The Biting Times

Newsletter for the North Carolina Mosquito & Vector Control Association

May 2018

54th Annual Conference

We have an upcoming annual conference for the NCMVCA in December (4, 5) in Greenville, NC.

A Phenological Approach to Mosquito Surveillance and Control in Brunswick County, NC

By Jeff Brown, Rick Hickman, Matthew Dupont and Abram Young

"**P**henology" is the study of periodic plant and animal life cycle events and how these are influenced by seasonal variations in climate, as well as local habitat. Phenological studies can help evaluate the dates of onset and termination of diapause, the period of reproductive activity, and the number of generations that can be expected in a season. Combined, this information provides insights that are important for mosquito professionals looking to develop control measures for individual mosquito species. From a public health perspective, data on the winter survival of mosquito females provides insights on the mechanism of arbovirus circulation and maintenance in nature. (Vinogradova et al 2007).

Currently, there are > 3,500 species of mosquitoes in the world. Of these, 176 species can be found in North America (AMCA 2018), 64 in North Carolina (NC) (Harrison et al 2016) and 49 in Brunswick County. The point being, it all depends on "where you're standing" and "when you're standing" for a particular mosquito species to be collected. Move in time and space and the mosquitoes change. For this reason, once a light trap site is selected it should not be moved. The surveillance goal is to develop a long-term data set that can be accessed in a public health emergency. Continued on page 6.

Inside this issue:

I'm a native mosquito adapted to use both natural and artificial containers, and the second most common mosquito in ovitrap studies in North Carolina. I am happy to feed on people, particularly when they disturb my resting sites. And they should watch out, because I am capable of transmitting La Crosse encephalitis virus, which I can give to my offspring, too. Photo: Sean McCann. Answer page 12.

Message from the President

By Stephanie Richards, MSEH, PhD

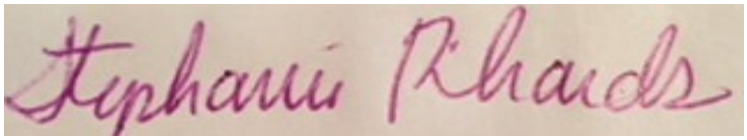
I am honored to serve as the 54th president of the North Carolina Mosquito and Vector Control Association (NCMVCA) in 2018. I was first introduced to the NCMVCA as a graduate student in the Environmental Health program at East Carolina University and got my first introduction to mosquito surveillance in the Craven County Health Department in New Bern. This led me to work in Dr. Charles Apperson's lab in the Entomology program at NC State University where my research focused primarily on control of *Aedes albopictus*. I gave my first conference presentation as a graduate student in front of the welcoming and inquisitive audience of NCMVCA members.

As a reminder, the NCMVCA is a non-profit professional association founded in 1965 to promote public health through mosquito and vector control in NC. Members of NCMVCA and others that conduct mosquito (and other pest) surveillance, research, and/or control are a dedicated group that are worthy of the highest recognition. Our group recognizes the nuisance and potential dangers that vectors pose and seeks to protect public health through an integrated pest management approach.

In October 2017, NCMVCA members and others were involved in a successful Train the Trainer event (in collaboration with the American Mosquito Control Association) in Carolina Beach. In February 2018, NCMVCA held a successful joint educational conference with the Mid-Atlantic Mosquito Control Association in Carolina Beach. The conference was well attended (about 140 attendees). We will have an educational workshop in December 2018 in Greenville and you will find more details in this newsletter.

I would like to thank past and current NCMVCA Board members for their guidance and also the Sustaining Members for their continued support. Without this framework of guidance and support, we would not be able to continue serving our mission. The NCMVCA would like to continue building our membership base in the coming years. We will collaborate with regional/national mosquito and vector control associations, where possible, to bring attention to the need for sustained funding for mosquito surveillance and control programs in NC.

As we enter another mosquito season in NC, please keep us informed of any issues for which the NCMVCA can help your organizations. We appreciate the work you are doing. Thank you again for allowing me to serve as President of the NCMVCA in 2018!



Ham Stevens Award and William Strickhouser Golden Dipper Awards.

Two of our members were honored at this the joint MAMCA/NCMVCA meetings in Carolina Beach for their contributions to mosquito and vector control in North Carolina. Keith Studt of New Hanover Mosquito Control received the William F. Strickhouser Golden Dipper Award for Outstanding Vector Control Operators or Technicians. Great job Keith! Dr. Brian Byrd of Western Carolina University received the Ham Stevens Award for his continuing contributions to mosquito control in North Carolina through his educational, outreach, and research activities.

Keith Studt and his Golden Dipper Award with Marie Hemmen, New Hanover Mosquito Control District Director.

The Biting Times, April 2018

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Photos: Matt Bertone, Sean McCann, Brian Byrd, Tim DuBois

Editor's Note: Provide feedback.

The Editor in Chief encourages feedback about The Biting Times, both specific concerns and general issues. Furthermore, we will happily publish letters to the editor on specific topics from any member of the association. So, if something strikes you in this issue and you want to compliment or complain, email the EIC: mhreiski@ncsu.edu.

State Vectorborne Program Updates

By Michael Doyle

Over the last year, the State Vectorborne Program, in partnership with NC State, East Carolina, and Western Carolina universities have been made considerable progress in preparing local mosquito and tick programs to prevent and respond to vector-borne illnesses. This has taken on many forms. First, we now have a solid understanding of the distribution of *Ae. albopictus, Ae. triseriatus,* and *Ae. japonicus*, as well as the absence of *Ae. aegypti*, across the state. We also better understand of the daily and seasonal behavior of container-breeding species (specifically *Ae. albopictus*). For example, we have learned about the daily host-seeking habits of Ae. albopictus, and its susceptibility to the most common adulticides used in North Carolina. As local programs learn of these results, they should be able to adjust the time of day that adulticiding is done for this species, and which adulticide active ingredients are most likely to be effective in their area.

The State's AA908 program, which involves providing State funding to, and collaborating with, 10 "Counties of Regional Expertise" (CRE) and 5 "Basic" county programs, has already resulted in increasing cooperation amongst counties. The funding has also provided for a wide variety of new tools, from scopes and lab equipment in Haywood County, to a Buffalo Turbine sprayer in New Hanover. All of these counties will be sharing information with each other through the new "MosquitoNet" database. For the 10 CRE counties, this means a minimum of monthly collections from CDC light traps, gravid traps, BG Sentinels, ovitraps, and Landing rate counts. For the 5 Basic counties, we will be seeing collections from at least one of these methods every month. Continued, next page.

Even better, these results are available to any North Carolina city, town, or county vector program that signs up for MosquitoNet. Summary data (at the County level) is viewable to all MosquitoNet members. (To protect privacy, detailed location data -- e.g., specific trap locations -- are only available within the boundaries of each mosquito program). All known NC vector control programs are already on file at CDC for acceptance, and can register at https://www.cdc.gov/Arbonet/MosquitoNET/.

Testing for infected mosquitoes will continue the summer of 2017, with the State Lab planning to test approximately 500 pools statewide for West Nile virus (WNV), eastern equine encephalitis (EEE), and LaCrosse encephalitis (LAC). If your program wishes to test mosquitoes this year, please contact the State to coordinate how many pools should be reserved for your program.

Please contact either Michael Doyle (primarily mosquito issues; michael.doyle@dhhs.nc.gov) or Dr. Alexis Barbarin (primarily tick issues; alexis.barbarin@dhhs.nc.gov) for more information.

Culex coronator shows up in Mecklenburg County!

By Brian Byrd, Western Carolina University, James Bjorneboe, Mecklenberg County

Larval collections of *Culex coronator* made in September 2017 were positively confirmed by James Bjorneboe (Mecklenburg County Health Department) and Brian Byrd (Western Carolina University). The two separate collections were within residential neighborhoods located in the southwestern portion of the county; both collection sites were less than 10 km from the South Carolina border. The finding is not unexpected as the geographic range of *Culex coronator* has increased from the Gulf States into the mid-Atlantic States in recent years[1-6]. As a competent West Nile virus vector, mosquito control agencies should keep a keen eye out for this species of public health importance. Additional information about the biology and spread of this species may be found in the below references.

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4. Gray, K.M., N.D. Burkett-Cadena, and M.D. Eubanks, Distribution expansion of *Culex coronator* in Alabama. J Am Mosq Control Assoc, 2008. 24(4): p. 585-7.

5. Smith, J.P., et al., *Culex coronator* Dyar and Knab: a new Florida species record. J Am Mosq Control Assoc, 2006. 22(2): p. 330-2.

6. Debboun, M., et al., First record of *Culex (Culex) coronator* in Louisiana, USA. J Am Mosq Control Assoc, 2005. 21(4): p. 455-7.

(**from Page 1**)

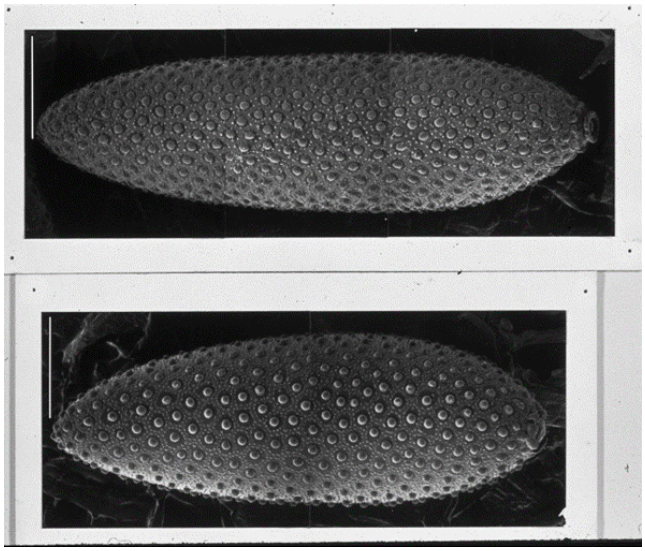
Let's begin our phenological journey by describing the criteria we need to evaluate mosquito seasonal lifecycle events. Latitude is the measurement in degrees of the earth in a North-South direction and is divided into four zones. They are the Tropical zone (0°-23°N), the Subtropical zone (23°-35°N), the Temperate zone (35°-66°N) N and the Frigid zone (greater than 66°N).

Southern NC is in the subtropical zone and northern N C is in the temperate zone (**Table 1**). For any given latitude there is a set of unique climactic properties. The temperate latitudes in NC cycle through four distinct seasons with regularly changing hours of daylight. The exact seasonal cues for each latitude are difficult to interpret on a daily basis. Typically, the variables are easier to interpret after the data is collected and evaluated at the end of the year. The overall goal of the mosquito professional is to put your finger on the pulse of the mosquito population and keep it there throughout the season. With this information mosquito programs can effectively implement Integrated Pest Management (IPM) strategies.

Tropical Zone	**0°-23°North**
Subtropical Zone	**23°-35°North**
Calabash	33°53′33″N
Wilmington	34°13′24″N
Lumberton	34°37′38″N
Jacksonville	34° 45′ 35″N
Temperate Zone	**35°-66°North**
Greenville	35°36′6″N
Fayetteville	35°3′9″N
Raleigh	35°46′N
Rocky Mount	35°56′18″N
Greensboro	36°4′48″N
Elizabeth City	36°17′44″N
Frigid Zone	**Greater than 66°North**

Table 1. Latitude references for cities in North Carolina

The next step in this phenology process is to identify the dormancy considerations that come into play at a given latitude. To do this we need to define the phenologic terms that may come into play. Hibernation is the cessation or slowing of activity at low temperatures; especially slowing of metabolism during the winter months. Aestivation is the cessation or slowing of activity during the summer; especially slowing of metabolism during a hot or dry period.



Aedes albopictus (top) and *Aedes aegypti* (bottom) eggs (SEM photo, JR Linley). Many *Aedes* go into an egg diapause, including *A. albopictus* (but not *A. aegypti*).

Diapause is defined as "a neurohormonally mediated, dynamic state of low metabolic activity. Associated with this is a reduced morphogenesis, increased resistance to environmental extremes, and altered or reduced behavior activity" (Vinogradova et al 2007).

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The terms "facultative" and "obligate" diapause are used to identify which type of diapause is occurring. Obligate diapause does not rely on environmental cues. It simply occurs in each generation when the insect reaches a certain developmental stage in its development (Romoser and Stoffolono 1998). Mosquitoes typically do not employ obligate diapause. Facultative diapause on the other hand relies on environmental factors and provides the potential for producing multiple broods of mosquitoes in a single season. Typically, daylength drives facultative diapause, but temperature, food quality and rainfall frequency may contribute. (Romoser and Stoffolono 1998).

Before diving into a discussion of diapause in mosquitoes we need to introduce one more term "quiescence", which is the state of inactivity caused by short-term unfavorable environmental conditions. This temporary condition stops shortly after exposure to favorable environmental conditions (Romoser and Stoffolono 1998). Quiescence is an adaptation to short term environmental changes where water level may be subjected to large and abrupt fluctuations. Such quiescence results in an asynchronous hatching of eggs. Usually the first flooding induces hatching of some of the eggs, whereas the remainder of the eggs may hatch much later after subsequent flooding episodes (Vinogradova et al. 2007). *Ochlerotatus*, *Aedes*, and *Psorophora* genera are good examples of mosquitoes that have adapted to deal with short tern climactic changes. (Vinogradova et al. 2007). Typically, we anticipate 5 to 12 salt marsh mosquito broods a year.

Mosquitoes can enter diapause at 3 of the 4 metamorphic life stages: the egg stage, the larval stage, and adult stages. The pupal stage seems to be the exception. Individual mosquito genera employ different diapause strategies. For example, egg stage diapause is typical for *Ochlerotatus*, *Aedes*, and *Psorophora*. Adult diapause occurs mainly in *Anopheles*, *Culex*, and *Culiseta*. Larval diapause is encountered in distinct representatives of many genera such as *Anopheles, Ochlerotatus, Culiseta, Mansonia, Orthopodomyia, Wyeomyia,* and *Toxorhynchites*.

Mosquitoes exhibit three types of diapause:

1. Egg Diapause: Egg or embryonic diapause occurs in mosquitoes of the genera *Ochlerotatus*, *Aedes*, and *Psorophora*.

2. Larval Diapause: The main characteristic of larval diapause in mosquitoes is a strong arrest of development, most often in the 3rd- or 4th-instars; certain environmental factors are required for the termination of such developmental delays. A similar retardation of larval development may be induced directly by low temperature; however, in this case development quickly resumes in response to an increase in temperature.

3. Adult Diapause: Adult mosquitoes overwinter in various natural (caves, hollows, holes, burrows, etc.) and artificial (cellars, crawl spaces, empty sheds, storm drain systems, etc.) (Vinogradova et al. 2007).

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Now that we have defined the terms needed to employ phenology, we need to examine the five phases of diapause so we can put our finger on the pulse of our local mosquito populations and keep it there. Diapause is the delay in development in response to regularly and recurring periods of adverse environmental conditions. It is a physiological state of dormancy with very specific initiating and inhibiting conditions. Diapause is a mechanism used as a means to survive predictable, unfavorable environmental conditions, such as temperature extremes, drought, or reduced food availability. Activity levels of diapausing stages can vary considerably among species. Diapause may occur in a completely immobile stage, such as the pupae and eggs, or it may occur in very active stages that undergo extensive migrations (Kostal 2006).

A *Culex pipiens* overwintering inside a home. This is an example of adult diapause. The female will emerge ready to lay eggs in the spring. Photo by Sean McCann.

Insect diapause is a dynamic process consisting of several distinct phases. While diapause varies considerably from one type of insect to another, these phases can be characterized by particular sets of metabolic processes and responsiveness of the insect to certain environmental stimuli (Kostal 2006). The five steps of diapause are induction, preparation, initiation, maintenance and termination.

The induction phase occurs at a genetically predetermined stage of life, and occurs well in advance of the environmental stress (Kostal et al. 2006). This sensitive stage may occur within the lifetime of the diapausing individual, or in preceding generations, particularly in egg diapause (Huffaker and Gutierrez 1999). During this phase, insects are responsive to external cues called token stimuli, which trigger the switch from direct development pathways to diapause pathways. Token stimuli can consist of changes in daylength, temperature and food availability. These stimuli are not in themselves favorable or unfavorable to development, but they herald an impending change in environmental conditions (Tauber et al. 1986).

The preparation phase usually follows the induction phase, though insects may go directly from induction to initiation without a preparation phase (Kostal et al. 2006). During this phase, insects accumulate and store molecules such as lipids, proteins, and carbohydrates. These molecules are used to maintain the insect throughout diapause and to provide fuel for development following diapause termination. Composition of the exoskeleton may be altered by changing hydrocarbon composition and by adding fats to reduce water loss, making the organism resistant to desiccation (Hegdekar 1979).

Photoperiod or daylength is the most important stimulus initiating diapause (Chapman 1998). The initiation phase begins when morphological development ceases (Kostal 2006). In some cases, this change may be very distinct and can involve molting into a specific diapause stage, or be accompanied by color change (Kostal 2006).

During the maintenance phase, insects experience lowered metabolism and developmental arrest is maintained (Kostal 2004). Sensitivity to certain stimuli which act to prevent termination of diapause, such as photoperiod and temperature, is increased. At this stage, insects are unresponsive to changes in the environment that will eventually trigger the end of diapause, but they grow more sensitive to these stimuli as time progresses and seasons change.

In insects that undergo obligate diapause, termination may occur spontaneously, without any external stimuli (Kostal 2006). With facultative diapause, token stimuli must occur to terminate diapause. These stimuli may include chilling, freezing, or contact with water, depending on the environmental conditions being avoided. These stimuli are important in preventing the insect from terminating diapause too soon, for instance in response to warm weather in late fall (Kostal 2006).

The next step is to discuss what regulates diapause. There are two primary influences that regulate diapause, they are environmental and physiological regulators. The environmental stimuli interact with genetic preprogramming to affect neuronal signaling, endocrine pathways, and, eventually, metabolic and enzymatic changes.

Environmental regulators of diapause generally display a characteristic seasonal pattern. In temperate regions like norther NC, photoperiod is the most reliable cues of seasonal change (Huffaker 1999). Depending on the season in which diapause occurs, either short or long days can act as token stimuli. Insects may also respond to changing day length as well as relative day length. Temperature may also act as a regulating factor, either by inducing diapause or, more commonly, by modifying the response of the insect to photoperiod (Huffaker 1999). Insects may respond to thermo-period, the daily fluctuations of warm and cold that correspond with night and day, as well as to absolute or cumulative temperature.

Mosquitoes use three physiological hormones to regulate diapause, juvenile hormone (JH), diapause hormone (DH), and prothoracicotropic hormone (PTTH). The corpora allata gland generates JH; as such, it plays a crucial role in metamorphosis. Adult diapause is often associated with the absence of JH, while larval diapause is often associated with its presence (Dorrer et al.1992). In adults, absence of JH causes degeneration of flight muscles and atrophy or cessation of development of reproductive tissues, and halts mating behavior. The presence of JH in larvae may prevent molting to the next larval instar. JH is required for the accumulation by the fat body of a storage protein that is associated with diapause (Brown 1978).

The DH regulates embryonic diapause in eggs. It is released from the subesophageal ganglion of the mother and triggers trehalase production by the ovaries. This generates high levels of glycogen or stored energy in the eggs, which is converted into the polyhydric alcohols glycerol and sorbitol. Sorbitol directly inhibits the development of the embryos. Glycerol and sorbitol are reconverted into glycogen at the termination of diapause (Horie et al. 2006).

Prothoracicotropic hormone (PTTH) stimulates the prothoracic glands to produce ecdysteroids that are required to promote development of the cuticle or exoskeleton. Larval and pupal diapause is often regulated by an interruption of this connection, either by preventing release of PTTH hormone from the brain or by failure of the prothoracic glands to respond to prothoracicotropic hormone (Denlinger 2002).

Brunswick County uses a phenological approach to mosquito surveillance and control in order to keep our finger on the pulse of its population. Certain criteria are needed to evaluate mosquito seasonal life cycle events. Latitude is the primary consideration, since the county falls in the northern range of the subtropical zone. As such, photoperiod is the most reliable cue of seasonal change for this area. Our year around daily light trapping provides the surveillance data to identity what time of year to expect any given mosquito to be present. For example, if you want to collect the univoltine mosquitoes *Ochlerotatus thibaulti* February and March is the best time to collect larva, while March and April are the best times to collect adults in Brunswick County.

The three types of diapause (egg, larval and adult) and the genus of the mosquito, determine which facultative diapause strategies come into play. All three types utilize the five physiological phases of diapause. Diapause is further regulated at the physiological level by JH, DH) and PTTH.

To sum up, Brunswick's phenogical approach to mosquito surveillance is similar to the chorus of Jimmy Buffet's song Changes in Latitude Changes in Attitude.

It's those changes in latitudes,

changes in attitudes, nothing remains quite the same.

With all of our running and all of our cunning,

if we couldn't laugh, we would all go insane.

Brunswick's approach is similar, it's the geography, topography, seasonality, climatology and individual mosquito biology which gives us something to put our fingers on and regularly check for a pulse. Continued, next page.

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North Carolina Division of Public Health Hopes to Confirm Lyme Expansion into NC

By

Dr. Alexis Barbarin, Public Health Entomologist

The North Carolina Division of Public Health, Communicable Disease Branch (CDB) has taken the first steps to uncovering the extent of Lyme expansion into North Carolina. Research published by Paul Lantos in 2015 used human disease surveillance data to suggest that Lyme will continue to creep into North Carolina along the south-western border of Virginia. With the help of CDC Expanding Laboratory Capacity (ELC) funding, the Communicable Disease branch contracted Dr. Gideon Wasserberg at UNC-G to conduct tick surveillance in five counties in the northwestern part of the state. Those counties include Ashe, Allegheny Surry, Wilkes, and Yadkin. Entomological surveillance in these five counties is ongoing, and ticks collected will be sent to the CDC in Fort Collins for pathogen testing. Preliminary results indicate that *Borrelia burgdorferi* is present in ticks collected via flagging in Stokes and Rockingham Counties, and collected off of deer hosts in Stokes, Rockingham, Yadkin, and Forsyth Counties.

Additionally, the Communicable Disease Branch is also kicking off *the North Carolina Tick Identification and Cataloging Program* or *NC TIC*! In an effort to understand the distribution of ticks in North Carolina, state public health entomologists will identify and catalog ticks submitted by veterinarians throughout the state. Data will be coupled with human disease surveillance to identify counties most at risk for high incidence of Rocky Mountain spotted fever, and Lyme disease; data will also be used to determine counties most in need of public education programming for vector borne disease prevention.

Guess that Skeeter! *Aedes triseriatus*

By Michael Reiskind

This mosquito is a common backyard pest throughout North Carolina, but is more common in heavily wooded areas. Consequently we find it in great abundance in western North Carolina, where it is a major threat to public health due to its role as the vector of La Crosse encephalitis virus, causing anywhere from a few to a dozen cases of disease every year, mostly in young children.

Aedes *triseriatus* feeding on a human . Photo by Sean McCann.

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Program	Dr. Stephanie Richards (website)	richardss@ecu.edu	252-328-2526
Parliamentarian	OPEN		
Auditor (from membership)	OPEN		

Do you want to be more involved with the NCMVCA as a member on a committee? Speak to any of the above individuals, or contact the new officers at the end of the conference to see how you can help your organization continue to grow and promote vector control in North Carolina.

NCMVCA

North Carolina Mosquito &Vector Control Association

Op/Ed: I Wonder if Anyone Heard What I Just Heard

By Joe Andrews, All-Pro Vector Group

I have just returned from the annual American Mosquito Control Association conference held this year in Kansas City, MO. Every year includes a grand banquet with introduction, awards, and a keynote address, a welcome way to end the week of papers and talks. This year's address was given by woman who has survived a neuro-invasive case of West Nile Virus. Despite her survival, she is forever altered and complications will continue.

She is a preschool teacher, who taught dance and had a vibrant, fun, and family-centered life; evidenced by the photographs flashing on the screen behind her. She began her story sharing the early signs of West Nile that mimic so many other ordinary illnesses. After going to the doctor and receiving a non-specific diagnosis, she was sent home. She continued, her symptoms grew worse and turned to another doctor, again she was sent home with pain medication and told to "tough it out."

Through all of this she was missing work and social outings and time with her family. Her suffering grew unbearable. After, several weeks of pain and anguish and internet research she found an infectious disease specialist who had the right tools and information to diagnose her with West Nile Virus.

Weak, racked with pain, a headache so terrible she could no longer tolerate the, she had her diagnosis but too late. Sadly, the damage had been done. Forced to wear sunglasses in the dim light of the banquet, her stance at the podium, and needing assistance to and from the podium all proved that her story is one of misdiagnosis.

During her speech, she mentioned that her nephew wants to be a mosquito control superhero. In fact, he looks forward to the mosquito control truck rolling through the neighborhood, every Tuesday.

Every Tuesday.

I wonder if anyone heard what I just heard. Yep! Every Tuesday, like clockwork, came the mosquito control truck. I am sure you have all read the literature and attended the presentations that show, categorically, that West Nile vectors are most active on Tuesday evenings. I'd bet dimes to doughnuts that the mosquito control program in her area does not have the ability or the capability of surveillance. In this instance, ability is "to have the knowledge to do surveillance" and capability is "to have the budget to do so." This instance of misapplication and missed surveillance could also be interpreted as *misdiagnosis*.

Surveillance is a broad term meaning "to have an awareness of mosquitoes and their pressures at a given time." It can be fancy or it can be simple. For many small towns it has to be simple to meet the ability and capability of the program. I am envisioning a public works employee who sprays for mosquitos on top their myriad responsibilities. Partnering with, or even communicating with, a larger district can increase the ability and capability of a smaller operation.

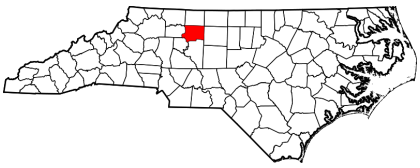
Imagine if the larger district two counties over had shared their knowledge on an increased risk of West Nile Virus. Imagine if that same district reached out in the off season to help the smaller operation understand the importance of surveillance and targeted application or how to setup a trap. Often times a small organization does not have the resources or knowledge to reach out when needed but should when needed, just as a larger organization should share with their neighbors in the spirit of public health.

I implore all reading this to continue to strive toward a public health stewardship. When told to spray in the afternoons explain why dusk would be better. When told to spray every Tuesday explain why regularly scheduled application may not be appropriate. Break it down to cost if you have to. Tell them that the nature of mosquito control lends itself to spraying at the right times on the right days (not necessarily Tuesdays) for maximum efficacy and efficiency.

If the woman at the beginning of this article didn't contract West Nile in her backyard, it could have been at the park while with her family. The misdiagnosis of her illness may have been related to the misdiagnosis of the mosquito control surveillance program in her area. Our mission should be to reduce the potential of transmission of vector-born disease. This state is blessed to have a deck loaded with vector management professionals, from our universities to the good ole boys who have been around the block more than once. Give 'em a holler and see what you can be doing better.

Culex nigripalpus a potential West Nile virus vector expanding northward in North Carolina.

Bruce's Corner, Guest Writer: Ryan Harrison



Trapping *Culex* in the Piedmont of NC

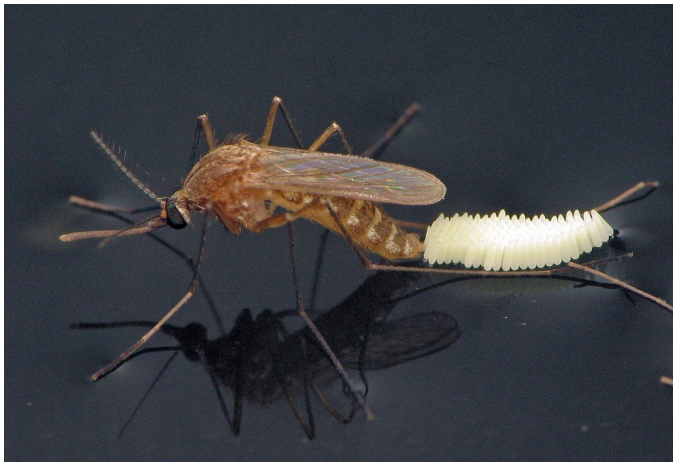
By Ryan Harrison, Forsyth County Department of Public Health

Since 2012 Forsyth County Department of Public Health has conducted arbovirus surveillance with CDC gravid traps using hay infusions. These traps are set out midafternoon and then collected the following morning 3 days a week. Using this technique, we are able to capture *Culex pipiens* and *Culex restuans*, which are known vectors for West Nile Virus (WNV). Gravid females are then pooled and tested by the State Lab of Public Health. Gravid traps will generally catch fewer specimens than other types of traps, as well as fewer species. Low variation of species and lower trap totals means a quicker turnaround with task of identification and pooling. These features together make gravid traps a great technique for smaller programs low on resources. Pinpointing Culex populations allows a small program to achieve the mission of preventing disease more efficiently and effectively.

Culex restuans adult female. This photo was taken in Raleigh on April 19, 2017 in the basement of Gardner Hall, where these mosquitoes were breeding in the sub-basement. Photo by Matt Bertone.

Learning where *Culex* spp. habitate can be a challenging process. In Winston Salem we find certain features that appear to be associated with our populations of *Cx. pipiens*. These include: Concrete structures (bridges), dilapidated buildings, municipal sewer vent pipes, septic tanks, old underground waterways, and storm water vaults. In the downtown area of Winston-Salem, the Norfolk Southern train system has several lines which are used to transport corn products. This railway supplies food (spilled corn) which in turn attracts a variety of birds, which, of course, are the reservoir for WNV. As these birds roost underneath the bridges and abutments, they are easy prey for mosquitoes. Our best trap area is located under one of these bridges. Also this site has a sewer vent pipe an underground waterway and is located in a 200-year-old section of Old Salem. This larval habitat has yet to be found, although I suspect it is in an underground void.

Once a potential area is found, traps may need to be set multiple nights to assess the population of *Culex*. as nightly totals of *Culex* may fluctuate significantly. Forsyth County has historical data demonstrating trap totals that rose from zero to fifty females, and then returned to near zero within 5-7 days. This population burst repeated itself a few weeks later, with no apparent correlation to natural phenomena such as temperature or rainfall. In the 2017 season, our trap averages rose from the usual low 1-5 nightly average to 15-25 gravid female *Culex* per trap and our best trap in 2017 captured 186 gravid Cx. pipiens in one night. It's easy to be discouraged by the low trap numbers with gravid traps, especially when you are accustomed to collecting CDC $C0_2$ baited light traps! Last season Forsyth County had four positive West Nile pools (*Cx. pipiens*). The largest of these pools held 35 mosquitoes and one of these pools only held one single mosquito. So low trap totals don't necessary mean much as it only takes one mosquito to transmit WNV to a human.



Ovipositing *Culex quinquefasciatus* mosquitoes. Photo by Sean McCann.

Surveillance for *Culex* spp. with CDC gravid traps is a tremendously beneficial process to any program big or small. Once populations of these species are found, the area can be mapped and trapped, and the data collected will be beneficial for years to come. For Forsyth County staff, we searched for years for our isolated but large populations of *Cx. pipiens*. Now that we are becoming more familiar with our quarry, we can more effectively monitor these populations and by doing so, fulfill our obligation to the citizens of Forsyth County more effectively. Good luck and good *Culex* hunting!

AMCA/CDC's "Train the Trainer" Came to NC

On October 11-12, 2017, the NCMVCA co-sponsored a "Train the Trainer" event in Carolina Beach, NC. The goal of this program, paid for by a grant from the Centers for Disease Control and Prevention to the American Mosquito Control Association, was to reach out to folks who are important decision makers with regards to mosquito control, but themselves may not have a strong knowledge base about mosquitoes. We had 42 attendees from NC, SC, VA, FL, and MI! The course involved hands-on activities, and was well received. The instructors also learned a lot about the benefits of a interactive learning environment, and some of the exercises might show up, in a modified form, at our future annual meetings. So watch out! You can also check out some on-line training opportunities from AMCA here.

Order Form

The Mosquitoes of the Mid-Atlantic Region: An Identification Guide

Bruce Harrison, Brian Byrd, Charles Sither, and Parker Whitt

This 201 page spiral-bound 8.5 X 11 inch guide includes dichotomous keys to the adult females and fourth instar larvae for 8 states (DE, GA, NC, MD, PA, SC, VA, and WV) with more than 585 novel Adobe Illustrator figures. Printed on 100 lb gloss paper, this guide includes sections such as: 1) Taxonomic Interpretations, 2) State Records, 3) Basic Morphology, 4) The Acquisition of Characters to Separate Larval Instars, 5) Extensive Notes, 6) Couplet Sequences, 7) Illustration Index, 8) How to Use a Dichotomous Key, 9) Glossary, and others. The keys were thoughtfully reviewed by experts from the Smithsonian Institute, North American Mosquito Control Districts, and Academia.

Item	Quantity	Price per key	Total
Mosquito key		**$30**	
		Grand total:	

Name: _____

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Mailing Address (where key will be mailed): _____

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Method of Payment: Check (payable to **NCMVCA**) Invoice required (emailed to address given) Credit card (see below)

Card number: _____ Expiration date: _____

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