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Zika Fever: An Emerging Mosquito-borne Pathogen in the Western Hemisphere .......... 5
by James Cilek

Aristides Agramonte and the Yellow Fever Commission: A Personal Journey .......... 11
by Natasha Marie Agramonte

Mosquitoes vs Head Lice: A Control Comparison .......... 17
by John Beidler

A No-Spray Request in Ada County Mosquito Abatement District .......... 22
by Desireé Keeney

Developing Rearing Cages for Toxorhynchites rutilus septentrionalis .......... 27
by Anita Schiller

From Where I Sit: Notes from the AMCA Technical Advisor .......... 33
by Joe Conlon

About the Cover: Toxorhynchites rutilus is not a bloodfeeder, but its predatory larvae eat other mosquito larvae, hence its potential as a biological control agent. With a wingspan of 12 mm, it is one of the largest North American mosquito species. Photo by Matthew Bertone, an entomologist with the Plant Disease & Insect Clinic at North Carolina State University, Raleigh, NC. His beautiful photographic images of insects and wildlife can be viewed at https://www.flickr.com/photos/76790273@N07.

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During June 2015, Brazilian Ministry of Health authorities reported a previously unknown mosquito-borne pathogen was now circulating in that South American country. Approximately 500 human cases of flu-like symptoms were reported that included headache, fever, joint, muscle, and back pain accompanied by a progressive skin rash. Many patients also reported photophobia and conjunctivitis (red eyes). The causative agent was identified by reverse transcription polymerase chain reaction (RT-PCR) as Zika virus (ZIKV), a disease of African origin (Zanluca et al. 2015).

So, what is this “newly emerging disease”?

Zika virus is a flavivirus related to dengue, yellow fever and West Nile. Historically, the virus was first isolated in 1947 from a rhesus monkey in the Zika Forest near Entebbe, Uganda, Africa (Hayes 2009). “Zika” means “overgrown” in the Luganda language (Henry 2014). In 1948, ZIKV was isolated from Aedes africanus trapped in the same forest (Macnamara 1954). The virus was isolated in humans from Uganda and Tanzania in 1952, and from Nigeria in 1968 (Hayes 2009). From 1951 through 1981, evidence of human ZIKV infection was reported from Egypt, Central African Republic, Sierra Leone, and Gabon, as well as parts of Asia, including India, Malaysia, the Philippines, Thailand, Vietnam and Indonesia (Hayes 2009). Since then, confirmed or suspected cases of ZIKV have been reported from French Polynesia, New Caledonia, the Cook Islands and Easter Island (New Zealand Ministry of Health 2015).

Early work by Boorman and Porterfield (1956) demonstrated ZIKV transmission to mice and monkeys by infected Ae aegypti; see Figure 1. ZIKV has since been isolated from a number of Aedes species (Marchette et al 1969), but at present it is unknown whether Ae albopictus can transmit the disease pathogen. Vertebrate hosts appear to include monkeys and humans. Remarkably, Brazilian local authorities link the ZIKV outbreak to the increased flow of foreign visitors into the country prompted by the 2014 Fédération Internationale de Football Association (FIFA) World Cup, coupled with large populations of Ae aegypti and Ae albopictus that inhabit the region.

The 2015 ZIKV outbreak in Brazil was not the first outside of Africa and Asia. A relatively mild outbreak of Zika fever was first reported in April 2007, on the island of Yap, in the Federated States of Micronesia. The outbreak lasted 13 weeks (April to July), with 49 confirmed cases, 59 unconfirmed cases, no deaths and no hospitalizations reported (Duffy et al 2009). The first human cases of ZIKV to appear in the Western Hemisphere occurred in French Polynesia in October 2013, where about 10,000 cases were reported (PAHO 2015). The mosquitoes responsible for transmission were Ae aegypti and Ae polynesiensis. Both species use containers as larval developmental habitats. In early 2014, the first locally acquired transmission of ZIKV in the Americas was reported on Easter Island by the Chilean Ministry of Health (ProMED-mail 2015). As a result, the Pan American Health Organization (PAHO) issued an epidemiological alert for the potential spread of ZIKV to several Caribbean basin countries based on the events in Brazil and Chile.

Zika virus could currently be considered an emerging pathogen, because it has now spread outside its usual geographic range of Africa and Asia (Hayes 2009). Thus far it has been a relatively mild disease with limited scope, but its true potential as a virus causing a significant amount of morbidity or mortality remains to be determined. Zika virus is not currently found in the United States. However, Duffy et al (2009) underscored the fact that accessibility of air travel and the abundance of flavivirus vectors in the Pacific region have raised concern for
the spread of ZIKV to other islands in Oceania and even to the Americas. In fact, these authors cite an anecdotal instance where a medical volunteer visited Yap from June 17 to June 29, 2007 and returned to the United States on July 7. The individual was probably viremic after arrival, with onset of symptoms meeting the case definition of suspected ZIKV disease. In addition, Fonseca et al (2014) reported a similar scenario in a Canadian traveler who was infected with ZIKV while visiting Thailand in January 2013, and returned home viremic with a papular rash that was initially misdiagnosed as dengue.

Zika virus infection usually appears as an influenza-like condition and can often be mistaken for dengue or chikungunya (New Zealand Ministry of Health 2015). Common symptoms of infection in humans with ZIKV begin with mild headache, low fever, discomfort, minor joint and/or muscle pain, and a progressive papular skin rash that consists of a red patch on the skin covered with small adjoining bumps; see Figure 2. Photophobia may also occur in patients as a result of inflammation of the outer surface of the eyeball and inner surface of the eyelid (PAHO 2015). Post-infection muscle weakness has frequently been reported in recovering patients (New Zealand Ministry of Health 2015). Incubation period of the virus appears to be about 3-12 days, with an average of 4 days. Signs and symptoms may last for an additional 4-7 days then may disappear, with only a rash remaining (Hayes 2009). Currently, there is no vaccine against ZIKV infection and symptoms are managed using non-steroid anti-inflammatories and/or non-salicylic analgesics due to the risk of hemorrhagic complications (CDC 2015). However, only 13 - 40% of patients may be symptomatic (Hayes 2009). Currently no mortality has yet been associated with infection, and compared with dengue, ZIKV infection appears to have a mild to moderate clinical picture. The onset of ZIKV is more acute and shorter in duration; no shock or severe bleeding has been reported (PAHO 2015). However, it is unknown whether co-infection can occur with dengue and/or chikungunya viruses that may in turn, profoundly change the pathogenicity of ZIKV in infected human populations.

As an interesting side note, Foy et al (2011) suggested that ZIKV could be sexually transmitted between humans. In 2009 a biologist visited Senegal to study mosquitoes and was bitten on a number of occasions during his research. A few days after returning to the USA he fell ill with Zika, but not before having sexual contact with his wife. His wife subsequently showed symptoms consistent with the disease, including extreme sensitivity to light. She was diagnosed as being infected with ZIKV, representing the first report of possible transmission of an insect-borne virus to another human by sexual contact.

ZIKV human infection can be detected in serum during the first 5 days after symptoms occur, which coincide with the acute (or viremic) phase. Detection of viral RNA can be performed from serum by RT-PCR. Serological tests such as the enzyme-linked immunosorbent assay (ELISA) or immunofluorescence to detect specific immunoglobulin antibodies (IgM or IgG) can be performed after 5-6 days following onset of symptoms (PAHO 2015). There can be cross-reactivity
with other flaviviruses – dengue, chikungunya and West Nile – so serology results should be interpreted with caution. Further laboratory, field, and epidemiologic studies would be useful to better define vector competence for ZIKV, in order to determine if there are any other arthropod vectors or reservoir hosts, and to evaluate the possibility of congenital infection or transmission through blood transfusion.

SURVEILLANCE

The vector surveillance response for Zika fever is considered to be similar to that used for dengue or chikungunya, because ZIKV transmission uses the same species – *Ae aegypti* – while the status of *Ae albopictus* as a vector remains to be determined in the Western hemisphere. In Florida, suggested surveillance methods for both species have been compiled by the Florida Mosquito Control Association’s committee on “Dengue/Chikungunya Vector Management and Response.” Two documents from this committee are available online that describe various methods one can use to determine location and monitor relative abundance of immature and adult *Ae aegypti* and *Ae albopictus* populations. These documents may be accessed at: 


The US Centers for Disease Control and Prevention (CDC) has recommended when traveling to countries where ZIKV is prevalent, travelers should avoid areas where they may be bitten by mosquitoes; for a current distribution map see: http://www.cdc.gov/zika/geo/index.html. Travelers should also use mosquito repellents containing DEET, picaridin, IR3535, or oil of lemon eucalyptus; wear long sleeves and pants, when weather permits; and stay in air conditioned buildings or places that use window and door screens or sleep under a bed net if they are not able to protect themselves from indoor mosquitoes (CDC 2015).

*The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the US Government.*

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<th>Equipment</th>
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My journey to discover Dr Aristides Agramonte and the Yellow Fever Commission started with a book, *The American Plague*, by Molly Caldwell Crosby (2006). I had started graduate school because of my interest in public health and vector-borne disease. I had already torn through a book on the bubonic plague and the Spanish flu pandemic in my first semester, when I found one on America’s plague, yellow fever (YF). It suited me perfectly. I was interested in infectious disease but mosquitoes and blood-borne pathogens were something I found fascinating. I had been working in the lab primarily with *Aedes aegypti*, the yellow fever mosquito. So what book could be more perfect to satisfy my curiosity than the story of how a group of scientists struggled to conquer this disease?

I learned a lot about YF in reading this book. Early in US history, regular outbreaks of yellow fever plagued the eastern port cities of New York and Boston. In Philadelphia, the US capital at the time, 10% of the population died in the 1793 yellow fever epidemic. After the civil war, the disease burden shifted to the South. Annual YF outbreaks in New Orleans caused over 26,000 cases and a devastating epidemic hit Memphis in 1878, subsequently killing 10% of its population. By 1898, the number of US Army casualties in the Spanish-American War was due more to disease than warfare itself, which spurred the military to investigate yellow fever transmission.

In 1898, Surgeon General George Sternberg assembled the Yellow Fever Commission and appointed Dr Walter Reed to lead the research efforts. As a result of the Commission’s work, the last YF outbreak in the US occurred in New Orleans in 1905.

In reading, I noticed that one of the “big four” research scientists, Aristides Agramonte, shared my boyfriend’s last name, but I didn’t give it much thought, since it was a well-known Cuban last name. After a few weeks and reading half of the book, I was happy to see that the book included black and white photographs. There were photos of the yellow fever wards depicting the severity of the disease, pictures of the tropical forests of Cuba, the wood huts constructed specifically for the experiments, the army compound in Cuba where it all took place, and the brave volunteers who participated in experiments – prohibited by today’s ethical standards.
Then I came to the pictures of the men involved in the Yellow Fever Commission: Walter Reed, the stoic leader; Dr James Carroll, an English bacteriologist and the first to be infected with YF; Dr Jesse Lazear, a physician who was a martyr to science by experimenting on himself; and Dr Aristides Agramonte. What I saw surprised me. I ran over excitedly to my boyfriend and showed him the photo of Agramonte. He was just as awestruck as I was, because Aristides Agramonte could have been his twin.

I knew a lot about all the players by now, but my interest in Aristides only began when I finished this book. After extensive research, I came to realize why he is generally unknown to either American or Cuban audiences. Agramonte was overshadowed by two military giants: one a colleague, Major Walter Reed of the US Army and leader of the Yellow Fever Commission; and the other his uncle, Major General Ignacio Agramonte, a lawyer, patriot and hero of Cuba’s Ten Years’ War for independence from Spain.

In the US, Reed dominated the history books, with research institutes and hospitals named in his honor for his work on the Commission. In Cuba, Ignacio was hailed as a war hero with parks, statues, and even the international airport in Camagüey bearing his name. Although Aristides is not as well known as these two great men, I feel his story is one filled with dedication to the field of tropical medicine, and merits being told.

Aristides Agramonte y Simoni was born in 1868 in Camagüey, Cuba. His mother and aunt – sisters who had both married men who fought, and subsequently died in the Cuban War for Independence – immigrated to New York City, where Aristides eventually grew up. He received his Bachelors degree in 1886 and graduated from the College of Physicians and Surgeons at Columbia University in 1892. He began conducting research in pathology and bacteriology at Bellevue Hospital and also served as Sanitary Inspector and Assistant Bacteriologist to the New York City Department of Health. It was in 1898 that he would receive a call from George Sternberg and be appointed assistant surgeon with the US Army, leading the field medical station in Cuba from 1898 to 1902. In 1900, after the experiments from the Yellow Fever Commission concluded, Agramonte finished his dissertation at the University of Havana and accepted a professorship there, where he continued to work on bacteriology and pathology until 1930.

Agramonte wrote textbooks for both of his fields and published over 100 peer-reviewed articles. He served as a member of the government board of infectious diseases, the cabinet secretary of health, and received honorary doctorates from Columbia University, Tulane, and the National University of San Marcos in Peru. By 1930, he was made an honorary fellow of the American Public Health Association. He was an influential leader of scientific medicine in Cuba, and was also the first Cuban to be nominated for a Nobel Prize. Although he did not win,
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the entire Yellow Fever Commission was acknowledged in 1951, when Max Theiler received the Nobel for his 1937 discovery of the YF vaccine.

In 1931, Agramonte was invited to be the first department chair of the Tropical Medicine Department at the newly founded Louisiana State University Medical School in New Orleans. He made the journey by boat to New Orleans and began preparing the necessary labs and courses for the new department. Unfortunately, he died of a heart attack just a few weeks shy of the start of classes in August 1931. His personal collection of books and journals became the first materials acquired for the medical school library, and in fact, the original name of the LSU Health Sciences Center Library was the Aristides Agramonte Memorial Medical Library. Agramonte is also featured in a 1930s frieze, titled The Conquest of Yellow Fever, which is on display in the LSU Library Commons. His body was transported to NYC, where he had spent so much of his childhood and was buried in Brooklyn’s Green-Wood Cemetery.

In Cuba, a memorial plaque in honor of Agramonte was erected at the site of Camp Lazear, renamed in honor of Jesse Lazear, who perished during the experiments. Agramonte’s daughter, Estela, assisted with the unveiling, although it is my understanding that since the regime change in 1959 the site has fallen into disrepair. In the United States, few outside the medical community recognized Agramonte's efforts or those of the Yellow Fever Commission during their lifetime. The US Government finally awarded Congressional medals to the families of the Commission members in October 1931, less than 2 months after the death of its last member, Agramonte.

I feel a very real kinship to Aristides Agramonte, not only because we now share a last name, but because we share a Cuban-American heritage and a passion for the field of public health, and because we are related! My husband is kin with Aristides Agramonte – they are 3rd cousins, 4 times removed – and they look a bit alike, too!

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Keep this number in mind.

PUBLIC REACTION

Do we really know how many people may have been incidentally exposed to permethrin when those 16,000,000 acres were treated? While most individuals may never have been exposed to ground ULV applications, others may have been exposed only once, some multiple times. Whatever that number might be, I think it’s a credit to our industry as a whole – chemists, manufacturers, distributors, label approvers such as FDACS and the US Environmental Protection Agency (EPA) and mosquito control agencies – that this is accomplished year after year with so few serious complaints, or even inquiries as to what we are doing – just kill the mosquitoes; see Figure 2. But as might be expected among those who may have been incidentally exposed, some will ask questions: Is the pesticide you’re using safe? Will it hurt my kids? Will it hurt my dogs?

Your answers can be varied. You can reply that “We follow the pesticide label and regard it for what it is – THE LAW.” You can point to the aforementioned record of few complaints. What you can’t say, however, is that a pesticide is “safe.” In fact, nowhere on a mosquito control product label does the word “safe” appear. EPA registers all pesticides used in the US and reviews and approves their labels – and has generally taken the position that the word “safe” on pesticide labeling is considered to be false or misleading. Why? Because any product intended to kill or repel something cannot be characterized as 100% safe. Instead, the agency has always stressed that by following the label directions for use, pesticides can be used safely, protecting both people and the environment, while effectively repelling or killing the intended pest.

HELPFUL COMPARISONS

When discussing potentially controversial (and complex) subjects like chemical usage or dosage with the public, it is often helpful to have comparisons, so others can more easily comprehend. To this end, let me introduce you to the head louse, Pediculus humanus capitis; see Figure 3. I am sure some of you are, unfortunately, well acquainted with this insect, a small parasite frequently found on the head of unsuspecting schoolchildren, much to the dismay of their parents. A while back I saw a product for head lice control while wandering the aisles in Publix, a large grocery chain based in Florida (we retirees do that sort of thing). The first thing that I noticed on the package was a big label stating: “SAFE.” Then I saw that the ai was our friend, permethrin.

There are at least 6 insecticide active ingredients commonly used for head lice control in the US: malathion, pyrethrins (with PBO),

<table>
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<tr>
<th>FORMULATION (permethrin + PBO)</th>
<th>TOTAL ACRES (IN MILLIONS)</th>
<th>ACREAGE (% TOTAL)</th>
<th>AVERAGE DOSE (LBS/ACRE)</th>
<th>NUMBER OF MOSQUITO CONTROL PROGRAMS</th>
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<td>0.8 M</td>
<td>5%</td>
<td>0.0046</td>
<td>13</td>
</tr>
</tbody>
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Figure 1: Table of permethrin formulations applied by Florida mosquito control programs in FY 2009-10.
spinosad, ivermectin, benzyl alcohol and permethrin; see Figure 4. Only products containing pyrethrins and permethrin can be purchased over-the-counter (OTC), the others available by prescription only. According to the US Centers for Disease Control and Prevention (CDC) the 6 insecticides can be arranged by the age limitation, “for use on children” (CDC 2013). How those age limitations are determined is another story, but what is important for this article is that permethrin, “our” major player, is the best of the lot, as it can be used on a two-month-old infant.

So back to our permethrin louse product, which goes by the brand name of NIX®. Inside each box are two 2-ounce bottles of a 1% solution of permethrin. Each bottle contains 560 milligrams (mg) of permethrin, sufficient for a single treatment. It is applied to the hair and scalp, worked in for 10 minutes and then rinsed out. The treatment kills the adult stage, but not the eggs.
called nits, which are glued to the base of hair shafts; a fine-toothed comb is provided for their removal. Any nits missed by the comb will hatch in 7 to 10 days, so treat again, even the baby. No mention is made of gloves for use by the applicator, but the product must be kept out of body openings and can’t be used around the eyes, eyebrows and eyelashes.

### DOSAGE: MOSQUITOES VS LICE

Dosage for mosquito adulticiding is generally stated in pounds of active ingredient per acre – even though we are actually treating the space over the acre, not the ground itself. As noted, the ground ULV label rates for the previously mentioned permethrin formulations is 0.00175 to 0.00700 lb/ac. It is active ingredient per area which we will compare. Remember, the average permethrin application rate used in Florida is 0.0034 lb/ac.

So what is the area covered with a head louse treatment? Let’s assume that the head is a 6-inch sphere, half covered with hair (and lice). The surface area of a 6-inch sphere ($4\pi r^2 = 4 \times 3.14 \times 3^2$) is 113 square inches (sq in), so we’ll consider the hair half to be about 56 sq in. The treatment dose was 560 mg per head, so that makes the dose per square inch 10 mg (560 mg/56 sq in = 10 mg/sq in), which is an easy figure to work with. Ten mg is equal to 10 thousandths of a gram, which doesn’t sound like much. However, let’s see: since 1 square foot (sq ft) equals 144 sq in, 10 mg per sq in x 144 sq in equals 1.44 gram (g) per sq ft. Do you think that is still not much? But wait, there’s more: we now need a per acre figure for our comparison.

Since there are 43,560 sq ft per acre, we must multiply our 1.44 g per sq ft times that amount to get g per ac. This comes to a whopping 62,726 g per ac. The last step is to convert grams to pounds, which Americans understand, by dividing by 453.592 (453.592 g = 1 lb). The answer is an equivalent dose, area to area, of slightly over 138 lb/ac. That application rate is over 40,000 times greater than our average mosquito ULV rate of 0.0007 lb/ac – or almost 20,000 times the maximum ground ULV rate of 0.0007 lb/ac!

If we converted 138 lbs ai to gallons of product, we would be pouring 55 gallons of the 30-30 formulation (or 489 gallons of a 4-4 formulation) on an acre – about the size of a football field – and either would be considered a major chemical spill! This can be expressed in a number of other ways such as sq ft treated per dose, 560 mg per half head for lice or 16,000 sq ft for mosquito control. The amount of permethrin used in 3 head lice treatments would cover over an acre for an adult mosquito ULV application.

So what do these projections prove? They demonstrate how on the one hand our comparatively low dosage of 0.0034 lbs per acre is considered unsafe by critics, yet how under the different circumstance of louse control, it is not only effective, but is considered “safe” by Federal authorities when using a much higher dose. Use this trivia as you would like. It was an enjoyable mental exercise.

I can hear it now: "John doesn’t have enough to do!"

### REFERENCES CITED


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<table>
<thead>
<tr>
<th>PEDICULICIDE ACTIVE INGREDIENT</th>
<th>MINIMUM CHILD’S AGE</th>
<th>PRESCRIPTION NEEDED?</th>
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<tr>
<td>MALATHION</td>
<td>6 YEARS</td>
<td>YES</td>
</tr>
<tr>
<td>SPINOSAD</td>
<td>4 YEARS</td>
<td>YES</td>
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<tr>
<td>PYRETHRINS + PBO</td>
<td>2 YEARS</td>
<td>OTC</td>
</tr>
<tr>
<td>BENZYL ALCOHOL</td>
<td>6 MONTHS</td>
<td>YES</td>
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<tr>
<td>IVERMECTIN</td>
<td>6 MONTHS</td>
<td>YES</td>
</tr>
<tr>
<td>PERMETHRIN</td>
<td>2 MONTHS</td>
<td>OTC</td>
</tr>
</tbody>
</table>

Figure 4: Six commonly used products for head lice control in the United States.
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A No-Spray Request in Ada County Mosquito Abatement District

by Desireé Keeney

Our district has had, for many years, a “no adulticide service request” option for residents interested in being exempt from evening adult mosquito applications – as long as they submit their own annual mosquito reduction plan for their property, in accordance with Idaho State Code. We have one resident in particular who submits her plan annually and requests that we notify her when we are in her neighborhood, so she can choose her nightly walking routine and avoid our ground ULV applications. Following our standard practices, we have complied with the request to notify her when we were spraying in the vicinity and do not spray her property.

Our 2013 season was no exception and we frequented that neighborhood often, fogging when we collected high numbers of nuisance and vector mosquitoes in our surveillance traps or when West Nile virus was detected in the specimens collected. At the end of our mosquito season, Mrs Jones called and thanked us for notifying her, and told us that her husband had made something for Ada County Mosquito Abatement District adulticide crew leader Charlie McNiel. When the couple came to our office, they handed him a piece of artwork and thanked him for being considerate by informing them when we would be in the area; see Figures 1 and 2.

As much as people like our mosquito control efforts, they also appreciate us for honoring their no-fog requests, and we can be recognized as the professionals that we are in our field.
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Harris County, TX, which includes the City of Houston, is divided into 4 precincts that fund the Mosquito Control Division of Harris County Public Health and Environmental Services (HCPHES). However, the Development, Research and Control / Mosquito Abatement Program (DRAC/MAP) is funded solely through Precinct 4, under the direction of Commissioner R Jack Cagle. In an effort to augment the existing integrated strategies employed by the countywide mosquito control program, Commissioner Cagle tasked me to find and evaluate naturally occurring, locally native biological control agents and develop methods for their culturing.

Given my own background in local biota, native invertebrate husbandry for display and education, but limited knowledge in specific mosquito ecology, I started by locating published materials on the subject. I found the scientific community gave much effort into the same goals from the 1950s through the mid-80s, but interest waned and focus shifted toward other remedies. Many predators had undergone evaluation and most were dismissed for one reason or another. I focused my search on those organisms that were dismissed only for logistical reasons in rearing, but were otherwise promising for broad application and efficacy. That led me to hone in on Dugesia species of predatory flatworms; select dragonfly species; cyclopoid copepods; and the predatory treehole mosquito, Toxorhynchites rutilus; see Figure 1. Thus far we have had the best laboratory rearing success with T. rutilus, though the path to developing our own proven domestic strain has been an arduous, but interesting one. Many months of changing single variables at a time with trial and error resulted in new insights for T. rutilus cage breeding and the creation of a domestic strain. After almost two years, we finally found success rearing a predator once deemed too difficult to breed for mosquito control. The following report describes our initial cage trials and illustrates the difficulties experienced when taking any critter from the wild and asking it to perform and breed in captivity.

Aedes aegypti and A. albopictus are common mosquito species found in urban and suburban Harris County, Texas. While the predatory mosquito T. rutilus habitat overlaps with both Aedes species, degradation of sylvan land by urban and commercial development has discouraged colonization by the wild T. rutilus population. Augmentative releases could speed up the predator population recovery time and field trials in Louisiana have demonstrated that timed releases of T. rutilus, coupled with conventional malathion ULV mosquito adulticiding, can be a highly effective way of controlling A. aegypti in urban New Orleans neighborhoods (Focks 2007). However, the high cost of conventional mosquito rearing protocols might limit the practicality of the mass rearing of T. rutilus, as it is both time consuming and labor intensive. Keeping cost in mind, our program aimed to streamline rearing protocols to raise and release locally sourced T. rutilus in an economically feasible way. Our first goal was to determine the minimum cage size required for successful oviposition in...
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laboratory-reared *Tx rutilus* adults.

**CAGE TRIALS**

From March 4 through April 10, 2013 we hatched 223 wild *Tx rutilus* eggs in the laboratory. The resulting pupae were set up in a standard, large 18 inch³ metal screened, mosquito breeder cage; 84 adults emerged between April 13 and May 18. These were kept indoors with an 85%+ humidity level and provided with 50% honey, 10% fructose solutions and fresh water via cotton dental wick vials that were replaced biweekly. Cut apples were offered and replaced once per week. Oviposition medium was provided in a 16 oz black plastic stadium cup filled with 5 oz of deciduous leaf infusion. Only 9 fertile eggs were oviposited by May 20. On July 28, the remaining 51 adults and new pupae were transferred to a larger 48 x 24 x 24 inch wooden frame cage. The foods, oviposition cup and media provided were the same as before, but in 4 weeks no eggs were deposited. On August 26, a total of 25 adults and pupae were placed in a vertical 72 x 24 x 24 inch pop-up frame caterpillar rearing cage made of 0.4 mm no-see-um mesh and outfitted with three stockinet sleeves to facilitate mosquito and cage maintenance. Both 72 inch and 48 inch cages were set up adjacent to one another in dense shade under trees. All culturing parameters between the two cages were the same except for cage size. Oviposition started on August 26 in the 72 inch cage, and a total of 63 eggs were laid within the first week. No eggs were laid in the 48 inch cage. At the end of the week, the adults from the 48 inch cage were added to the 72 inch cage and moved indoors. By the end of the following week, 177 eggs had been oviposited in the 72 inch cage. As a result, we determined that adult *Tx rutilus* require a minimum height and space of 72 x 24 inch to initiate interest in mating and/or oviposition.

Additional cages were needed to continue the mass-rearing project, but we were not successful at finding commercially available mosquito cages in...
that size. We designed our own with the following basic requirements:

- Cage must be approximately 72 inches tall and 32 to 36 inches in diameter;
- Removable exterior framework attached with Velcro;
- Durable and reasonably priced;
- Cage assembly requires little to no tools;
- No-see-um mesh for netting; and
- Cage can be machine laundered.

Based on these criteria, we worked with the vendor BioQuip Products, Inc, Rancho Dominguez, CA, to develop our custom *Tx rutilus* cages; see Figure 2.

The cage is made of ultrafine 0.4 mm white no-see-um nylon mesh netting with permanent access sleeves and double zipper full panel door sewn in to facilitate ease of maintenance and cleaning. The frame work and interior feeder bar is made of materials readily available at hardware stores. We used 3/4 inch PEX tubing for the top and bottom hoops, connected with 3/4 inch PEX Quick Connectors. The bottom hoop is filled with wet sand for additional weight. The interior t-bar is adjustable via a thin rope hanger, dismantles for cleaning, and is perforated with small holes 1 inch apart where wire hangers insert. The materials are two 12 inch and one 24 inch Schedule 40 3/4 inch PVC pipe pieces, friction-connected by a Schedule 40 3/4 inch t-fitting. A hole was drilled through the t-fitting and vertical bar while connected, and secured with aluminum wire. The entire assembly can be taken apart for cleaning. Rows of holes 1/16 inch apart where wire hangers insert. The materials are two 12 inch and one 24 inch Schedule 40 3/4 inch PVC pipe pieces, friction-connected by a Schedule 40 3/4 inch t-fitting. A hole was drilled through the t-fitting and vertical bar while connected, and secured with aluminum wire. The entire assembly can be taken apart for cleaning. Rows of holes 1/16 inch apart where wire hangers insert.

We are now moving forward with designing alternative diets and culturing methods to decrease larval development duration and reduce mortality. Currently, we are on the 8th generation of a second strain and routinely get 10,000 eggs from 4 cages each week; see Figure 3. Future goals include a larger automated production set up with higher output of releasable animals in any stage, and to develop a “speed strain” that will enable us to rear quickly for release. We look forward to continuing our research and developing partnerships with other agencies, such as HCPHES Mosquito Control Division; New Orleans Mosquito, Termite and Rodent Control Board; and Lone Star College Biotechnology Institute.

**REFERENCES CITED**


Figure 3: *Toxorhynchites rutilus* eggs (and shells) at various stages of development, with darkened eggs nearing eclosion (top) and a *Toxorhynchites rutilus* larva with a *Culex* larva as prey. Photos by Anita Schiller

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From Where I Sit: Notes from the AMCA Technical Advisor
by Joe Conlon

As we enter full bore into mosquito control season it is well that we review our media relations strategies. There will no doubt be challenges to our operations, but we have a story to tell. Let’s see how we can tell it. As background, I have borrowed liberally from a superb presentation on message development given by Mark Newberg of Central Life Sciences. Mark is a renowned expert in communications and I have learned much about messaging from him over the years. His advice on messaging has proven invaluable to me during interviews with local and national media during my service as AMCA Technical Advisor. To the extent that this discussion helps your program in telling your “story,” please thank Mark for sharing his expertise.

Why are “messages” needed as a means of conducting our critical role as public health protectors? Concise and effective messages are extremely important in dealing with the media and, by extension, the public, for at least 4 reasons. They help:

• Define your agenda and help you focus on what’s important;

• Make it easy for you to “tell your story” – and for others to remember it;

• Provide you with a “life raft” during interviews or debates; and

• Ensure consistency in your presentation over a wide variety of scenarios.

Prior to beginning the process of developing effective messages to the public, it is important to remember that the public is overwhelmed with information from print, broadcast, social media and the Internet. A by-product of being continually bombarded with information is that we are forced to prioritize what we choose to remember. Research has shown that we usually forget two-thirds of what we hear in a day and 98% within 30 days. Thus, in order for our message to make an impression, we need to make it as “unforgettable” as possible – and therein lies the rub. As scientists, we are keenly aware of how complex the world is – and mosquito control is exceedingly complex, indeed. Nonetheless, society’s commitment to read a single e-mail is only 15-20 seconds. Effective sound bites last a mere 4.5 seconds. This puts a premium on succinct, memorable messaging.

There are three phases involved in the development of effective messages.

First, you need to define your goals. What do you want to accomplish? What do you want to communicate? Put a lot of time into this component. Without a clear idea of what you want to accomplish, you can easily get sidetracked or lost in minutia. A common goal during an informational interview on mosquito control is to increase understanding of the critical role mosquito control plays in protecting public health. With that established, you can concentrate on the second stage of message development.

Second, after your goals have been defined, you need to identify your intended audiences so you can tailor the message to that demographic. Whom do you want to reach? What matters to them personally/professionally? What motivates them? Common audiences for mosquito control are policy makers to whom constituent health and budgetary issues are important motivators in addition to parents, to whom family health and an understanding that mosquito control agencies are acting in their best interest are critical. Each audience with whom you need to communicate will have their own set of specific motivators, so it’s important that you both identify them and strive to meet them in your messaging.

Third, once your goals and audience have been identified, then you must address a call to action. What, in fact, do you want the audience to do? Support mosquito control programs under fire by activist groups? Allocate funding for mosquito control programs by policy makers?

When you’ve identified what you want your audience to do to meet your goals, then you can begin drafting your message. Keep in mind, though, that your goal is to communicate with an audience that probably does not possess the lexicon of your colleagues. Therefore, here are a few caveats to keep in mind while drafting your message:

Beware of acronyms. You’re not addressing your colleagues; you’re addressing constituents who might have no idea what you’re talking about. Use of acronyms prevents you from making personal contact with your audience. Spell them out!

Remember that those whom you want to call to action need to have a firm grasp of what you’re trying to get across. Don’t make them have to interpret your message through your use of jargon. Thus, instead of saying “mosquito abatement,” say “mosquito control.” A “vector” should be termed “a mosquito that can transmit disease.” Analogize measurements, if possible. Thus, parts per million should be described as analogous to 1 inch in 16 miles, or 1 minute in two years. These will help make your
point. Parts per billion can be explained as 1 second in 32 years or 1 kernel of corn in a 45-foot high, 16-foot diameter silo. This gives your audience a frame of reference with which they can identify.

“Source reduction” should be re-stated as “removing standing water where mosquitoes tend to lay their eggs.” Don’t use the term “breed.” “Adulticiding” should be rephrased as “controlling adult mosquitoes” The same goes with regard to “larviciding.” This can be rephrased as “controlling mosquito larvae, preventing them from becoming biting adult mosquitoes.”

With all that in mind, it’s time to begin drafting your message.

Effective messages:

- Are clear and easy to understand;
- Possess three or four main stand-alone points;
- Provide supporting facts that solidify your claim such as:
  - Statistics,
  - Comparisons,
  - Anecdotes or case histories, and
  - Quotable language.
- Make an emotional connection to the audience.

Let’s take a look at a few examples from my own experience. The first occurred when I was being interviewed live on national television regarding West Nile; see Figure 1. What makes these key message points so effective is that no matter what question was being asked during the interview, I could always bridge back to one of these message points – because these were the messages I wanted to get across. I had these message points memorized going into the studio and I felt confident that these message points were a suitable life raft for whatever was going to transpire during the question and answer segment. I was right, and the interview turned out to be a piece of cake. The message points I used (and continue to use) were derived from past questions from the public and interviews with print copy reporters. Adding these to a generalized topic list provided to me prior to the interview by the producer, I had a good idea of what was to be discussed during the interview itself. I had also memorized key facts/data that supported each message point:

- West Nile is here to stay;
- West Nile is serious;
- West Nile is preventable:
  - Personal protective measures – the 3 “Ds;”
  - West Nile control measures pose no undue risk; and
  - West Nile control is effective.

If you’re involved with a media interview involving a wide-ranging array of mosquito control topics or merely a general discussion of mosquito control, the following messaging points will serve you well:

- Our primary goal is to protect public health from diseases transmitted by mosquitoes.
- Our prevention and control strategies and methods are based on sound science.
- We are committed to protecting families by:
  - Urging the public to protect themselves and take an active role in the reduction of mosquito populations;
- Eliminating mosquito egg-laying sources; and
- Applying safe, effective EPA-registered insecticides when needed.

That’s it. That’s really all there is to it. The message concepts are familiar to all of us. It would be prudent to draft a number of different message points for various scenarios you might encounter. Prior to any interview, commit the appropriate key messages to memory. This is the story you want the audience to remember. If you can effectively direct or redirect any questions back to these key messages, then you have accomplished your goals and made your points.

Now let’s take a look at specific examples of media questions and how to use message points in effectively answering them.

### EXAMPLE 1

**MEDIA QUESTION**

We continue to have West Nile virus even after the application of toxic products to the environment, so why do we continue to spray?

**KEY MESSAGE POINT**

Our primary goal is to protect the public health from diseases transmitted by mosquitoes.

**SAMPLE ANSWER**

“Even after these effective products have reduced mosquito populations and spread of disease in an area, migrating birds continually reintroduce the virus. Studies by public health agencies and universities have shown that incidence of WNV is significantly less in areas where mosquito populations have been monitored and controlled compared to untreated areas.”
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EXAMPLE 2

MEDIA QUESTION
How has funding impacted mosquito control in...?

KEY MESSAGE POINT
Our primary goal is to protect the public health from diseases transmitted by mosquitoes.

SAMPLE ANSWER
“Adequate funding gives mosquito control professionals the equipment and manpower needed to detect and control mosquito-borne disease in a timely manner. We will continue to use all the resources available to maximize the protection of the citizens in this community.”

EXAMPLE 3

MEDIA QUESTION
Aren’t the chemicals used to kill mosquitoes toxic to other insects, other organisms, and are neurotoxins that can harm people?

KEY MESSAGE POINT
The strategies and methods used to make decisions on mosquito control are based on sound science.

SAMPLE ANSWER
“The EPA has determined that, when used according to label directions, these products do not pose an unreasonable risk. We utilize these products at times and in a manner that minimizes contact with non-target insects and other animals while reducing the population of mosquitoes that carry disease.”

EXAMPLE 4

MEDIA QUESTION
Are the pesticides you’re using destroying our environment?

KEY MESSAGE POINT
The strategies and methods used to make decisions on mosquito control are based on sound science.

SAMPLE ANSWER
“We use pesticides that have undergone stringent testing and are EPA approved. Like medicines, these products are safe and effective when used according to the label directions.”

EXAMPLE 5

MEDIA QUESTION
We just learned that we have a case of EEE in the area. What are you doing to help protect us?

KEY MESSAGE POINT
Mosquito control personnel are committed to protecting families.

SAMPLE ANSWER
“We continue to:
• “Identify and treat specific sites where immature mosquitoes are reproducing;
• “Target areas showing large mosquito populations to kill adult mosquitoes; and
• “Encourage people to eliminate standing water around their houses, which allows mosquitoes to reproduce and to use EPA-approved insect repellents for personal protection.”

EXAMPLE 6

MEDIA QUESTION
What can consumers do to protect themselves from mosquito-borne diseases?

KEY MESSAGE POINT
We urge communities and residents to protect themselves and take an active role in the reduction of mosquito populations.

SAMPLE ANSWER
“We want communities and citizens to take an active role in helping to reduce the mosquito population. This can be accomplished by individuals remembering these 3 ‘Ds’: 

• “Drain any containers or areas of standing water in your yard where mosquitoes can lay their eggs;
• “Dress in light-colored, loose-fitting clothing to protect you from attracting mosquitoes and making it harder for them to bite; and
• “Defend by properly applying EPA-registered repellents.”

See how it’s done? I used the key message points to provide the framework for the answer. It’s quite easy once you practice it. Politicians are masters at it and all successful enterprises are at least adept at it. There’s no reason you can’t master the technique – and you should, for it will pay big dividends in the long run by making you focus on what mosquito control is all about and how your organization’s operations fit into our public health infrastructure – the finest in the world.

So, what have we learned?
Foremost, understand your goals, what constituency you want to influence, and what you want them to do BEFORE you write.

Be simple and clear – avoid jargon in your messaging.

In drafting messages, seek to make a personal connection with your audience.

Use facts, but don’t rely solely on science and data. Find out what motivates your audience and direct your message to that.

Memorize your key messages and utilize them to redirect any and all questions to your “story.”

To assist you in your public relations program, the American Mosquito Control Association has archived a number of public relations resources on its webpage at www.mosquito.org. The AMCA encourages members to use these to the maximum extent possible. You must be a member to access these resources. AMCA’s Public Relations and Public Outreach Tools include: news release examples, media plans for a complete public relations program, how to conduct a media blitz, a mosquito awareness week program and powerful survivor videos.

The fact is, we all serve at the pleasure of the taxpaying public in one way or another. It behooves us to make the case to these same taxpayers that our services are needed, are conducted professionally, and make for a healthier environment for humans and animals.

Indeed, since the discovery by Sir Ronald Ross in 1897 that mosquitoes transmit malaria, the control of mosquitoes has assumed a significance far beyond the federally accepted goal of protecting the quality of life by reducing the hordes of biting insects. No longer would devastating outbreaks of malaria, yellow fever and dengue fever in the United States and elsewhere go unchallenged due to ignorance of their means of transmission. Realizing there now existed a means to obtain a measure of public health protection heretofore unavailable, citizen groups began conducting referenda to establish special taxing districts to fund organized mosquito control activities. In the ensuing years, mosquito control personnel refined their methods through applied research and assisted federal and state agencies in developing certification criteria to ensure conformance to stringent safety standards. The result – the most technically proficient, professional vector control agencies in the world. That is our story, and those are the messages we must continually – and effectively – convey.

“If we think the people are not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion.”

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How do you measure responsiveness and safety when you put a plane in the air for routine or emergency mosquito control? Whether it’s 5,000 acres or 2 million, your confidence shouldn’t come with tradeoffs.

No other organization exceeds the aerial experience, craft, protocols and support of the Dynamic / Clarke team. Price per acre doesn’t tell the full story. For a complimentary Competency & Capabilities Guide to Aerial Application contact a Clarke representative.

Call 800/323-5727 or email your request to Clarke@clarke.com