018 as compared with 3 control neighborhoods (Fig. 5). The study included 3,063 households across 724 acres. One of the impressive technological advances of the project is an error rate of 1.13 females per billion mosquitoes in the sex-sorting protocol. This is impressive! This picture shows Jodi Holeman, Scientific Services Director of Consolidated MAD, releasing mosquitoes from a shipping tube in 2017 (Fig. 5). Since Verily joined the project, the *Wolbachia*-infected mosquitoes are released from a van. While this approach appears to be effective on a local geographic scale, the extent that this approach will be incorporated into practical vector control operations will depend in part on the relative cost and the potential for application on a large geographic scale. We will hear more about the use of cytoplasmic incompatibility (Fig. 5) for mosquito control and vector-borne disease reduction in northeastern Australia and Southeast Asia in an upcoming plenary talk by Peter Ryan.

CONCLUDING REMARKS

I conclude my address by reiterating salient points made by Ronald Rosenberg of the CDC in a recent plenary address. I use Zika virus as an example.

This table (Table 1) shows the virus isolations from febrile children in Nigeria in the late 1960s (Moore et al. 1975). Note the occurrence of several nasty arboviruses: chikungunya virus, two dengue serotypes, and yellow fever virus. Note also the long list of viruses that you probably have never heard of . . . yet! Regarding Zika virus, it was thought to be a very minor concern. During the 7-year study, there were 3 isolations of Zika virus from febrile children, and none of these children was admitted to hospital. Moore et al. (1975) concluded that Zika virus, the cause of mild febrile illness in Uganda and Senegal, is now found in Nigeria. Before the Zika virus outbreak in Yap during 2007, there were probably only a handful of hospitalizations (~5) that resulted from Zika virus infection. Something about the virus changed abruptly; the consequences of which we are all aware.

Where will the next inimical vector-borne pathogen emerge? Will it arise from a small patch of tropical forest such as the Zika Forest in Uganda or in South America? Will it emerge from Asia or Europe (Pandit et al. 2018)? Will it emerge from a wetland in New Jersey? A marsh in Florida? A swamp in Louisiana? A wetland in the Central Midwest? A marsh surrounding the Great Salt Lake? A wetland in California? We do not know!

What we do know is that we are unlikely to have a vaccine on hand to quell the rapid spread of the pathogen. Monitoring the presence of arboviruses in enzootic reservoirs is unlikely to give us sufficient early warning of an impending outbreak in humans. The focus on the control of a pathogen's mosquito vector needs to be rapid and effective, often across a large geographic area. As Dr. Rosenberg pointed out, it is vector control that provides the most effective response to mosquito-borne disease.

This is what you do. This is what we do. This is what the AMCA does through its members. I am proud to call this group of dedicated professionals "colleagues." I thank you again for the opportunity to serve as your president.

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