UF | IFAS Research
UNIVERSITY of FLORIDA

NATURAL RESOURCES

AGRICULTURE

HUMAN SYSTEMS

# MOSQUITO-BORNE DISEASES

Mosquitoes are notorious for disturbing outdoor activities, but the blood-feeding varieties also cause extensive human-health impacts by transmitting pathogens including Chikungunya, dengue, Zika, and West Nile viruses. The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) operates a dedicated research facility, the Florida Medical Entomology Laboratory (FMEL), to investigate diseases transmitted by mosquitoes and ticks. Launched in 1956, the facility is located just south of Vero Beach and serves as home base for 13 faculty members in the UF/IFAS Entomology and Nematology Department, most of whom currently focus on combating one or more mosquito-transmitted diseases.

Throughout its history, FMEL has taken a broad scientific view that encompasses topics such as mosquito genetics and development, disease epidemiology, and interactions between mosquitoes and predators. This holistic approach has helped FMEL faculty find answers and develop viable solutions more quickly. Today, FMEL research is arguably more important than ever, as faculty members respond to newly detected disease threats such as Zika and use the latest scientific technologies to reduce the toll exacted by one of the world's deadliest organisms.

## Ongoing Research

### DIAGNOSTIC TECHNIQUES

Rapid identification of pathogens is critical to the effective monitoring and control of human diseases transmitted by mosquitoes. Disease ecologist Nathan Burkett-Cadena, a UF/IFAS assistant professor, leads a team pioneering the use of "honey cards" to screen wild mosquito populations for viral infections. They collected virus-laden saliva samples from mosquitos by outfitting mosquito traps with papers impregnated with sugars and preservatives. Initial experimental efforts with infected mosquitoes revealed that the preservative was effective, but feeding rates were low, indicating the need to improve the experimental design to get a sufficient number of samples from the wild. With further development, honey cards may be an affordable alternative to current collection techniques when monitoring for the spread of a virus, which relies on costly blood draws from birds housed in remote, outdoor locations.

### WILD BIRD TRANSMISSION

Wild birds play an important role in the epidemiology of some mosquito-transmitted human diseases because infected birds are reservoirs for disease pathogens, transmitting them to feeding mosquitoes. Consequently, bird abundance influences virus availability, especially for the spread of eastern equine encephalitis and West Nile viruses. UF/IFAS professor Jonathan Day, a medical entomologist, says collecting data on wild bird populations can help scientists predict disease outbreaks. Day leads a team that conducts roadside bird surveillance in southeast Florida, counting and mapping four common species susceptible to viral infection. The resulting numbers reflect the year's avian breeding success and the potential for a disease outbreak to occur. The team is working to incorporate wild bird surveillance into routine monitoring for mosquito-transmitted diseases to enhance effectiveness of epidemic prediction and control methods.

### INSECTICIDE RESISTANCE

A certain class of pesticides (organophosphates) kills mosquitoes by interfering with a chemical that transmits nerve impulses. Mosquito populations can gradually develop resistance to these pesticides if the females produce large amounts of certain proteins that interfere with the pesticides, enabling those mosquitoes to survive, reproduce and pass their genes along to future generations. A research team led by molecular biologist Chelsea Smartt, a UF/IFAS associate professor, has identified a gene that controls expression of one such protein. The researchers examined the gene's activity in several populations of *Culex nigripalpus* mosquitoes that had received varying levels of organophosphate exposure over time and found that the gene was more active in resistant mosquitoes. The team is developing a procedure to identify resistant mosquito populations by detecting the resistance-related protein in captured specimens.

## Research with Impact

### SPECIES COMPETITION

Two invasive, container-occupying mosquito species — *Aedes aegypti* and *Aedes albopictus* – are entrenched in Florida, and where their ranges overlap, they compete for resources. Both species transmit viruses responsible for dengue, Zika, and chikungunya diseases, but one species can often transmit a particular virus more effectively and therefore pose a greater threat when a disease outbreak occurs. Entomologist Phil Lounibos, a UF/IFAS distinguished professor, led a team that discovered *A. albopictus* can displace *A. aegypti* in habitats where the two species encounter one another because of "satyrization," whereby males of one species mate with females of another species which are disabled from producing offspring throughout their lifespans. This discovery was achieved during heightened awareness of container-occupying mosquitoes, now the state's top mosquito concern, and has aided reevaluations of mosquito-management priorities.

### LARVAE CONTROL

Zika virus has reached Florida, and the risk of an outbreak depends partly on the longevity of local mosquito populations, namely *Aedes aegypti* and *Aedes albopictus*. Previous studies have demonstrated that environmental stressors encountered as larvae may influence adult mosquito traits. This concept intrigued medical entomologist Barry Alto, a UF/IFAS assistant professor. His research group completed studies showing that larvae raised in the presence of a predatory midge had shorter lifespans as adults, meaning that they would be less likely to transmit viruses. Biological control agents, such as predators, reduce risk of disease transmission through reductions in the number of mosquitoes. Another unanticipated benefit of this biological control used by mosquito control agencies is predator-induced shortened lifespans of adult mosquitoes.

### INFECTION AND TRANSMISSION

In 2013, an Asian strain of Chikungunya virus spread in Caribbean and Latin American countries, raising the possibility of outbreaks in the southeastern U.S. Both *Aedes aegypti* and *Aedes albopictus* are potential vectors and present in Florida. To gauge the public-health risk, medical entomologist Barry Alto, a UF/IFAS assistant professor, analyzed specimens of both mosquito species collected in four regions of the state. Mosquitoes were fed Chikungunya virus infected blood and were later evaluated using molecular techniques for infection and presence of the virus in their saliva, an indicator of transmission potential. Both species demonstrated high potential for transmitting Chikungunya virus and their susceptibility to infection varied by region. These results allow for more targeted and, therefore, effective mosquito-control efforts in communities with greater risk.

## Unit Leaders

Blair Siegfried
Chair and Professor
Entomology and Nematology
352-273-3970 • bsiegfried1@ufl.edu

Jorge R. Rey
Director and Professor
Florida Medical Entomology Laboratory
772-778-7200 • jrey@ufl.edu

## Researcher Contacts

DIAGNOSTIC TECHNIQUES
Nathan Burkett-Cadena,
Assistant Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 141
nburkettcadena@ufl.edu

WILD BIRD TRANSMISSION
Jonathan F. Day, Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 132
jfda@ufl.edu

INSECTICIDE RESISTANCE
Chelsea T. Smartt,
Associate Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 156
ctsmart@ufl.edu

SPECIES COMPETITION
Phil Lounibos,
Distinguished Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 146
lounibos@ufl.edu

LARVAE CONTROL
Barry Alto,
Assistant Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 153
bwalto@ufl.edu

INFECTION AND TRANSMISSION
Barry Alto,
Assistant Professor
Entomology and Nematology Department
Florida Medical Entomology Laboratory
772-778-7200, ext. 153
bwalto@ufl.edu