

## The Connecticut Center for Vector Biology & Zoonotic Diseases: A Long History of Research Partnership and Outreach in Public Health Entomology

by Goudarz Molaei and Theodore Andreadis

The Connecticut Agricultural Experiment Station (CAES) is a Land Grant Institution that was established in 1875 as the first agricultural experiment station in the United States. The mission of the Station is to develop, advance, and disseminate scientific knowledge, improve agricultural

scientists have conducted many landmark investigations on the ecology and epidemiology of a myriad of mosquito-borne arboviruses native to the region that cause human disease including: Cache Valley, eastern equine encephalitis (EEEV), Jamestown Canyon, La Crosse, and West Nile

was established in 2009 as a joint venture among the Departments of Entomology, Environmental Sciences, and Forestry. The Center formally brought together the research, surveillance, and diagnostic activities of the CAES scientific and technical staff on arthropods of public health concern



Figure 1. Research technician Angela Bransfield working at the CVBZD Biosafety Level 3 containment laboratories in New Haven, CT.



Figure 2. Research technician (Noelle Khalil), seasonal research assistant (Julia Ellman), and student interns (Morgan Fitch and Kristy Lok) from the New Haven University performing molecular assays and identifying tick species at the CVBZD Tick and Tick-borne Diseases laboratory located at the Jenkins-Waggoner Building in New Haven, CT.

productivity and environmental quality, protect plants, and enhance human health and well-being through basic and applied research in four core areas: agriculture, food safety, the environment, and public health. The CAES is currently organized into five academic departments: Analytical Chemistry, Entomology, Environmental Sciences, Forestry, and Plant Pathology & Ecology.

CAES scientists have a long, rich tradition of research in public health entomology (see Anderson 2010) with the first publication on mosquitoes dating back over a century ago when malaria was still a serious disease in the state (Britton and Viereck 1904). Over the past 118 years, CAES

(WNV) as well as equally significant investigations on mosquito biology, behavior, and ecology, morphology and physiology, genetics, taxonomy and biological, chemical and physical control (Anderson 2010). The Station has also been a leader in the study of ticks and associated tick-borne diseases in the northeastern US with a major focus on tick ecology and control. These research activities have resulted in publication of hundreds of scientific papers in peer-reviewed journals and contributed to a better understanding of the role of arthropods in pathogen transmission.

The CAES Center for Vector Biology & Zoonotic Diseases (CVBZD)

and the infectious disease organisms they transmit in Connecticut and the Northeastern US. The mission of the Center is to advance the knowledge of epidemiology and ecology of vector-borne disease organisms and to develop novel methods and more effective strategies for their surveillance and control.

The CVBZD is currently engaged in laboratory and field research on the biology and control of mosquitoes, ticks, and bedbugs and is investigating the epidemiology and ecology of mosquito-borne viruses that occur throughout the region including WNV, EEEV, and other arboviruses, as well as



Figure 3. The Johnson-Horsfall Building in New Haven, CT, where the CVBZD Biosafety Level 3 containment laboratories are located.

tick-borne pathogens such as *Borrelia* spp., *Anaplasma phagocytophilum*, *Babesia microti*, *Ehrlichia* spp., and Powassan virus. The Center is additionally responsible for conducting the state-wide mosquito and arbovirus surveillance for EEEV and WNV as well as active and passive tick and tick-borne diseases surveillance.

In 2017, the CVBZD in partnership with Cornell, Columbia, and Rutgers Universities, and Wadsworth Center, New York State Department of Health, established the Northeast Regional Center for Excellence in Vector-Borne Diseases (NEVBD) network of researchers, public health experts, and vector-borne disease professionals to collaborate on applied research projects, professional training programs, and the sharing and creation of resources on mosquitoes, ticks, and the pathogens they carry in the region. The NEVBD received a competitive research grant from the Centers for Disease Control and Prevention for 2017-2021, and as a result of this research funding and partnership, has published over 100 articles in peer-reviewed journals and hundreds of other educational materials on vector-borne diseases.

The CVBZD maintains several microbiology, pathology and molecular biology laboratories, a transmission and scanning electron microscope laboratory, a Biosafety Level 3 containment facility (Figure 1), the Tick and Tick-borne Diseases Laboratory (Figure 2), and the Insect Information

Office located at the main campus in New Haven, CT (Figure 3 and Figure 4). Insectary facilities for maintaining insect and tick colonies are located at the New Haven campus and the CAES' 75-acre research farm in Hamden, CT. A field station for conducting additional studies is located at the Griswold Research Center in Griswold, CT.

Core funding for the CVBZD is provided by the State of Connecticut and federal Hatch funds administered by the United States Department of Agriculture (USDA). The Active Tick and Tick-borne Disease Surveillance Program is supported in part by the CDC. Research and surveillance activities are additionally supported by grants from the Centers for Disease Control and Prevention, the National Institutes of Health, USDA Agricultural Research Service, Northeastern Mosquito Control Association, and other mosquito control agencies through cooperative research agreements. Current staff includes 7 PhD Lead Scientists, 2 PhD Emeritus Scientists, 3 PhD Postdoctoral Scientists, 1 MS Support Scientist, and 7 Research Technicians.



Figure 4. The Jenkins-Waggoner Building in New Haven, CT, where the Department of Entomology, Insect Information Office, and Tick and Tick-borne Diseases Laboratory are located.

### The CVBZD Scientific Staff:

#### **Kirby C. Stafford, PhD.**

Dr. Stafford is a Chief Scientist and the State Entomologist investigating the ecology, distribution, and control of the blacklegged and lone star ticks with a major emphasis on natural, biological, and integrated tick control.

#### **Philip M. Armstrong, ScD.**

Dr. Philip Armstrong is a Research Scientist conducting studies on the eco-epidemiology and evolution of arboviruses in the eastern U.S. He also directs the CAES Mosquito and Arbovirus Surveillance Program.

#### **Goudarz Molaei, PhD.**

Dr. Molaei is a Research Scientist conducting studies on the role of mosquitoes and ticks in transmission of human and veterinary pathogens. He also directs the CAES Passive Tick and Tick-borne Disease Surveillance Program.

#### **Scott C. Williams, PhD.**

Dr. Williams is a Research Scientist investigating systemic treatment of wildlife to manage important tick species of medical and veterinary concern, in particular lone star and blacklegged ticks.

#### **Gale E. Ridge, PhD.**

Dr. Ridge is an Associate Research Scientist who manages the CAES Insect Inquiry Office. She is the curator of the CAES insect collection and the chair of the Connecticut Coalition Against Bed Bugs.

#### **Douglas E. Brackney, PhD.**

Dr. Brackney is an Associate Research Scientist investigating the cellular and molecular mechanisms mediating virus-vector interactions using next-generation sequencing, and high-throughput RNAi screens.

#### **Andrea Gloria-Soria, PhD.**

Dr. Gloria-Soria is an Assistant Research Scientist II who studies the genetic

composition of mosquito vector populations and associated pathogens. Her work is focused on *Aedes aegypti*.

#### **John J. Shepard, MS.**

Mr. Shepard is an Assistant Research Scientist I and has expertise in the identification of larval and adult mosquitoes, phylogenetic relationships of mosquitoes, mosquito biology, and the ecology/epidemiology of arboviruses.

### The CVBZD Emeritus Scientists:

#### **John F. Anderson, PhD.**

Dr. Anderson is an emeritus Distinguished Scientist and former CAES Director. He has worked on the ecology of ticks and mosquitoes, and has isolated and characterized microbial pathogens carried by ticks and mosquitoes and the animals and humans they parasitize.

#### **Theodore G. Andreadis, PhD.**

Dr. Andreadis is an emeritus Chief Scientist and former CAES Director. His research has focused on mosquito ecology, microbial control of mosquitoes, the epidemiology of mosquito-borne arboviruses, and the impact of global climate change on mosquito-borne diseases.

### Postdoctoral Scientists at the CVBZD

Although the CAES is not an academic institution, several CVBZD members have academic affiliations with local universities including Yale University School of Public Health and the University of Connecticut. They co-advise graduate students and train student interns and physician residents in their vector-borne diseases laboratories. Since its establishment, CVBZD scientists have trained seven postdoctoral scientists, and currently have three trainees working on tick- and mosquito-related projects:

#### **Megan A. Linske, PhD.**

Dr. Linske is investigating the roles hosts and habitat play in the density and distribution of native and invasive ticks. She has studied the impact wildlife diversity has on ticks and their associated pathogens.

#### **Rebecca Johnson, PhD.**

Dr. Johnson is investigating the impacts of multiple bloodmeals on virus transmission and extrinsic incubation period in mosquitoes.

#### **Zannatul Ferdous, PhD.**

Dr. Ferdous is investigating how successive blood meals enhance virus dissemination within mosquitoes and increase transmission potential.

### The CVBZD Research Partnership with Mosquito Control Agencies:

Over the years, the CVBZD scientists have partnered with the mosquito control agencies in California, Illinois, Massachusetts, New Jersey, New York, Pennsylvania, Vermont, Virginia, and Texas to investigate distribution, abundance, vector-host interactions, population genetics, and the role of several mosquito species in transmission of arboviruses including WNV and EEEV to humans. Results of these collaborative works have been published in peer-reviewed journals, including the following:

Little EAH, Hutchinson ML, Price KJ, Marini A, Shepard JJ, and Molaei G.(2022). Spatiotemporal Distribution, Abundance, and Host Interactions of Two Invasive Vectors of Arboviruses, *Aedes albopictus* and *Aedes japonicus*, in Pennsylvania, USA. *Parasites and Vectors* 15. <https://doi.org/10.1186/s13071-022-05151-8>.

Khalil N, Little EAH, Akaratovic KI, Kiser JP, Abadam CF, Yuan KJ, Misencik MJ, Armstrong PM, and Molaei G. 2021. Host Associations of *Culex pipiens*: A Two-Year Analysis of Bloodmeal



Sources and Implications for Arboviral Transmission in Southeastern Virginia. *Vector Borne Zoonotic Dis* 21:961–972.

Little EAH, Harriott OT, Akaratovic KI, Kiser JP, Abadam CF, Shepard JJ, and Molaei G. (2021). Host Interactions of *Aedes albopictus*, an Invasive Vector of Arboviruses, in Virginia, USA. *PLoS Negl Trop Dis* <https://doi.org/10.1371/journal.pntd.0009173>

Molaei G, Armstrong PM, Graham A, Kramer LD, and Andreadis TG. 2015. Insights into the Recent Emergence and Expansion of Eastern Equine Encephalitis Virus in a New Focus in the Northern New England USA. *Parasit Vectors* 8, 516. DOI: 10.1186/s13071-015-1145-2.

Molaei G, Armstrong PM, Abadam CF, Akaratovic KI, Kiser JP, and Andreadis TG. 2015. Vector-Host Interactions of *Culiseta melanura* in a Focus of Eastern Equine Encephalitis Virus Activity in Southeastern Virginia. *PLoS One*: DOI: 10.1371/journal.pone.0136743

Huang S, Smith DJ, Molaei G, Andreadis TG, Larsen SE, and Lucches EF. 2013. Prevalence of *Dirofilaria immitis* (Spirurida: Onchocercidae) Infection in *Aedes*, *Culex*, and *Culiseta* Mosquitoes from North San Joaquin Valley, CA. *J of Med Entomol* 50:1315–1323.

Molaei G, Andreadis TG, Armstrong PM, Thomas MC, Deschamps T, Cuebas-Incle E, Montgomery W, Osborne M, Smole S, Matton P, Andrews W, Best C, Cornine III F, Bidlack E, and Teixeira T. 2013. Vector-host Interactions and Epizootiology of Eastern Equine Encephalitis Virus in Massachusetts, USA. *Vector Borne Zoonotic Dis* DOI: 10.1089/vbz.2012.1099.

Molaei G, Cummings RF, Su T, Armstrong PM, Williams GA, Cheng

ML, Webb JP, and Andreadis TG. 2010. Vector-host Interactions Governing Epidemiology of West Nile Virus in Southern California. *Am J Trop Med and Hyg* 83:1269–1282.

Molaei G, Farajollahi A, Armstrong PM, Oliver J, Howard JJ, and Andreadis TG. 2009. Identification of Blood meals in *Anopheles quadrimaculatus* and *Anopheles punctipennis* from Eastern Equine Encephalitis Virus Foci in Northeastern USA. *Med Vet Entomol* 23:350–356.

Molaei G, Farajollahi A, Scott JJ, Gaugler R, and Andreadis TG. 2009. Human Blood Feeding by the Recently Introduced Mosquito, *Aedes japonicus japonicus* (Diptera: Culicidae), and Public Health Implications. *J Am Mosq Control Assoc* 25:210–214.

Huang S, Hamer GL, Molaei G, Walker ED, Goldberg TL, Kitron UD, and Andreadis TG. 2009. Genetic Variation and Blood-feeding Pattern of *Culex pipiens*, the Major Vector of West Nile Virus. *Vector Borne Zoonotic Dis* 9:637–642.

Molaei G, Andreadis TG, Armstrong PM, Bueno R Jr, Dennett JA, Real SV, Sargent C, Bala A, Randle Y, Guzman H, Travassos da Rosa A, Wuithiranyagool T, and Tesh RB. 2007. Host Feeding Pattern of *Culex quinquefasciatus* Say (Diptera: Culicidae) and Its Role in Transmission of West Nile Virus in Harris County, Texas. *Am J Trop Med Hyg* 77:73–81.

Molaei G, Oliver J, Andreadis TG, Armstrong PM, Howard JJ. 2006. Molecular Identification of Blood-meal Sources in *Culiseta melanura* and *Culiseta morsitans* from an Endemic Focus of Eastern Equine Encephalitis Virus in New York. *Am J Trop Med Hyg* 75:1140–1147.

## REFERENCES CITED

Anderson JF. 2010. The History of Public Health Entomology at The Connecticut Agricultural Experiment Station, 1904-2009. Bulletin 1030 of the Connecticut Agricultural Experiment Station, pp 68.

Britton WE, Viereck HL. 1904. Report on mosquito investigations. Report of the State Entomologist of Connecticut 4:253-310.



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