One Health Newsletter

Volume 9, Issue 2

This newsletter is dedicated to enhancing the integration of animal, human, and environmental health for the benefit of all by demonstrating One Health in practice.

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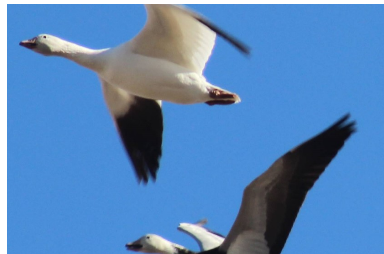

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The One Health Newsletter is a collaborative effort by a diverse group of scientists and health professionals committed to promoting One Health.

South East Asia One Health University Network program: Empowering a regional network of social and intellectual excellence in One Health

Apiradee Treerutkuarkul

The South East Asia One Health University Network (SEAOHUN) was established with support from the U.S. Agency for International Development (USAID) in 2011 as an independent non-profit organization, and registered as a foundation under Thai law. When it began, the network was comprised of only 10 founding universities from four countries: Indonesia, Malaysia, Thailand, and Vietnam. Together these universities collaborated to build One Health capacity and academic partnerships with governments and other national and regional stakeholders. Through their efforts, satellite national networks have been established in the four countries and SEAOHUN has expanded dramatically, now with 61 universities and 104 faculties. Such a significant increase in the number of universities and faculties reflects the importance of One Health and emphasizes the efforts required from multiple sectors, including education, to work together to reduce the impacts of infectious and zoonotic diseases.

As members of the global community, countries in South East Asia are dedicated to combating and preventing disease outbreaks from pathogens such as avian influenza virus, Ebola virus, SARS virus, and Zika virus. Not only do these emerging infectious diseases result in illness and the loss of lives, but they also have tremendous social and economic impacts on communities and livelihoods. Undeniably, there are gaps in national and regional capabilities to deal with unprecedented health incidents, particularly the lack of a well-trained workforce at all levels, be it government, academia, or the private sector. High standards of training in each of these areas are necessary to systematically prevent, detect, and respond to emerging pandemic threats.

SEAOHUN Logo. Credit SEAOHUN.

Photo credit: Richard Nyberg/USAID

Along these lines, SEAOHUN, with support from USAID's One Health Workforce project, the University of Minnesota, and Tufts University, aims to enhance learning experiences and professional development among students, academics and related professionals. SEAOHUN encourages and facilitates collaborative activities and projects among network members, with an emphasis on transdisciplinary and transboundary partnerships.

Following the One Health concept, SEAOHUN works closely with the four country networks to support fellowship and scholarship programs, student and staff exchanges, development of innovative curricula and teaching methodologies, and en-

hanced research capacity. SEAOHUN also organizes train-the-trainer activities on global health initiatives and regional intergovernmental engagement programs. These activities are intended to strengthen One Health capacity in our members' countries and to support innovative projects that provide an evidence-based One Health advocacy with government and other collaborating agencies.

SEAOHUN Strategic Objectives.
Provided by SEAOHUN.

We hope that by 2020, SEAOHUN will have helped to develop and institutionalize One Health policies and practices in the region. Countries facing emerging pandemic threats in South East Asia will thus be equipped with the appropriate tools and an effective workforce to strengthen One Health across all sectors. Young graduates of SEAOHUN's One Health programs will be able to put their knowledge into practice and to implement the One Health concept in their new careers. Collaboration among network members will continue to strengthen global expertise in the One Health approach, and our aim is for One Health to be accepted widely, making local communities and policymakers more resilient to emerging public health challenges.

Apiradee Treerutkuarkul is a communications specialist at SEAOHUN. SEAOHUN Foundation is based in Chiang Mai, Thailand. Visit @SEAOHUN on Facebook and @seaohun_sec on Twitter.

One Health professional profile: Wildlife veterinarian for the U.S. Fish and Wildlife Service's National Wildlife Refuge System

Samantha Gibbs, DVM, PhD

If you go and explore your nearest National Wildlife Refuge, it won't take you long to recognize that even here, on this land set aside for conservation, wildlife health is still tightly linked to that of humans and domestic animals. In fact, your visit is made possible by the guiding principles of the Refuge system that include not only fish and wildlife conservation and restoration, but also opportunities for the public to take part in wildlife-dependent recreation and education. As you look around, in addition to seeing other people, you might also observe domestic animals on the refuge such as feral pigs, cattle being used as a tool to manage grasslands, or working dogs accompanying hunters. So as you can

Photo

Snow geese at the Rainwater Basin Wetland Management District. *Photo credit: Samantha Gibbs.*

see, the intersection of humans, domestic animals, and wildlife occurs here on Refuges too. As a result, in my position as a wildlife veterinarian for the National Wildlife Refuge System, I practice One Health every day. Let me give you a few current examples… We see many visitors at our 565 Refuge units, and their numbers are growing. In addition, there are around 3,000 people employed by the National Wildlife Refuge System. Maintaining a strong workforce and healthy visitors is essential to the success of our conservation efforts. So when imported Zika virus cases began appearing in North America we needed to consider not only the health implications for visitors and our staff, but also think about the potential impacts that the associated mosquito control activities could have on Refuge ecology. This has led to ongoing conversations with municipal governments, public health departments, and mosquito control experts to determine how best to balance vector control efforts for human safety with wildlife health in and around Refuges.

Refuges must be good neighbors to the agricultural sector and at the same time maintain the integrity of the land and ecosystems under our care. When cattle fever ticks were detected on animals at one of our Refuges on the U.S.-Mexico border, it demonstrated just how challenging this can be. Standard tick control practices for domestic livestock aren't consistent with the principles guiding Refuge management and wildlife health, but effective control strategies that do fit within these bounds have not yet been identified. So in this case, we worked with our partners to find a solution that preserves the health of livestock and the cattle industry while also respecting the tenets of wildlife conservation.

Of course, wildlife health in and of itself is a priority for the U.S. Fish and Wildlife Service. And in fact many of the health issues we deal with on Refuges aren't known to impact domestic animal or human health; examples include white-nose syndrome, Wellfleet Bay virus, and chronic wasting disease. When wildlife disease issues do have the potential to affect domestic animals and humans however, we team up with the experts in those sectors

Dr. Samantha Gibbs leads the Wildlife Health office, which provides veterinary support for wildlife health issues on the U.S. Fish and Wildlife Service's National Wildlife Refuges. Sam obtained a bachelor's degree (Wildlife Ecology and Conservation) and a veterinary degree (DVM) at the University of Florida. She completed a PhD (Medical Microbiology) with a focus on vector-borne diseases in wild birds at the University of Georgia. She worked for the Southeastern Cooperative Wildlife Disease Study at the University of Georgia as a wildlife disease diagnostician during her PhD and post-doc. Sam then took a position as veterinary epidemiologist with the Australian government's Commonwealth Scientific and Industrial Research Organization (CSIRO) conducting work on avian influenza in Australia and Indonesia. She moved back to the U.S. in 2008 to take the position of Avian Disease Coordinator with the U.S. Fish and Wildlife Service's Division of Migratory Bird Management; transferring to Refuges five years later to create the Wildlife Health office. Sam's interests and expertise are focused on the investigation of chronic and emerging infectious diseases affecting the conservation of free-ranging wildlife.

to ensure an appropriate and coordinated response. This cooperation is exemplified by the Interagency Steering Committee for Surveillance of Highly Pathogenic Avian Influenza in Wild Birds, which includes representatives from state and federal wildlife management and conservation agencies, U. S. Department of Agriculture Animal and Plant Health Inspection Service Veterinary Services and Wildlife Services, as well as the Centers for Disease Control and Prevention. Over the years, our regular meetings have grown from planning the goals and logistics of avian influenza surveillance in wild birds into a community of practice in which we share new information, our experiences, and advice on many different zoonotic diseases.

Going back to your exploration of the nearest Refuge, try and look at it through the lens of a wildlife veterinarian. You will see that everything is connected; that this refuge, no matter how large or small, does not exist in a bubble. The health of the Refuge is affected by previous uses of the land, the quality and quantity of the water flowing from upstream, the air quality above it, the mineral resources below it, the fragmentation and development of the habitat along its borders, the health of the domestic animals both inside and outside the Refuge boundaries, and the health of the humans visiting or working there. For a wildlife veterinarian, the concepts of One Health are inescapable; they are just a reality of my everyday work.

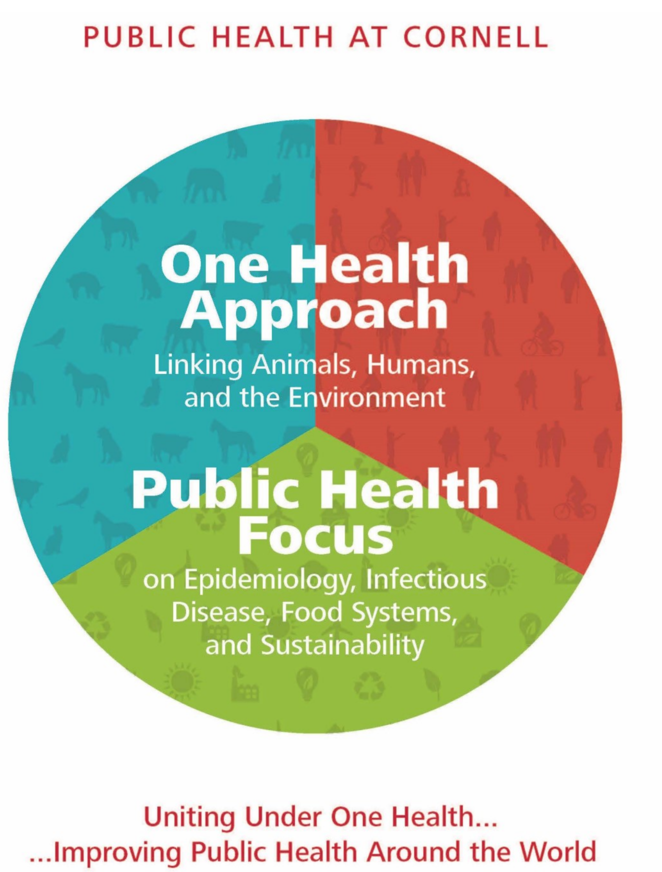
Cornell University MPH: Uniting under One Health to improve public health at home and around the world

Alexander Travis, VMD, PhD, Gen Meredith, MPH, OTR, and Cecelia Madsen

The nature of our ever-changing global community—including both people and animals within the environment—requires a comprehensive systems approach to public health to prevent disease, promote health, and improve the quality of life of the planet's population as a whole.

Starting in Fall 2017, Cornell University will offer a campus-wide Master of Public Health (MPH) program that will create public health leaders who are inspired, developed, and trained to ensure the health of people, animals, and the world in which we live.

Cornell's MPH program will be founded on the "One Health" paradigm, which focuses on the multiple types of relationships connecting humans, animals, and the environment. This paradigm recognizes that we must take a trans-disciplinary approach to public health issues, encouraging us to draw from the best practices of complementary disci-



Graphic courtesy Cornell University

plines, and allowing us to look beyond traditional human health models.

The program will offer two initial concentrations, Infectious Disease Epidemiology and Food Systems for Health, with the intent to expand in the future. Graduates from the Infectious Disease Epidemiology concentration will be trained from a human, animal, and vector (arthropod) perspective to be well equipped to respond to emerging viral, bacterial, or parasitic disease outbreaks. This will include the ability to measure and track disease spread, map and disseminate appropriate public health communications, and lead coordinated routine or emergency responses to address public health needs. In an era of routine Ebola, Zika, Middle East respiratory syndrome (MERS), severe acute respiratory syndrome (SARS), measles, dengue, Lyme, *Escherichia coli*, cholera, and chikungunya outbreaks, such public health expertise is imperative. Our graduates will play a crucial role in the global commitment to global disease detection and response, global health security, and bio- and agro-defense.

Graduates from the Food Systems for Health concentration will be trained from a systems perspective to assess and coordinate policy, programs, and interventions that ensure safe and sustainable land use, food production and processing, food delivery, and consumption, as well as food and water security. In an era of paradoxes, such as famine and food waste, undernutrition and obesity, the ongoing challenges of food-borne illness and product recall, genetically modified organisms (GMO) and food labeling debates, and concern about sustainable food production and land use, such public health expertise will be highly valued.

Cornell University exemplifies cutting-edge research and innovation in human, animal and environmental sciences, which are the core elements of One Health. The MPH program will build on these research strengths, a profound commitment to sustainability and community engagement for impact, and existing world-class graduate school programs. Course and practicum work will be led by experts from multiple fields across the university to reinforce a multidisciplinary approach that will prepare graduates to tackle diverse public health issues at the municipal, state, national, and international levels. For additional information please follow the Cornell One Health blog, visit the program website, and see the article in the Cornell Chronicle.

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The worldwide reemergence of Zika virus

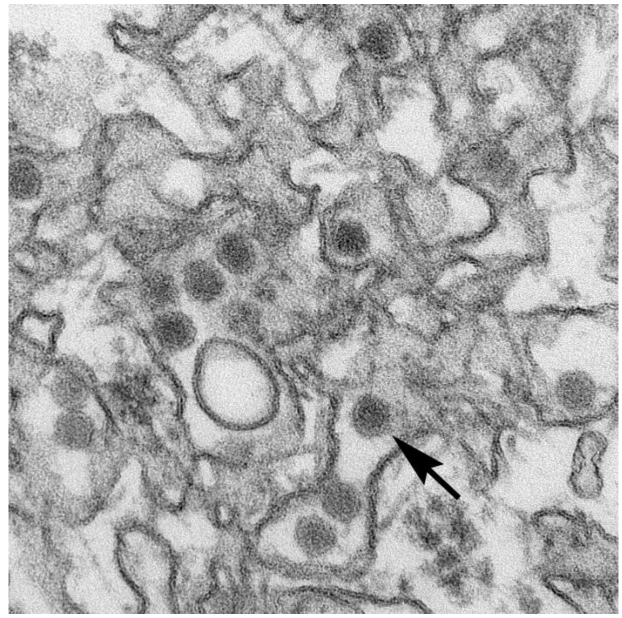
Jonathan F. Day, Ph.D.

The Emergence and Reemergence of Zika Virus

Prior to 2007 Zika virus (family *Flaviviridae*, genus *Flavivirus*, ZIKV) was little more than an academic curiosity. In fact, ZIKV is not even mentioned in *Herms's Medical Entomology*[1], only in a single sentence in *The Arboviruses: Epidemiology and Ecology* Volume II (page 148), and as several passing references in the yellow fever chapter in Volume V of the same series[2]. How did ZIKV transform from little more than a footnote in medical entomology textbooks to a disease about which virtually everyone has an opinion? More importantly, as ZIKV continues its trek around the world, what is the long term outlook for Zika transmission in the southeastern United States?

By now, the history of ZIKV is well-known. The virus consists of three lineages; two African and one Asian, all of which originated in Uganda around 1920[3]. The virus was first isolated, almost by accident, in 1947 from a sentinel monkey used to detect yellow fever virus in the Zika Forest of Uganda. However, it wasn't until 1952 that the virus was described and named.

For the first 60 years of its known existence, ZIKV was found in a narrow equatorial zone from Africa through Central and Southeast Asia where it caused minor asymptomatic disease, with fewer than 20 human cases reported during that time period. Sometime during late 2006 and early 2007 the virus began an eastward trek across the Pacific Ocean. It is difficult to know exactly how the virus made these leaps. Two plausible explanations are that infected mosquitoes were transported by air and/or the more likely possibility; an infected human traveler transported the virus in much the same way that the chikungunya virus was transported between India and Italy in 2007[4].



Transmission electron microscopic (TEM) image of Zika virus. Virus particles are 40 nm in diameter, with an outer envelope, and an inner dense core. The arrow identifies a single virus particle. *Image and caption information by US CDC / Cynthia Goldsmith*

From April through August of 2007 an outbreak of febrile illness initially suspected as dengue and later confirmed as Zika was reported on the island of Yap in the Federated States of Micronesia. This epidemic differed from previous Zika outbreaks in that human cases were more prevalent and widespread. Zika infections were reported throughout the island where three quarters of the nearly 8,000 residents were infected. However, in keeping with observations made during previous Zika outbreaks, fewer than 20% of the infected individuals displayed symptoms. Over the next six years the virus continued to move through the Pacific Islands and by late 2013 it reached French Polynesia. It was there the virus first displayed signs that it had mutated into a

far more pathogenic strain with the ability to cause severe neurological infection including Guillian-Barré syndrome[5].

An unanticipated consequence of the Zika epidemics on Yap in 2007 and the islands of French Polynesia in 2013 was the dispersal of ZIKV in infected tourists and travelers returning home from the islands. The virus spread to Australia, France, Italy, Japan, Norway, and even Anchorage, Alaska, USA. The one redeeming feature in this rapid worldwide distribution of virus was the absence of suitable mosquito vectors to establish local transmission foci in the cities to which infected individuals returned. This would not be the case when ZIKV reached northern South America, where the highly competent vector of ZIKV, *Aedes aegypti*, is one of the most common urban mosquitoes[6].

Female Aedes aegypti mosquito after having taken a blood-meal. *Image by US CDC / James Gathany*

In May of 2015 the World Health Organization confirmed ongoing transmission of ZIKV in eastern Brazil. By the end of 2015, an estimated one million Brazilians were infected with ZIKV. Along with this New World epidemic came a troubling new twist, microcephaly and other severe birth defects. As of June, 2016 more than 7,800 cases of microcephaly and/or central nervous system malformations were reported in Brazilian neonates. The apparent link between ZIKV and birth defects dramatically increased the risk of Zika infection for pregnant women, especially when infection occurs during the first two trimesters. Another concern was the observation that ZIKV is sexually transmitted and spread through blood transfusions[5]. By mid-2016 locally-acquired Zika cases were reported from South, Central, and North America and throughout the Caribbean Basin.

Transmission of Zika Virus in the Western Hemisphere

Throughout its history ZIKV has displayed two main transmission patterns. Sylvan transmission involves non-human primates and the arboreal *Aedes* mosquitos that feed on them, including *Aedes africanus*, *Ae. furcifer*, *Ae. hensilli*, and *Ae. vittatus*. The more important urban cycle involves humans and the almost exclusive transmission of ZIKV by *Ae. aegypti*, although an outbreak of ZIKV in Gabon, West Africa in 2007 was sustained by *Ae. albopictus* mosquitoes[7].

As is the case with dengue, yellow fever, and chikungunya viruses, humans serve as the amplification host for ZIKV and, in the urban transmission cycle, it is human-to-mosquito-to-human transmission that leads to seasonal epidemics that shadow the abundance and age structure of the primary vector mosquito populations. *Aedes aegypti* mosquito populations are driven by rainfall cycles, making the transmission of ZIKV primarily a wet season occurrence. The temporal distribution of Zika outbreaks follows the seasonal flow of vector mosquitoes while the spatial distribution of Zika cases is focused in areas where vector mosquitoes are abundant. As such, the seasonal and spatial distribution of *Ae. aegypti* will determine where locally-acquired cases of ZIKV are reported. *Aedes aegypti* are extremely abundant throughout northern South America, Central America, and the Caribbean Islands. This mosquito species has been detected in

the southern half of the USA as far west as California and up the east coast as far as Long Island. However, large focal *Ae. aegypti* populations are restricted to urban centers in south Florida such as Key West, Miami, and Ft. Lauderdale as well as urban habitats along the Gulf Coast states into Texas, and Mexico. It is in these areas of persistent and elevated *Ae. aegypti* populations that ZIKV can be introduced and initiate local transmission cycles.

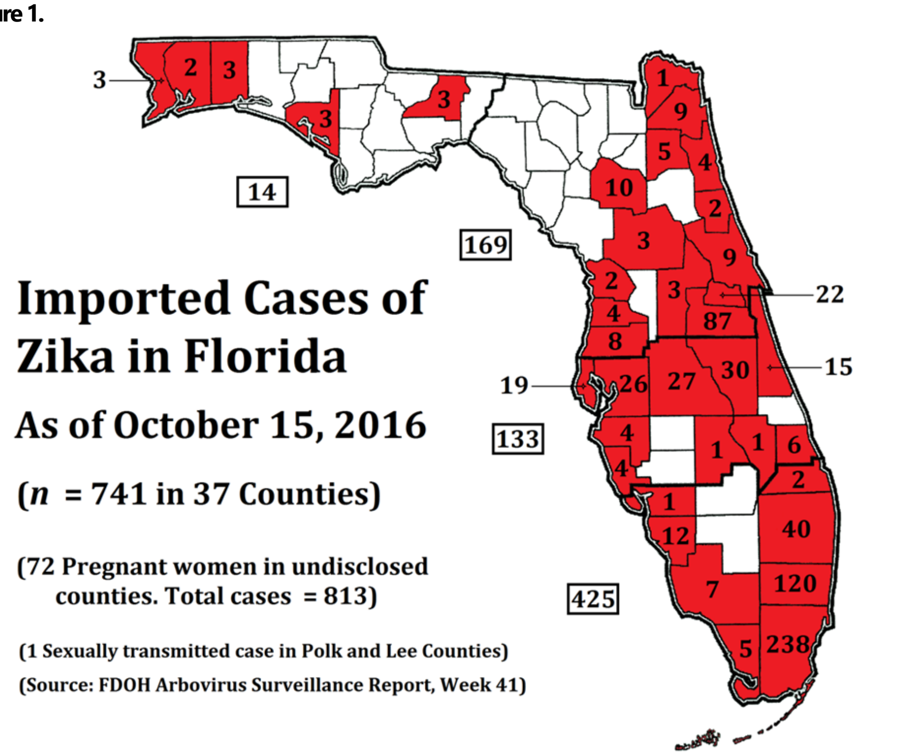
Zika Virus Transmission in Florida

The first three imported cases of ZIKV in Florida were reported during Week 2 (January 10-16, 2016) in Hillsborough and Dade Counties. Since then, a steady flow of imported Zika cases has been reported in Florida. By the conclusion of Week 41 (October 9 to 15, 2016), 813 imported cases were reported in 37 Florida counties (**Figure 1**). Many (55%) of these cases were reported from three counties: Dade (238 cases), Broward (120), and Orange (87) and more than half (425 cases, 52.3%) of the imported Zika cases in Florida were reported from counties in the southern tip of the peninsular. These numbers likely reflect movement of infected individuals from South and Central America and the Caribbean Islands. Many (50%) of the imported Florida cases originated in three countries: The Dominican Republic (124 cases), Jamaica (94), and Puerto Rico (187).

With a steady flow of active ZIKV cases into Florida and an abundance of urban *Ae. aegypti* populations, the probability of locally-acquired cases seemed inevitable. The first two locally-acquired Zika cases were reported in the Wynwood neighborhood north of Miami during Week 28 (July 10-16, 2016). Since then, locally-acquired Zika cases have been reported in four Florida counties. As of the conclusion of Week 41 (October 9-15, 2016) 179 locally-acquired Zika cases were reported in Florida residents (**Figure 2**). Most (83.2%) were reported in Dade County with distinct transmission foci reported in Wynwood (34 cases) and Miami Beach (54).

The risk of focal and sporadic outbreaks of ZIKV in Florida is quite high as evidenced by the ongoing outbreaks of locally-acquired infection shown in **Figure 2**. The report of 11 locally-acquired cases of chikungunya in four south Florida counties in 2014 and 130 locally-acquired cases of dengue in 8 south Florida counties from 2009-2016 suggests that the ecology supporting *Ae. aegypti*-driven virus transmission cycles exist in Florida. The introduction, establishment, and persistence of ZIKV transmission foci in Florida will likely resemble the movement of chikungunya virus into Italy in 2007 where

Figure 1.



a single chikungunya-infected individual returned to Italy from India. The infected traveler visited a cousin in the Italian Province of Ravenna where *Ae. albopictus* mosquitoes were particularly abundant and aggressive. Exposure of the infected traveler to these mosquitoes resulted in high mosquito infection rates and more than 200 human cases that were reported between July 4 and September 28, 2007[4].

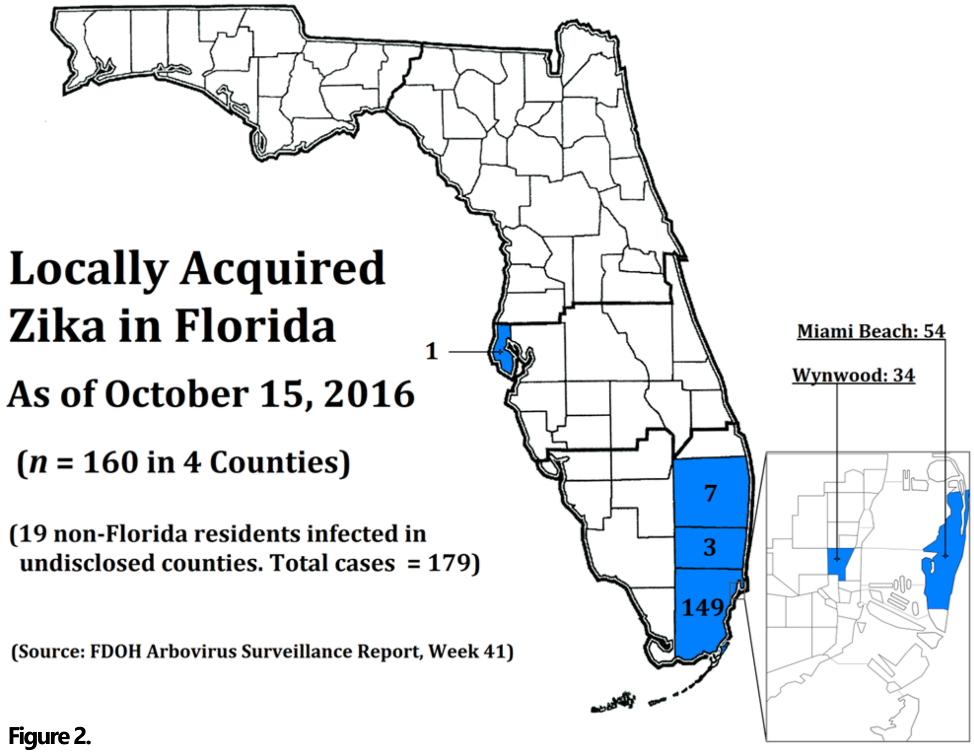


Figure 2.

The risk of a widespread Zika epidemic in Florida is likely low. Habitats that support extensive *Ae. aegypti* populations will support focal outbreaks of ZIKV, but *Ae. aegypti* has a patchy distribution in Florida. There are urban habitats in the state where this mosquito species is abundant, but in many places it is absent. The same factors that prevent widespread dengue epidemics in the state are the ones that will prevent a widespread Zika epidemic. One of the challenges of managing Zika, dengue, and chikungunya outbreaks in Florida will be the ability to accurately predict, map, and control local *Ae. aegypti* populations in real time.

The management and Control of Zika virus

The management of ZIKV is simple, manage the vector and the disease will disappear. Unfortunately, the long history of *Ae. aegypti* control programs in the Americas has shown that this mosquito species is notoriously difficult to manage effectively[8]. *Aedes aegypti* was nearly eradicated from the Western Hemisphere by the very successful Pan American Health Organization *Aedes aegypti* eradication program in the mid-twentieth Century[9]. However, when the program faltered for a number of financial and political reasons, *Ae. aegypti* rebounded from near extinction to become one of the most abundant and dangerous mosquitoes in the New World tropics and subtropics.

Larval control through breeding site elimination, otherwise known as source reduction, is the method that historically has proven to be most effective at managing *Ae. aegypti* populations. Our modern reliance on plastic in every conceivable form has made source reduction far more difficult. Education and public outreach is the only hope of achieving widespread source reduction that leads to effective *Ae. aegypti* control. The responsibility of homeowners to eliminate *Ae. aegypti* breeding sites in and around the home cannot be stressed strongly enough. *Aedes aegypti* control education needs to start in preschool and continue to include parents and guardians. The reported failures of aerial and ground insecticide spray campaigns to control *Ae. aegypti* suggests that the adults of this species cannot be controlled by insecticide intervention[10,11].

Recent suggestions that genetically modified *Ae. aegypti* may provide a temporary reduction in the population are encouraging, but even under the best of circumstances, adult *Ae. aegypti* control is fleeting and very difficult. The widespread outbreak of ZIKV in North, South, and Central America and the Caribbean Basin will likely result in herd immunity in human hosts that may dampen the size of future outbreaks. However, as long as travel remains frequent and easy, the importation of active Zika cases into areas that support large *Ae. aegypti* populations means that we will continue to have outbreaks of locally-acquired Zika in Florida.

Future Outlooks

The worst-case scenario concerning the transmission of ZIKV from a Medical Entomologist's point of view is the involvement of secondary mosquito vectors in the transmission cycle. Early reports from Brazil that virus had been isolated from *Culex quinquefasciatus* was disturbing, although there is no evidence that this mosquito can transmit ZIKV. *Aedes albopictus*, also known as the Asian tiger mosquito, is far more abundant than *Ae. aegypti* in many tropical, subtropical, and temperate habitats. However, while *Ae. aegypti* is primarily a domestic mosquito species that lives in and around human dwellings, *Ae. albopictus* is found around human homes as well as in rural settings where it utilizes natural containers such as tree holes and water-holding plants as oviposition sites. *Aedes albopictus* is similar to *Ae. aegypti* in that it can transmit dengue, chikungunya, and Zika viruses. If *Ae. albopictus* becomes involved as a major ZIKV vector in Florida, focal and sporadic viral transmission may become more frequent and widespread epidemics of ZIKV may become an unwanted seasonal reality.

The proven ability of ZIKV to mutate into more pathogenic strains is alarming. How the virus will change as it enters new habitats and encounters new mosquito vectors is of great concern. The rapidity with which the virus mutated into a far more pathogenic strain as it crossed Polynesia gives us pause as we observe the virus moving throughout the western hemisphere.

Zika virus is just the most recent vector-borne pathogen to reemerge and invade new habitats. Publically funded health and vector control agencies are at the forefront of viral detection, surveillance, and outbreak mitigation. However, an important lesson from the Florida Zika outbreak has been that some responsibility for the control of vector-borne diseases falls to the individual. Short of a military intervention similar to that seen in Brazil in the 1950s and 1960s for the control of *Ae. aegypti* and yellow fever, the only way to achieve widespread source reduction of mosquito breeding sites is to have committed involvement at the neighborhood, family, and individual levels. By taking ownership of *Ae. aegypti* control at the neighborhood scale, a reduction of available mosquito breeding sites can be realized along with a decrease in dengue, chikungunya, and Zika virus transmission risk in the southeastern United States. The only way to effectively manage *Ae. aegypti* and *Ae. albopictus*-driven disease systems to effectively manage mosquito populations.

Acknowledgements

This work would not have been possible without the continued commitment and dedication to mosquito surveillance and control by personnel from all of the Florida mosquito control programs and local and state Department of Health personnel. The weekly FLDOH updates cited in this manuscript have been instrumental in the tracking of ZIKV in Florida. The willingness of these agencies to conduct local and regional mosquito surveillance and to freely disseminate surveillance information is one of the reasons that Florida has internationally-

recognized arboviral and mosquito surveillance programs. I thank Gregg Ross, Tim Hope, and an anonymous OHNL Editor for their helpful suggestions for the revision of this manuscript and Tim Hope for designing and updating the graphics used in this manuscript. This work was supported by several research contracts from the Florida Department of Agriculture and Consumer Services.

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Reducing risk from Zika, dengue, and chikungunya diseases in the U.S. by controlling *Aedes aegypti* in populated areas

Seth C. Britch, PhD, Kenneth J. Linthicum, PhD, Robert L. Aldridge, MS, and Daniel L. Kline, PhD

Expanding populations of the *Aedes aegypti* L. mosquito present significant and increasing threats to public health in the United States (Tatem et al. 2006, WHO 2014). This invasive mosquito, considered the major vector for chikungunya, dengue, and Zika viruses, thrives in populated areas which are currently seeing a number of infectious travelers returning from epidemic areas of the Neotropics. Approved vaccines are not yet available or in widespread use for any of these viruses, and the only effective strategies for reducing transmission are for humans to avoid bites from *Ae. aegypti*, or suppress or eliminate populations of the mosquito (Scott and Morrison 2004, Eisen et al. 2009, WHO 2016).

Unfortunately, it is very difficult for humans to avoid this mosquito where populations of *Ae. aegypti* have become established. The exclusive human feeding behavior (Christopher 1960), day and evening biting habits, and reclusive resting behavior (Perich et al. 2000) of *Ae. aegypti* enhances vectorial capacity and risk of disease transmission, and causes great nuisance and anxiety for people spending time outdoors around their homes, interfering with recreation and general quality of life. Even in areas where people take care to reduce or eliminate *Ae. aegypti* immature habitat in their yards, the presence of a few ideal larval and pupal habitats may provide a source of adult *Ae. aegypti* mosquitoes affecting dozens of residences in all directions.

Furthermore, populations of *Ae. aegypti* are difficult to control with standard ultra-low volume (ULV) sprays of larvicides and adulticides. *Aedes aegypti* exploit abundant and diverse micro-habitats such as rainwater trapped in plant axils or a gutter for development of immature (larval and pupal) stages that larvicide sprays often cannot reach effectively (Kittayapong and Strickman 1993, Ponlawat and Harrington 2005). Adult *Ae. aegypti* rest in and around homes in locations where adulticide sprays do not reach easily, such as in closets or behind furniture, or in vegetation. Unfortunately, *Ae. aegypti* control in the United States tends to be nested within control for other kinds of mosquitoes, with only incidental impact on *Ae. aegypti*. Innovative ULV application techniques and strategies are needed that are specifically scaled and calibrated to target adult and immature *Ae. aegypti* habitat.

Extensive research conducted by the U.S. Department of Agriculture, Agricultural Research Service Center for Medical, Agricultural, and Veterinary Entomology (USDA-ARS-CMAVE) found that the majority of pesticides, equipment, and techniques used for spraying against immature and adult mosquitoes have largely been developed under laboratory or semi-field conditions in a single ecological region—the southeastern United States—against

only a few representative species of mosquitoes, which were themselves reared from laboratory colonies. Consequently, the CMAVE lab undertook a long-term program to conduct rigorous field testing of larvicides, adulticides, and spray equipment across multiple environments against several mosquito species to better understand environmental factors limiting the efficacy of pesticide treatments. From these studies, CMAVE is developing guidance points that provide specific recommendations for combinations of pesticides, equipment, and techniques optimized for a range of environments against key mosquito targets, including *Ae. aegypti* (Britch et al. 2014).

For example, CMAVE conducted a series of ULV adulticide and larvicide spray trials against *Ae. aegypti* in a simulated urban habitat in the Camp Blanding Joint Training Center of the Florida National Guard located in Starke, Florida. This warm, humid sub-tropical location provided a variety of structures, such as shown in Fig.1, that are in some ways similar to those found in dengue-endemic areas. The efficacy of adulticide sprays was evaluated by tallying mortality observed in adult female *Ae. aegypti* mosquitoes contained in special 'sentinel' cages permeable to pesticide sprays. Similarly, larvicide spray efficacy was evaluated by capturing spray droplets in plastic sentinel cups that were later filled with water and *Ae. aegypti* larvae for observations of larval mortality. Sentinel cages and cups were placed in protected and unprotected positions simulating the interior of closets or spaces under furniture, or simulating locations in vegetation or peridomestic objects such as discarded containers, to evaluate the capability of sprays to reach target mosquitoes through a gradient of refugia (Fig. 1). Results indicated that a range of efficacy can be expected depending on the density of protective cover harboring the mosquitoes, the pesticide and spray equipment used, and whether the pesticide is applied by air or from the ground—and, if by air, whether applied with fixed wing or helicopter aircraft.

Analysis of the data from the Camp Blanding investigations may be used to produce best-practice guidelines to configure spray missions for optimal efficacy against *Ae. aegypti* in similar urban,

Figure 1. A ULV truck-mounted sprayer applying liquid larvicide while driving along a path outside simulated urban structures, Camp Blanding, Florida. Note plastic cups placed on the ground to collect droplets of sprayed larvicide for later lab tests to observe frequencies of mortality in *Ae. aegypti* larvae. These cups were placed at increasing distances from the sprayer, through the inside of the building, and outside to the rear of the building. This experimental larvicide spray application represents one control method used in neighborhoods infested with *Ae. aegypti* mosquitoes in dengue-endemic regions, and the placement of sentinel cups reflects the challenge of reaching cryptic habitat throughout a residential property with access only from the street.

warm-humid environments in the US. However, *Ae. aegypti* has a close affinity for human dwellings and actively exploits very small habitats created, for example, by planting and watering ornamental foliage. These micro-habitats provide excellent breeding and refuge areas for *Ae. aegypti* even when surrounding environments are entirely inhospitable to this species, as is the case in neighborhoods harboring focal populations of *Ae. aegypti* but surrounded by hot-dry desert in southern California and Arizona. In these regions, adulticide and larvicide spray applications must be tuned for efficacy in a hot-arid ecological zone, even though the target mosquito is sequestered in warm-wet micro-habitats. To this end, using a similar array of adulticides, larvicides, and spray equipment, the CMAVE lab investigated efficacy of ULV sprays against *Ae. aegypti* and other mosquito species in a hot-arid desert plot in southern California (Fig. 2). These investigations demonstrated that, not unlike the results seen in Florida, pesticide formulations and application equipment need to be chosen carefully to effectively reach and cause sufficient mortality in adult and immature *Ae. aegypti* targets.

Figure 2. Operators applying liquid larvicide combined with adulticide using a backpack ULV sprayer against adult and immature mosquitoes in desert study area in southern California. These trials were designed to investigate the resilience of sprays exposed to extreme conditions before they reach adult or immature *Ae. aegypti* sequestered in micro-habitats. Note plastic sentinel collection cups on ground adjacent to upright poles holding adult mosquito sentinel cages.

With the emergence of chikungunya and Zika viruses in the United States, it is important that further *Ae. aegypti* control research is expanded into hot-arid zones. Observed oscillations of climate extremes over the past decade and increasing patterns of short-term climate change (Anyamba et al. 2014) compel us to identify optimal combinations of pesticides and spray equipment to permit the flexibility for effective suppression of *Ae. aegypti* populations embedded in dynamic ecological regions. Despite promising demonstrations of ULV adulticide and larvicide efficacy in the two tested environments, long-term suppression of *Ae. aegypti* will only be achieved with a system of integrated vector management (IVM) strategies. These strategies should include standard as well as innovative technologies, such as sterile insect technique and *Wolbachia* incompatible insect technique mass-release approaches, and sustained recruitment and commitment of the public to reduce immature habitat in residential yards. Although *Ae. aegypti* has been highlighted as a primary target for reducing transmission of chikungunya, dengue, and Zika viruses, a related species, *Aedes albopictus*, could become an important secondary vector of these viruses in the United States and research and development of IVM control strategies should consider both species.

Acknowledgments

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One Health – One Method of Antimicrobial Susceptibility Testing

Thomas R. Shryock, PhD, and Mark G. Papich, DVM, MS, Dipl. ACVCP, on behalf of the Veterinary Antimicrobial Susceptibility Subcommittee (VAST) of the Clinical and Laboratory Standards Institute (CLSI).

The below article was originally published on the One Health Commission's "Narratives of One Health in Action" webpage and shared with the OHNL by Cheryl Stroud, DVM, PhD, Executive Director, One Health Commission.

Antimicrobial resistance is a globally recognized issue; therefore, efforts to combat this problem have been initiated by international organizations such as the World Health Organization (WHO), the Office International des Epizooties (OIE) as well as national antibiotic action plans in the United States, the European Union, and other countries. Many associations, stakeholders and professional societies have made commitments to fulfilling various components of these plans to combat antimicrobial resistance.

One of the fundamental technical aspects in these initiatives begins in the clinical microbiology laboratory with antimicrobial susceptibility testing (AST). Laboratories that identify and test bacterial isolates for susceptibility to antimicrobial agents report the results that are used by epidemiologists, veterinarians, physicians, and research scientists, and other stakeholders, for many purposes. Clinicians use the data for treatment decisions, epidemiologists evaluate the data for trends in resistance prevalence, and researchers use the data for advancing new innovations to mitigate resistance.

Standardized AST methods are used to generate minimal inhibitory concentration (MIC) data or zone of (growth) inhibition data. The MIC or "zone size" data is "translated" at specific "breakpoints" into the categories of Susceptible, Intermediate or Resistant. These categories provide guidance to clinicians (physicians or veterinarians) to assist in antibiotic treatment decisions as a component of Responsible Use guidelines.

From a research viewpoint, an MIC frequency histogram is compiled from the cumulative results of tests over time, geography or other parameters so that epidemiologists and monitoring program researchers can ascertain the presence of wild-type populations (isolates with low MICs) vs. non-wild type (higher MIC isolates) populations.

Moreover, regulatory agencies may recommend standardized AST methods within guidance documents to ensure validity and comparability for test data. Researchers may use AST methods to evaluation of new agents compared to existing agents.

The U.S. National Action Plan for Combating Antibiotic-Resistant Bacteria (CARB) calls for validated methods to document antimicrobial resistance in order to "… facilitate identification and implementation of interventions to reduce the spread of antibiotic-resistance." The OIE Terrestrial Manual (2013)[2], the WHO Action Plan[3], the National Antimicrobial Resistance Monitoring System (NARMS)[4], the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)[5], and Judicious Therapeutic Use Guidelines generated by veterinary and human medical professional societies and organizations have all identified the need for standardized methodology for AST.

The Clinical and Laboratory Standards Institute (CLSI), an international standards organization, has produced through its internationally constituted volunteer subcommittees specific technical standards documents for human and animal pathogen AST that provide reproducible and validated methods that allow for global implementation which can address the need for harmonized AST methodology[6,7]. Simply put, while it is possible to make local therapeutic decisions that rely on determining "resistant" or "susceptible", it is very difficult to perform national scale resistance monitoring and surveillance that allows trans-national comparisons unless an approved AST standard method is used that is globally implemented.

The CLSI is the only organization in the world that provides testing methods and interpretive categories for both animal and human pathogens. The value of CLSI standards is that they have been in use for many decades, are continually updated, aligned with the International Standards Organization and have been integrated into many AMR surveillance programs, clinical diagnostic laboratories, and regulatory guidelines; therefore, they offer a "one method" approach that will enable global harmonization. The benefits of globally uniform and standardized antimicrobial susceptibility testing methods include the following: harmonization and alignment across diagnostic, research and reference laboratories, countries and time to ensure comparability of MIC data; quality-controlled data for pathogens, zoonotic and commensal bacteria, regardless of the species of origin, for the major classes of antibiotics; accurate antimicrobial susceptibility test results and interpretive categories provide veterinarians and physicians with information upon which to make appropriate antibiotic treatment decisions further ensuring responsible and judicious use of antimicrobial agents. Lastly, the use of breakpoints and interpretive categories is intimately connected to the AST method used, so it is not appropriate to use an AST method that is different than the one used to set the interpretive category or to apply a breakpoint using a different method. Interpretation of MIC frequency histograms is a fundamental data presentation that cannot be achieved unless the data comes from laboratories that all use the same standardized method. The CLSI Interpretive Categories are now available online: Animal Pathogen Tables, Human Pathogen Tables.

In conclusion, within the spirit of One Health, a One Method approach provides a means to ensure that antimicrobial susceptibility testing methods are aligned and uniformly applied on an international basis to facilitate information exchange, provide comparability across boundaries and time, and minimize confounding of data that may be generated by other means.

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Mark G. Papich, DVM, MS, Dipl. ACVCP is a veterinarian and Professor of Clinical Pharmacology at North Carolina State University, and is the current Chair-holder of the CLSI VAST subcommittee (mark_papich@ncsu.edu).

In memoriam: John P. Woodall, PhD (1935-2016)

We are saddened to share that Dr. John P. (Jack) Woodall has passed away. Dr. Woodall was an active One Health Newsletter (OHNL) Contributor, most notably providing the quarterly ProMED updates for the OHNL. We would like to share a brief personal statement regarding Dr. Woodall's communications with us before also sharing a more detailed memoriam, kindly provided by the One Health Initiative team.


Jack Woodall, PhD

It is often intimidating, though exciting, to engage with scientists and professionals who are quite frankly our role models as part of our responsibilities of the OHNL. Dr. Woodall, in similar fashion to other OHNL Board Members and Contributors, did his best to reassure us in our roles as Co-Editors with many words of encouragement. He earnestly requested our feedback, incorporated our suggestions with humility, and was incredibly patient. He participated in our conference calls, and willingly contacted colleagues to contribute articles. It was an honor to get to know him and to learn from his efforts to improve lives through interdisciplinary collaboration. We are thankful for time shared with him and express our sincere condolences to his family, friends, and colleagues.

Mary M. Merrill & Sarah K. White
Co-Editors, One Health Newsletter

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The below article was originally published on the One Health Initiative website.

Extraordinary Scientist, Admired One Health Supporter-Activist-Leader Dies

London, U.K., October 24, 2016 — Jack Woodall, PhD (John Payne Woodall) 1935 – 2016, a viral epidemiologist, scientist and visiting Professor and Director (retd.) Nucleus for the Investigation of Emerging Infectious Diseases at the Institute of Medical Biochemistry, Center for Health Sciences, Federal University of Rio de Janeiro, Brazil has died after a valiant battle with pancreatic cancer.

Dr. Woodall was a co-founder and associate editor of ProMED-mail, the outbreak early warning system online of the Program for Monitoring Emerging Diseases of the International Society for Infectious Diseases. ProMED-mail was one of Dr. Woodall's primary passions since its inception. He became the contents manager/editor of the ProMED-mail section in the One Health Initiative website in February 2009 and retired from that endeavor in May 2016. Jack was an integral member of the One Health Initiative Autonomous pro bono team comprised of Laura H. Kahn, MD, MPH, MPP, Bruce Kaplan, DVM, Thomas P. Monath, MD and Lisa A. Conti, DVM, MPH. Promotion and support of One Health with the goal of eventual implementation was of great importance to our esteemed colleague, Dr. Jack Woodall.

Other posts that Dr. Woodall held included the Biological Weapons Working Group of the Center for Arms Control and Non-Proliferation, Washington DC (USA) since 2004, the Editorial Advisory Board of The Scientist magazine since 2007, and the Editorial Advisory Board, Journal of Medical Chemical, Biological & Radiological Defense since 2008. In addition, he was on the Scientific Advisory Board, Sabin Vaccine Institute, Washington DC from 2004 – 2006. He has served on the American Committee on Arthropod-Borne Viruses, American Society of Tropical Medicine & Hygiene (ASTMH) and as Web Site Editor of the ASTMH from 2002 – 2008.

Dr. Woodall earned his PhD in virology/entomology at the London School of Hygiene & Tropical Medicine. He was subsequently Senior Scientist for Her Majesty's Overseas Research Service, East African Virus Research Institute, Entebbe, Uganda; a staff member of The Rockefeller Foundation, New York, NY (USA); Director, Belem Virus Laboratory, Belem, Para, Brazil; Research Fellow, Yale Arbovirus Research Unit, Yale University, New Haven CT (USA); Head, Arbovirus Laboratory, New York State Health Dept., Albany NY, (USA); Staff member, US Public Health Service, Centers for Disease Control and Prevention (CDC), (USA); Director, San Juan Laboratories, San Juan, Puerto Rico; Scientist with the World Health Organization, Geneva, Switzerland; and Director, Arbovirus Laboratory, New York State Health Dept., Albany, NY, (USA). Dr. Woodall published numerous articles in peer-reviewed journals.

Dr. Woodall was an internationally recognized public health authority, educator and One Health leader. Serving as a pro bono contents manager of the ProMED-mail page of the One Health Initiative website, he was an active participant of the autonomous pro bono One Health team of Drs. Kahn, Kaplan, Monath and Conti. He traveled frequently by invitation to promote the online reporting of emerging disease outbreaks and One Health.

The One Health Initiative team has suffered a profound and irreplaceable loss with the death of our dear friend and colleague, Jack Woodall. He collaborated brilliantly and freely on every major One Health issue since joining the OHI team in 2009. Numerous email communications were exchanged each week and frequently on a daily basis between the five of us. Laura, Bruce, Tom and Lisa depended a great deal on Jack's experience and wise insights about a variety of topics. Our hearts go out to his wife Mary and all family members. The national and international One Health community has lost an invaluable, dedicated and trusted advocate with the passing of Jack Woodall. He shall be sorely missed and yet remembered fondly and affectionately.

Please see more here and here.

Brief Items in One Health

Florida Keys moving forward with field trial of genetically modified mosquitoes

In the November General Election, Florida Keys residents voted for a field trial testing the efficacy of genetically modified mosquitoes, designed by the British company Oxitec, to reduce wild mosquito populations. The genetically modified male mosquitoes produce unviable offspring after mating with females of *Aedes aegypti,* the main vector of chikungunya, dengue and zika viruses. Oxitec's self-limiting OX513A mosquito has been under review by the U.S. Food and Drug Administration, which found no significant impact on health through an environmental assessment. Other countries including Brazil, Panama and India have collaborated with Oxitec, and have seen promising results. In a trial in Panama, a 93% reduction in *Ae. Aegypti* population was observed within six months of introduction and maintained throughout the wet season.

While the bill passed with 58% of the vote, two precincts were against the trial. Key Haven, an initial trial site was one of them, with a 65% opposition. The commissioners of the Florida Keys Mosquito Control Board agreed to not move forward with the trial in Key Haven and are now planning for alternate locations within the county. Pending FDA approval of the new trial location, the commissioners aim to start in spring 2017. More information about Oxitec and the Florida Keys Mosquito Control Board can be found at http://www.oxitec.com/programmes/united-states/ and http://keysmosquito.org/.

Webinar Available on the Relevance of Evolution to Clinical Medicine and One Health

Contributed by Leonard C. Marcus, VMD, MD

On Sept. 19, 2016 the Massachusetts Medical Society sponsored a one hour webinar entitled *From Darwin to Genomes: The Emergence of Evolutionary Medicine*. The speaker was James P. Evans, MD, PhD, Bryson Distinguished Professor of Genetics and Medicine, University of North Carolina at Chapel Hill. The webinar had been available for continuing education credit for physicians and veterinarians and it is presented from a One Health perspective. It is now available for viewing without

charge (but without formal continuing education credit) at www.massmed.org.

A wide range of topics from behavioral disorders to orthopedics to oncology and infectious disease are covered from the perspective of evolution and genetics. It is clinically oriented and relevant to medical and veterinary practitioners and academicians. It underlines the importance of evolution as the scientific basis of One Health.

EvMedEd.org

Contributed by Randolph M. Nesse, MD

EvMedEd is a curated collection of learning and teaching resources for students, teachers and interested people with backgrounds ranging from high school through senior physicians and researchers. It is sponsored by the International Society for Evolution, Medicine, & Public Health, with major support from the ASU Center for Evolution and Medicine. EvMedEd.org provides links to all available education resources relevant to evolutionary medicine, including hundreds of videos, articles, podcasts, websites, and syllabi. We are working to also provide "how to get started" pages for teachers and all learners. You can and should submit your papers, books, and videos so others can be aware of them. Just click the "Contribute" button on the front page.

Upcoming Events

17th National Conference and Global Forum for Science, Policy, and the Environment
24-26 January 2017
Washington, DC, USA
http://www.ncseconference.org

2017 ASM Biothreats: Research, Response, and Policy
6-8 February, 2017
Washington, DC, USA
http://www.asm.org/index.php/biothreats-2017

AVMA Global Summit: Food Security - Understanding the Role of Animal Health & Well-Being
9-11 February, 2017
Washington, DC, USA
https://www.avma.org/Events/Symposiums/Pages/Global-Food-Security-Summit.aspx

National Academies of Practice Annual Forum: Access, Quality, Value and Outcomes in Interprofessional Healthcare
17-18 March 2017
Philadelphia, Pennsylvania, USA
http://www.napractice.org/Events/Annual-Meeting-Forum/2017

International Society for Economics & Social Sciences of Animal Health Inaugural Meeting
27-28 March 2017
Aviemore, Scotland
http://www.isessah2017.org/

Society for Veterinary Epidemiology and Preventive Medicine Conference & Annual General Meeting
29-31 March 2017
Inverness, Scotland
http://www.svepm2017.org/

Epidemics in a Globalised World: Multidisciplinary Perspectives
22-24 March, 2017
Antwerp, Belgium
http://www.ucsia.org/main.aspx?c=*UCSIAENG2&n=121803&ct=121803

15th World Congress on Public Health
3-7 April, 2017
Melbourne, Australia
http://www.wcph2017.com/

Healthy People, Healthy Ecosystems. 8th Annual Consortium of Universities for Global Health Conference
7-9 April, 2017
Washington, DC, USA
https://www.eiseverywhere.com/ehome/cugh2017

Global Health & Innovation Conference
22-23 April, 2017
New Haven, Connecticut
http://www.uniteforsight.org/conference/

The James Steele Conference on Diseases in Nature Transmissible to Man
24-26 May, 2017
Irving, Texas
https://sites.google.com/site/diseasesinnature/

3rd Annual Meeting of the International Society of Evolution, Medicine & Public Health
18-21 August 2017
Groningen, Netherlands
https://evolutionarymedicine.org/2017-isemph-meeting/

2017 Congress of the European Society for Evolutionary Biology
20-25 August 2017
Groningen, Netherlands
http://eseb2017.nl/

33rd World Veterinary Congress
27-31 August, 2017
Incheon, Korea
http://www.wvc2017korea.com/

The Sixth ESWI Influenza Conference
10-13 September, 2017
Riga, Latvia
http://eswi.org/influenzaconferences/

Recent Publications in One Health

Journal Articles

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Book Review:

Sharks Get Cancer, Mole Rats Don't: How Animals Could Hold the Key to Unlocking Cancer Immunity in Humans

James S. Welsh, MD. Prometheus Books, 2016

The purpose of this book is to explain the development, rationale and value of immunotherapy for treating cancer in humans. The intended audience is not well defined. The book includes extensive notes and bibliography like a scientific text, but it is also full of definitions of scientific terms that are written for a lay audience.

The author takes a circuitous route, for example discussing transmissible tumors in animals and fossil evidence of tumors in dinosaurs, comparing inflammation with neoplasia and immune tolerance of the fetus in pregnancy with immune tolerance of tumors. It is possible, but laborious to connect the dots.

Many of the author's digressive notes do not add to our understanding of immunotherapy of human cancer and result in some errors. For example, he describes the life cycle of the fish tapeworm, *Diphyllobothrium latum*, including a discussion of the oncosphere, which is not part of that worm's life cycle. He makes confusing statements about the importance of cats as the source of human toxoplasmosis. Also, he states that bowhead whales are second in size to blue whales; however, that honor goes to fin whales.

Chapter 18, Frodo of Flores, is a discussion of a fossil hominid found in Indonesia, and Chapter 29, A Standard Model of Molecular Oncology, includes a belabored discussion about atomic structure. These chapters do not support the purpose of the book and should be removed for clarity.

Some of the author's analogies are useful, such as comparing immunity to military or predator/prey situations, and some readers may be fascinated by the reams of facts presented. Many of the subjects covered are relevant to comparative medicine if not to the stated objective of the book. The book would be useful in a One Medicine library, but it would be more appropriate as a series of articles in the New Yorker or Scientific American.

Contributed by Leonard C. Marcus, VMD, MD

Journal Articles (continued)

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