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Editor-in-Chief
Stephen L Sickerman
850-814-2610
tickerman@comcast.net

Managing Editor
Jack Petersen
850-866-9895
drjack3@hotmail.com

Director of Advertising
Dennis Moore
727-376-4568
amoore@pascomosquito.org

Circulation Editor
Kellie Etherson
352-275-8143
ethersonk@cityofgainesville.org

Associate Editors
Dave Dame, Gainesville, FL
CDR Eric Hoffman, Jacksonville, FL
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Florida Mosquito Control Association
FMCA President
C Roxanne Connelly, Vero Beach, FL
crc@ufl.edu
FMCA Executive Director
Shelly Redovan
PO Box 61598
Fort Myers, FL 33906
239-694-2174
redovan@lcmed.org

American Mosquito Control Association
AMCA President
Janet McAllister, Ft Collins, CO
jmcallister@cdc.gov
AMCA Executive Director
Sarah B Gazi
15000 Commerce Parkway, Suite C
Mount Laurel, NJ 08054
856-694-2174
amca@mosquito.org

About the Cover: The beautiful illustrations that grace the cover and this page were contributed by Hana Nardi, who graduated May 2011 from Florida Gulf Coast University, with a major in environmental studies and minors in art, biology, and interdisciplinary studies. She hopes to earn a spot in the Science Illustration, Graduate Certificate program at California State University in Monterey Bay.

Florida Mosquito Control Association • PO Box 61598 • Fort Myers, FL 33906-1598

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The Vector Genetics Laboratory at the University of California Davis is dedicated to research and training in the areas of population and molecular genetics, genomics and bioinformatics of insect vectors of human and animal disease. We have developed a program aimed at expanding knowledge that may be applied to improving control of disease vectors and that also addresses specific problems of interest in the field of evolutionary genetics. The Laboratory is located in Haring Hall on the UC Davis campus and is part of the Department of Pathology, Microbiology and Immunology of the School of Veterinary Medicine. The research programs within the Vector Genetics Laboratory are directed by Drs Gregory Lanzaro, Yoosook Lee (Department of Pathology, Microbiology and Immunology) and Anthony Cornel (Department of Entomology). We are currently engaged in a range of projects, including studies on sand fly vectors of leishmaniasis in Latin America (Lutzomyia longipalpis), the Culex pipiens complex in the US, Culex theileri in Turkey, mosquito vectors of avian diseases in North America and Africa and the mosquito Psorophora confinis in North and South America, but the major research focus is on vectors of human malaria in Africa.

Malaria, caused by parasites in the genus Plasmodium, is by far the most significant vector-borne disease of man, with about 300 million clinical cases and 1 million deaths each year. The heaviest burden is in sub-Saharan Africa. Why is Africa hit so hard? There is no simple answer to this question. Economic and political issues are major contributing factors, but there are biological factors that also contribute, in a major way, to the African malaria problem. Plasmodium falciparum is the most lethal malaria parasite of man. Among the most important and potent vectors are two closely related and morphologically indistinguishable species: Anopheles gambiae and An arabiensis. Aspects of the ecology and behavior of these species result in their being exquisitely disposed to transmitting malaria parasites and well-adapted to resist efforts to control them. Research being conducted at the Vector Genetics Laboratory at UC Davis is aimed at understanding the genetics of natural populations of these two species and, specifically, in establishing the genetic basis of traits important for malaria transmission and vector control. Our approach centers on two common-sense principles: (1) use the best tools available to address the problem at hand and (2) don’t be afraid to get your hands dirty.

Exciting new tools have been, and continue to be, developed for studying the genetics of disease vectors. The whole genome of An gambiae was sequenced and published in 2002. This achievement and the work leading up to it provided the means of extending studies of vector population genetics into the era of population genomics. In the not-too-distant past the genetics of mosquito populations were described by determining the distribution of variation in 10-20 genetic markers (isozymes, microsatellite DNA). Today such studies can use hundreds or even thousands of
markers such as single nucleotide polymorphisms (SNPs). SNPs are single base pair differences in the DNA of individual mosquitoes. More advanced technologies employing DNA microarrays can allow the simultaneous analysis of hundreds of thousands of markers in a single mosquito (Turner et al. 2005, Neafsey et al. 2010). The University of California Malaria Research and Control Group recently developed what is called a “whole genome tiling array” for An gambiae; see story in Wing Beats Fall 2007. This is a microarray that contains millions of small DNA probes (25 base pairs in length) that cover the entire genome of An gambiae. This allows us to compare the genomes of individual mosquitoes for 13 million genetic markers! The much higher resolution offered by these new tools not only improves our ability to detect genetic divergence between mosquito populations but allows us to pinpoint precise locations in the genome where they differ. Ultimately this will lead to the identification of genes that affect important traits, such as mate choice, host preference, susceptibility/refractoriness to parasite or virus pathogens, insecticide resistance, etc.

Much of the early work that employed these new tools utilized mosquitoes from laboratory colonies that differed in traits like susceptibility to malaria parasites or insecticide resistance. Such studies have serious limitations however, because often the genes influencing these traits in laboratory strains may differ from those operating in nature (Tripet et al. 2008, Boëte 2009). The Vector Genetics Lab is committed to work based on natural populations and we have conducted “boots on the ground” field work in Africa in collaboration with institutions in a number of African countries. We currently have projects involving fieldwork in Guinea-Bissau, Mali, Cameroon, Tanzania and the Comoros Islands. The malaria vector genetics projects currently underway in the Vector Genetics Laboratory are briefly described herein.
The Ecology and Genetics of Anopheles gambiae on Islands

Progress toward the development of genetically modified mosquito (GMM) strains to be used in a genetic control program for mosquito vectors of malaria has reached a point where most of the scientific community involved in this research is beginning to think about field trials. The following recommendation was made by a group of experts in the field of vector biology participating in a meeting entitled “Genetically Engineered Arthropod Vectors of Human Infectious Diseases”: "The exciting progress in molecular strategies for blocking parasite development in vectors has far..."
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outpaced the related and essential work on field sites and vector populations that must precede any GM release field trial.” (Imperial College, London 14-15 September, 2001).

We believe that the most promising sites for GMM field trials would be on islands off the coast of sub-Saharan Africa. In this project we are conducting studies aimed at assessing the suitability of two island groups. Based on a critical analysis of available data we chose to study An gambiae populations on islands in the Bijago Archipelago off the coast of Guinea-Bissau in West Africa and the Comoros Islands located between Madagascar and Mozambique in East Africa. The project includes:

(1) collection of basic ecological and biological data for An gambiae at each site, including relative population densities and adult distribution;

(2) an assessment of the degree to which island populations are genetically isolated from the nearest mainland populations and from populations on neighboring islands, and a description of the genetic structure of populations on individual islands within each of the two island groups;

(3) creation of a GIS system that describes the ecology of each site and is fully integrated with information from the ecology and population genetics studies.

This project is being conducted in collaboration with Drs Charles Taylor and Yongkang Xue of the University of California, Los Angeles. Collaborators in Africa are Dr Amabelia Rodrigues, National Institute of Health (INASA) Guinea-Bissau and Dr Ahmed Ouledi, University of the Comoros (Union of the Comoros).

Identifying Immune Genes Responsible for Susceptibility to Plasmodium Parasites in Anopheles gambiae in Mali and Cameroon

Various signaling pathways in the mosquito immune system have been implicated in the regulation of malaria parasite development in the An gambiae midgut. However, no data are available to confirm that these pathways regulate parasite development in nature. The Vector Genetics Lab, in collaboration with the laboratory of Dr Shirley Luckhart in the Department of Medical Microbiology and Immunology, School of Medicine at UC Davis, are addressing this issue using a SNP association approach with field-collected mosquitoes from Mali and Cameroon. The first component of this project includes population genetic analyses. Plasmodium falciparum infected and uninfected An gambiae are being collected from sites in Mali and Cameroon. These sites were carefully selected to include all of the mosquito genetic diversity known to exist in the region (three molecular forms and chromosome inversion polymorphism). Mosquito samples are grouped by site with respect to infection, molecular form and karyotype. Each mosquito is then genotyped for roughly 384 immune signaling gene SNPs and examined to determine if these SNPs are correlated with infection. If any of the 384 SNPs occurs more frequently in infected versus uninfected mosquitoes, they may contribute to making the mosquito susceptible to Plasmodium infection. In the second project component, being conducted in Dr Luckhart’s laboratory, selected SNPs of interest will be analyzed to determine their effects on mosquito protein function and on susceptibility to P falciparum infection in the laboratory using both mosquito cell lines and live mosquitoes from colony. Protein inhibitors and DNA transfection
protocols are used to mimic the effects of SNP-containing alleles on *P. falciparum* development in artificially infected mosquitoes. This work will take functional data from Dr Luckhart’s lab and from the labs of our colleagues to examine the importance of the selected immune signaling pathways in field-collected mosquitoes. These studies will facilitate selection of appropriate gene targets for strategies involving genetically modified mosquitoes for malaria control and provide critical new insights into the population genetics of immunity in *An. gambiae*. This project is being conducted in collaboration with Dr Sékou Traoré, Malaria Research and Training Center, University of Bamako, Mali and Dr Etienne Fondjo, National Malaria Control Programme, Youndé, Cameroon.

**Ecological and Genetic Determinants of Malaria-transmitting Behaviors in Anopheles arabiensis in Tanzania**

*An. gambiae* is frequently referred to as the most important vector of malaria in Africa and has been the main focus of malaria vector research. Despite this attention, there is growing evidence that it is not this species, but its sister species *An. arabiensis* that is increasingly responsible for malaria transmission in Africa. Reports indicate that in areas of high insecticide treated net (ITN) coverage, *An. arabiensis* outcompetes *An. gambiae* and has become the dominant vector species in many locations. If this phenomenon continues as large-scale ITN programs are rolled out across Africa, this species could become the only medically relevant vector in many parts of the continent. Consequently, the ecology, vectorial capacity and population genetics of this some-what neglected vector merit particular attention in preparation for future vector control scenarios.

This research program integrates vector population genomics, ecology and vector behavior with the goal of understanding the determinants of two mosquito behavioral phenotypes crucial to the transmission and control of malaria: (1) host preference and (2) adult resting behavior. The approach builds upon a sizeable base of preliminary work, conducted in the Vector Genetics Lab, which has identified an extensive panel of *An. arabiensis* SNP markers, and preliminary field work in Tanzania that has identified a range of appropriate sites where sampling methods have been piloted and the behavior of *An. arabiensis* is known to vary. *An. arabiensis* mosquitoes will be intensively collected from four villages in the Kilombero Valley of Tanzania during the wet and dry seasons to determine the association between their feeding and resting phenotype and environmental factors that vary temporally and spatially (component #1). DNA will be extracted from individual samples and multi-locus SNP genotypes determined from each individual. Genotypes will be organized by phenotype (exophilic vs endophilic and human fed vs animal fed) and analyzed to determine SNP allele associations with each phenotype after correcting for population structure (component #2). Knowledge of the genetic basis of these behavioral changes will be vital for prediction of both possible downstream evolutionary responses to current vector control strategies, and also for the development of novel control strategies that improve the application of currently available vector control methods and/or that are based on vector genetic manipulation. This project is being conducted in collaboration with Drs Heather Ferguson and Daniel Haydon, University of Glasgow, UK, Dr Gerry Killeen, Ifakara Health Institute, Tanzania and Dr Eleazar Eskin, UCLA.

Figure 7: Team on the edge of a pasture outside the village of Eticoga on Ilha de Orango one of the Bijago Islands, Guinea-Bissau. Left to right - Joao Denis, Yoosook Lee, Anton Cornel, Greg Lanzaro, George (our boat driver), Charles Taylor and Daniel Otiudi Go.
PopI: An Online Database for Vector Population Genetics

PopI is an individual-level Population Genomics Database for arthropod disease vectors. It is the first open database that combines population, ecology, and individual-level genomic information for arthropod vector species. Content is coordinated by the Vector Genetics Laboratory at UC Davis.

Current research on the genetics of vector populations is evolving toward the integration of genomics with classical population genetics. The relatively new field of “population genomics” will vastly expand our understanding of the biology of human disease vectors by providing a bridge between the laboratory and field. Research in this area promises to:

- define the role of natural variation in complex vector-borne disease transmission cycles
- reveal new targets for next generation of control methodologies
- improve our understanding of how vector populations evolve to avoid current control measures
- inform the development of vectorborne disease models

We envision this database opening new research opportunities both for vector ecologists/epidemiologists and molecular biologists. By integrating information on ecology with information on the spatial and temporal distribution of molecular polymorphisms we will provide opportunities for ecologists to explore the genetic basis of vector phenotypes and at the same time enable molecular biologists to explore the behavior of genes of interest as they occur in nature. PopI can be viewed at: https://grassi2.ucdavis.edu.

LITERATURE CITED


Figure 8: Preparing specimens following 3 days collecting in the village of Nara, Mali. L to r - Adama Sacko, Anton Cornel and Abdrahamane Fofana.

photo by Gregory C Lanzaro

Gregory C Lanzaro
Professor
gclanzaro@ucdavis.edu
Yoosook Lee
Postdoctoral Researcher
yoslee@ucdavis.edu
Vector Genetics Laboratory
Department of Pathology
Microbiology and Immunology
School of Veterinary Medicine
University of California Davis
1 Shields Avenue
Davis, CA 93616
530-752-5652

Anthony J Cornel
Assistant Entomologist
cornel@uckac.edu
Kearney Agricultural Center
University of California Davis
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The hypothesis that the bite of an insect or other arthropod could somehow cause illness or death to human beings has been around for some time. This theory was put forth by several individuals during the second half of the 19th century, although it had been mentioned, perhaps cryptically, in some earlier writings.

GIANTS IN MEDICAL ENTOMOLOGY

Prominent among these early advocates was Dr Carlos Juan Finlay. Finlay, of French and Scottish descent and born in Cuba, graduated from Jefferson Medical College in Philadelphia in 1855 and moved back to Cuba, becoming a highly respected physician. He claimed, rightly so it turned out, that the mosquito Culex fasciatus, now known as Aedes aegypti, transmitted yellow fever virus. However, he had been unable to fully convince the international scientific community during many years of experiments. In most scientific and medical circles, the idea that an insect bite was dangerous was scoffed at, or at least disregarded as folly.

What has been referred to as ‘The Golden Age of Medical Entomology’ began around 1878, when Sir Patrick Manson, working in China, observed the development of the nematode Wuchereria bancrofti in Culex quinquefasciatus. Shortly thereafter, in 1880, a French physician named Alphonse Laveran found the causal organism of malaria living in the red blood cells of humans.

In 1889, Theobald Smith, working for the United States Department of Agriculture, discovered the organism responsible for causing Texas cattle fever, and in 1893, Smith and F L Kilbourne clearly demonstrated that the
A cattle tick was the necessary developmental host to complete the pathogen’s life cycle.

Sir David Bruce, a Scottish pathologist and microbiologist, established in 1895 that the causative agent of nagana (animal African trypanosomiasis) was conveyed from animal to animal by bite of the tsetse fly. Sir Ronald Ross, a physician in the British Army working in India in 1897, reported discovering sexual stages of malarial parasites in “dapple-winged mosquitoes,” which we now call Anopheles.

However, the main piece of scientific work that would, for the most part, convince the world of the role of arthropods in the transmission of pathogens causing human disease was yet to be accomplished.

WORK OF THE REED COMMISSION

In May of 1900, a special commission consisting of Major Walter Reed, Dr James Carroll, Dr Aristides Agramonte, and Dr Jesse Lazear was ordered to Cuba by the United States Army to investigate the cause and prevention of yellow fever. Through a series of simple yet elegant experiments, for the first time using human volunteers with informed consent, the commission showed conclusively that yellow fever virus was spread only by mosquito bite and not by contaminated objects known as fomites, nor by poisoned air.

Most significantly, the commission proposed that the spread of yellow fever could be stopped through rigorous mosquito control methods coupled with patient isolation from mosquito bites. This finding turned out to be one of the great contributions to public health and disease control.

Dr William Gorgas, a sanitary engineer for the Army working in Cuba, skillfully applied the recommendations of the commission in Cuba and within a few short months yellow fever had been eliminated from Havana. Basically, it was a military-style operation, going from house to house looking for mosquito larval sites and fumigating houses with sulfur.

A hideous plague had been swept away. Without doubt, thousands of lives eventually were spared and millions of dollars were saved. This, however, was not the end of the story in Cuba, especially with respect to the use of human volunteers. What follows is the tragic but moving and inspirational story of Clara Maass.
Walter Reed sailed home from Cuba on February 9, 1901, never to return. On board with him were John Kissinger and John Moran, two of his human volunteers, both of whom contracted yellow fever during the experiments but declined the payments in gold offered to them. Major Gorgas, who remained in Cuba, believed in the validity of the commission’s experiments and findings, but he felt that in addition to controlling mosquitoes, means would be needed to completely eliminate yellow fever.

One such approach, ill-fated as it turned out, involved immunization, using infected mosquitoes. With the advice and consent of Major Gorgas and Major General Leonard Wood, the Military Governor of Cuba, Dr Juan GuiJerás, a Cuban physician, began a series of experiments designed to immunize humans by giving them a mild case of yellow fever through mosquito bite.

The hypothesis was simple: allow mosquitoes to feed on a mild case of yellow fever, hold them in the laboratory until they were ready to transmit the virus, then allow them to feed on susceptible (non-immune) humans, who would theoretically acquire a mild case of the disease, survive, and hence be immunized for life. Well, we now know that yellow fever does not behave in this fashion!

Tragically, some of the cases produced in these experiments were much more severe than expected. Three of the volunteers died, including Miss Clara Maass.

Clara Maass was born June 28, 1876 in East Orange, New Jersey. Her parents were German immigrants and she was the oldest of nine children. Economic hardship forced her to leave school at age 15, when she went to work in the Newark Orphan Asylum. In 1893, she entered the nursing program at what was then known as Newark German Hospital, graduating in 1895. In 1898, at age 21, she was named the Head Nurse. Clara Maass was obviously very intelligent, highly motivated and had a bright future.

Also during 1898, Clara served as a contract nurse for the United States Army during the Spanish-American War. At that time, nurses were not able to serve as officers in the Army, as they are today. She cared for soldiers
in Jacksonville, FL; Savannah, GA; and Santiago, Cuba, becoming intimately familiar with typhoid fever, malaria, dengue and yellow fever. After successful service, she was discharged in February 1899 and returned home to New Jersey. The following November, however, Clara again boldly volunteered for service in the Philippines, where the United States Army was fighting. After seven months she was sent home to recover from what was reported to be a case of dengue fever!

OFF TO CUBA AGAIN

Clara Maass must have been a remarkable woman, for in October of 1900, after most of the work of the Reed Commission was complete, Clara again volunteered to go to Cuba to assist in the fight to control mosquitoes and yellow fever. Upon receiving an urgent message – “Come at once” – from Major Gorgas to report, she did so. Upon returning to Cuba, Clara worked in the Las Animas Hospital, caring for victims of yellow fever. Also, she bravely volunteered for the Guiteras mosquito experiments, sending nearly all her payment of $100 in gold home to her mother. Of the 19 participants in these studies, she was the only woman and the only American. She received numerous mosquito bites during May, June and July but did not contract yellow fever, not even a mild case as some historical documents claim.

Clara Maass was bitten for the last time on August 14, 1901. She became ill on the 18th and even with the best medical care available, she died on August 24. She was all of 25 years old. Dr Gorgas kept Clara’s family fully up to date by telegram of her illness and death. After Clara became ill, she wrote to her mother in New Jersey: “God will care for me in the yellow fever hospital the same as if I were home. I will send you nearly all I earn, so be good to yourself and the two little ones. You know I am the man of the family, but do pray for me.”

FALLOUT AND RECOGNITION

As might be expected, Clara’s death, and the deaths of two other volunteers, sent shock waves through the Army, that reverberated all the way back to the United States. The major New York City newspapers carried the story of her death on the front page, and shortly thereafter all human experimentation with yellow fever in Cuba ceased. The New York Times reported that not only was Clara willing to incur the risk of infection and disease, but she desired to make herself immune through infection in order to better serve those suffering from yellow fever.

With her sister Sophie present, Clara Maass was hastily buried in Havana, with full military honors. About six months later, her body was returned to the United States and reinterred on February 20, 1902, in Fairmount Cemetery in Newark. Her plaque reads in part, “greater love hath no man than this,” from the Book of John, chapter 15, verse 13.

Clara’s contributions and memory have been honored in several ways. A Senate Committee finding “…that the services of this nurse can be accepted as of a military character at the time of her death…” resulted in the award of a pension to her mother. Postage stamps bearing her likeness were issued by Cuba in 1951 and by the United States in 1976, which served to help celebrate her 100th birthday. Also in 1976, Clara was inducted, along with 14 others, as a charter member in the American Nurses Association Hall of Fame. In 1952 the Newark German Hospital, where Clara had once been the Head Nurse, was renamed the “Clara Maass Memorial Hospital” in her honor, and it remains so to this day.

POSTSCRIPT

The angel Clara Louise Maass lived and died a true American heroine. Let those of us who toil in the fields of mosquito control and public health resolved to honor and cherish her name and memory, and the names and memories of so many others who have made the ultimate sacrifice for the sake of humanity.

Disclaimer: The views contained herein are solely those of the author and do not necessarily reflect the views of the Department of Defense or the Department of the Navy.

The author thanks John T Cunningham, author of Clara Maass – A Nurse, A Hospital, A Spirit for permission to use photos from his book. A special thank you to my friend and colleague, Dr Rich Robbins, Armed Forces Pest Management Board, for his careful review of the manuscript.
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For the past 23 years, the Lee County Mosquito Control District (LCMCD) has employed certified teachers to teach environmental topics as they relate to the services that the LCMCD provides to our community. The Aquatic Systems Mosquito Education Program began with one instructor and, due to the rapid increase of schools in our area, has grown to three. Since the summer of 2010, I have had the privilege of being a part of this team of Mosquito Educators. Under the direction of Deputy Director Shelly Redovan, we provide instruction to students in K-12 public and private grade schools and post-secondary students at Florida Gulf Coast University.

Now entering a full year of employment with the LCMCD, I feel as though I’ve been a part of this program and the Lee County Mosquito Control family much longer. This feeling of tenure is due in part to the time I spent working with the men and women of the LCMCD last summer. For six weeks, I was immersed in the operations of the agency, learning the roles and responsibilities of each department. From “pant-leg counts” to service requests, trap setting to aerial inspections, blood sample collections from sentinel chickens to bottle-bioassays, I had the opportunity to experience much of what the skilled employees at the district do each and every day. I refer to this summer immersion experience as MOSQUITO BOOT CAMP. I recorded each day’s events in a journal and the following entries are just a few of the learning opportunities I experienced.

07-05-10
I accompanied LCMCD Aerial Inspector Tommy Stewart, who conducted aerial inspections of the Sanibel/Punta Rassa area. This was my first experience in a helicopter, and thankfully our pilot decided to take it easy on me; see Figure 1. It was amazing to see how beautiful the area looks from the air. We inspected a variety of islands by helicopter, looking for larvae as well as larval problem spots on Sanibel, Captiva, and North Captiva. I witnessed the loading of larvicide material and learned how aerial inspectors determine how an area should be treated. Upon landing at the base at the end of the day I felt pretty accomplished – saw the area we live in from a completely different perspective, learned a great deal about the aerial aspects of mosquito control, and made it the entire day without getting airsick!

07-06-10
LCMCD Public Relations Assistant Rick Pardo demonstrated how LCMCD handles service requests. We covered a large area in eastern Lee County, visiting the sites where mosquitoes were claimed to be a nuisance for residents, as well as regular checkpoints; see Figure 2. Rick explained how to determine landing rates and the process of...
Figure 2: The wilds of Lehigh Acres, near the offices of the Lee County Mosquito Control District.

Figure 3: Johnny Jeter, LCMCD Field Inspector.

Figure 4: Bill Stephens, LCMCD Marine Inspector.
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recording the data and reporting to headquarters. I’ll admit that when Rick first explained that the object is to stand still and actually let mosquitoes land on you so they can be counted, I thought he was joking . . . !

**07-07-10**

Field inspection for larvae and adults was the topic of the day. I worked with LCMCD Field Inspector Johnny Jeter, who handles the Pine Island area; see Figure 3. This was my first experience witnessing the absolute necessity of having a mosquito control program for a particular area. Johnny walked me into an area of mangroves, where we immediately were attacked by hundreds of mosquitoes. I’m guessing that within minutes I had forty to fifty bites on my face and neck. After catching up with me as I bolted for the truck, Johnny explained that this experience was nothing compared to how unbearable it would be without LCMCD. Of course, there was no mention of my hasty exit from the mangroves when bragging about my battle scars to friends.

**07-09-10**

LCMCD Marine Inspector Bill Stephens demonstrated how he does his job in the Estero Bay area of the county; see Figure 4. Using a district boat, we inspected a number of mangrove islands and shoreline for larvae and adult mosquitoes; see Figure 5. Bill also explained...
the various regulations regarding pesticide use on state land. He described the impact of the tide on mosquito populations and pointed out quite a few notorious larval habitat sites. I also was given a brief history lesson on the Estero Bay. On one island we inspected, there was an old abandoned drag-line; see Figure 6. Bill explained that at one time the island, along with many others in the area, was set to be developed for condos and marinas. The scars from half-dug channels and the rusty old equipment were evidence of this.

**07-12-10**

I began the day conducting aerial inspections with LCMCD Aerial Inspector Paul Morgan and Pilot Robert Roper; see Figures 7 & 8. We covered a large part of the South Fort Myers area from Bonita Beach up to Iona. We didn’t find a lot of larvae, as much of the areas we inspected were dry. Adult mosquitoes were present at a few of the stops. Later after the aerial inspections were complete, Paul, Wayne Luettich, and I examined other larval sites by truck. We visited a low area where standing water
mosquitoes were developing and apparently breeding, as all stages of mosquito larvae, pupae, and adults drying their wings were present.

07-14-10

I went out with LCMCD Mosquito Surveillance Investigator Tom Miller in the morning to collect the traps that we set the afternoon/night before; see Figure 9. We then sorted them to get weights, while Tom helped me to identify some of the common species. He showed me key characteristics of certain species that made identification easier. Later, I worked with Milton Sterling in the lab to prepare for the PCR (polymerase chain reaction) tests to be conducted. Milton explained...
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the importance of preventing cross-contamination and his role in identifying the presence of disease in the mosquitoes collected. I found this aspect of mosquito control and surveillance fascinating. This is the CSI - Crime Scene Investigation - of Mosquito Control...

07-19-10

I started the day with LCMCD Pilot Dave Johnston, flying to Boca Grande to pick up Aerial Inspector Clyde Nabers; see Figure 10. We inspected the barrier islands around Boca Grande, and after a bout with nausea and vomiting (yes, I got sick), proceeded to Pine Island where I could finish the day inspecting for larvae by truck. The area was relatively dry; therefore the larvae counts were down. An amazing thing I learned today was how efficient lines of communication are at Mosquito Control. I’m not sure there was anyone at headquarters who hadn’t heard of the newbie’s “proper” initiation to helicopter flight by the end of the day...

07-20-10

LCMCD Pilot and Airport Manager, Jim McKeever, flew Arbovirus Technician Sandy Martin and me to draw blood from caged chickens stationed in various parts of Lee County. No airsickness today! Sandy explained the process of extracting blood from the donors and gave me the opportunity to try it out; see Figure 11. Thankfully all the birds survived; see Figure 12. Upon returning to the lab, we separated the blood to catalog it; see Figure 13. The serum was then sent to both the state lab and our own biotechnology specialist, Milton Sterling. Jim McKeever also explained a project that his department has been working on regarding making night flying safer around the various towers in the county.

07-27-10

LCMCD Aerial Adulticiding Coordinator Don Claytor demonstrated how he scans the data from the fog trucks from the previous night’s mission and produces maps of where treatment occurred in the county. He explained that the process is similar for aerial spraying and showed the various maps he has...
archived over the months and years. I spent the rest of the day with Sonny Williams, a field inspector whose territory includes Sanibel Island and Iona. We visited various mosquito larval habitat sites on Captiva and Sanibel and treated areas as needed. I witnessed a fly-over of one of our Jet Rangers as the pilot distributed BTI over parts of South Seas Plantation. We drove through the Ding Darling National Wildlife Refuge and Sonny pointed out the various paths that were carved out to access dipping pools to check for larvae.

Figure 12: Taking blood samples (and sharps) back to the lab.

Figure 13: The author working in the LCMCD science lab.

EPILOGUE

From previous years of experience as a classroom teacher, I recognize that there are times that teachers need to ‘brush up’ on content prior to presenting the material to students. In most cases the teacher is limited to secondary sources from a textbook or teacher’s manual. Upon being hired, if I were simply given a Teacher’s Guide for Mosquito Control and was told to read it and prepare to teach the material, I may have gotten by. However, there is no substitute for ‘hands-on’, real-life experiences.

My confidence in the material and ability to deliver it to our students was greatly enhanced by my time spent at MOSQUITO BOOT CAMP.

Eric Jackson
Aquatic Systems / Mosquito Education Teacher
ericdj@leeschools.net
Lee County Mosquito Control District
Lee County School District
2855 Colonial Blvd
Fort Myers, FL 33966
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As you can well imagine, the AMCA has been engaged on a number of levels with respect to legislative and regulatory problems facing our profession. Our capability to protect our citizenry is increasingly being constricted by environmental laws whose initial purpose is most commendable. Unfortunately, nature often sides with the hidden flaw and the complexities of life on this planet rarely dovetail with congressional intent and regulatory oversight. Such is the case with both the Clean Water Act (CWA) and the Endangered Species Act (ESA) and their effects on public health and agriculture. Both have simple salutary goals easily articulated by their supporters and those charged with their enforcement. The devil, as they say, is in the details.

As you are no doubt aware, the CWA was originally enacted to prevent pollution of our waterways. Fair enough. Unfortunately, pesticides, whether biological or chemical in nature, are now conmingled in the same regulatory scheme with industrial discharges that originally drove the legislation because of the gross pollution of waterways. Was that the original intent of the CWA? I think not. Philosophically, it’s difficult to argue in favor of willfully putting anything into our waterways that adulterates the water column. Nonetheless, larviciding and adulticiding are both components of any comprehensive integrated mosquito control strategy and require our arguing for their continuance if we are to successfully protect the public from mosquito-borne disease. These applications are regulated through the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) – not CWA. However, activists and the courts have been torturing the language of CWA until it has become what they want to hear – and the American public is all the worse for it.

Fortunately, the court mandate for imposition of National Pollutant Discharge Elimination System (NPDES) permits has been postponed until 31 October of this year, in order to allow for the resolution of ESA issues and development of state permits. Absent any legislative fix to the problem, you’d better have your NPDES permits in place by that date.

Speaking of legislative fixes, a bill, HR 872, known as “The Reducing Regulatory Burdens Act of 2011,” passed the House by a bipartisan two-thirds majority that seeks to amend both FIFRA and CWA to exempt pesticide applications done in accordance with the label from further permitting requirements. A similar bill, S 718, was introduced to the Senate, but only sought to amend FIFRA and served as a placeholder for further dialogue and introduction of a Senate bill that parallels HR 872. It may have a different title and number designation in its Senate form. We are awaiting that evolution as I write this and I’ll inform the membership when it is in the offing. It is important to recognize that our membership needs to mobilize and contact their representatives, governors, senators and anyone else involved in the process and present our case that a legislative resolution to this problem is needed if we are to continue to provide cost-effective mosquito control services to our public.

But, alas, NPDES impacts are not the only sticky wicket we face. AMCA has always been wary of the disastrous impacts on mosquito control from an out of control ESA. Indeed, the ESA is rearing its head as environmentalists have levied their so-called “mega-suit” against EPA in the US District Court for the Northern District of California over how it considers endangered species impacts in hundreds of pesticide registrations. The suit argues that EPA has failed to consult with the Interior Department’s Fish and Wildlife Service (FWS) and Commerce Department’s National Marine Fisheries Service to ensure agency pesticide registration decisions do not harm endangered or listed species, a requirement laid out in Section 7 of the ESA. The Center for Biological Diversity (CBD) lawsuit is notable for its broad scope, asking that the agency look at the impacts of 300 pesticides on 214 endangered or listed species across the country.

This is a particularly pernicious suit that could have devastating implications nationwide for both mosquito control and agriculture if successful. The Center for Biological Diversity (CBD) and Pesticide Action Network (PAN) are the plaintiffs and aver that EPA has failed to provide timely consultations regarding approximately 280 active ingredients and their effects on 214 listed/endangered species in 49 states. CBD has said the suit is
designed to force action where there is information that listed species are impacted by pesticides use. Lawyers from Responsible Industry for a Sound Environment (RISE) are petitioning to be granted intervener status in the suit. EPA and CBD recently asked the court for a 90-day stay of the suit to allow for settlement talks. While CBD opposes RISE’s petition, they have no objection to them joining the settlement talks. Indeed, whereas the suit nominally seeks to get the Agency in line with the provisions of Section 7 in terms of meeting statute timelines, it is beginning to look as if the suit has been all about the settlement money the entire time — with the potential injunction against pesticide use serving as a convenient vehicle.

Further complicating the issue, in March a federal appellate court ruled in Dow AgroSciences v. NMFS to reassert the courts’ ability to review BiOps, allowing industry to challenge the opinions before EPA adopts them in its pesticide registration decisions. This is a major blow to the activists, for it introduces a measure of oversight heretofore not available to ensure sound science is used in a more transparent process for development of the BiOps. In speaking of one of the BiOps, Michael Leggett, a senior policy analyst for CropLife, stated it bluntly. “The analysis and conclusions are qualified: “we expect,” “we anticipate,” “reasonably assumed,” “may lead to,” “we believe,” “in general,” or “we suggest” is the type of language that appears throughout the Opinion with little or no quantification of uncertainty.” He further states that, “The speculation of potential effects is strung together to weave an Opinion, including findings of jeopardy, that does not stand up to any ground truth of reality and with no evaluation of likelihood of events.” Wished I’d said that, for it’s the crux of what passes for science in our increasingly regulated environment.

Rep Doc Hastings (R-WA), chairman of the House Natural Resources Committee, has conducted hearings to examine the potential ramifications of the pesticides “mega-suit” and other similar litigation. The ESA issue is a primary concern for Hastings, because upwards of 61% of his home state of Washington is listed habitat and prescriptions on pesticide use in these areas could have devastating effects on both public health and agriculture there. Fortunately, Angela Beehler, vice-president of the Northwest Mosquito and Vector Control Association and the director of the Benton County Mosquito Control District in Representative Hastings’ home district, testified at a joint House Agriculture and Natural Resources Committee hearing on May 3 and did a marvelous job of educating the hearing panel on the public health impacts she expects from this lawsuit should it be successful. The other panel member of note at the hearings was Debbie Edwards, former Director of the Office of Pesticide Programs at EPA. Dr Edwards’ testimony and her responses to committee member questions afterwards involved a letter she sent to NMFS taking them severely to task for shoddy science in their malathion BiOp involving models based upon misuse, incomplete usage data, and faulty modeling assumptions that resulted in unacceptable Reasonable and Prudent Alternatives put forth by NMFS.

Interestingly, Representative Hastings sent a January 26 letter to White House Council on Environmental Quality (CEQ) Chairwoman Nancy Sutley, urging officials to oversee what he termed a “flawed consultation process” be-
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As of this writing, he has not received an answer to his request. Democrats recently sent a letter to EPA urging the agency to strictly address species concerns in its pesticide decisions. Game on.

All AMCA members need to keep a keen eye on this mega-suit, for, if successful, it could adversely effect every mosquito control district in the country where listed or potentially listed species are found – in short, game over.

The key messages we need to keep in mind are:

1: Pesticides are already rigorously regulated and are not in need of further regulation through ESA. Effects determinations by EPA, when forwarded, by statute, to the Services in timely manner through the registration process, should drive timely and coherent BiOps to protect listed species, prevent lawsuits, and not unduly adverse effect legitimate public health and agricultural activities.

2: The ESA consultation process is dysfunctional with regard to pesticides. The process takes entirely too long, the science is oftentimes questionable, and the Services do not have the resources to either speed it up appreciably or provide a more scientifically valid product.

3: In a March 10 letter to the National Academy of Science, the Administration acknowledged fundamental flaws/disagreements with the process. Even the feds are convinced the current process is broken.

4: Therefore, the Services should suspend the implementation, and further development, of BiOps until problems with the current process are resolved.

On a more personal note, my default position is that the government should not be allowed to take away our freedoms until and unless they prove that it is fully and legally justified. Environmental laws inevitably take away some measure of our freedom. So the government as a matter of practice should not impose such regulations unless it can prove that the dangers it is guarding against are, indeed, real. How about this? In order to justify an environmental regulation, the government should be made to satisfy the same burden of proof that you or I would face if we wanted an injunction against our neighbor to stop him from doing something we claimed was endangering our families. Yeah, good luck with that….

Joseph M Conlon  
AMCA Technical Advisor  
conlonamcata@gmail.com  
1500 Millbrook Court  
Fleming Island, FL 32003  
904-215-3008

As stated in number 3, the EPA, USDA, Department of the Interior and Department of Commerce recognize these shortfalls, and on March 10, 2011 sent a request to the National Research Council (NRC) of the National Academy of Sciences to institute a study to come up with a workable solution to some of the fundamental science issues that are compromising the process. Federal officials estimate that it may take as long as 18 months to complete once the project is initiated. In the meantime, it’s business as usual until and if, the lawsuit proceeds. We’ll keep you posted.

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