Emerging Disease Vectors

NE-1043 (2009-2014)

Mosquito-Borne Diseases Threaten Human Health & Economy

Diseases transmitted by mosquitoes are a serious threat to human lives. Viruses transmitted to humans from mosquitoes often result in an infection that can cause brain inflammation, which can result in death or severe neurologic after-effects. Incidence is on the rise as new diseases and vectors emerge and spread, often fueled by international travel. As a travel and immigrant destination, the U.S. must protect itself from diseases in other parts of the world, such as malaria. Each year there are 300 to 500 million cases of malaria reported, resulting in up to 2.7 million deaths, mostly children. Other diseases have already emerged in the U.S. Mosquitoes in the U.S. transmit several serious viruses including St. Louis, LaCrosse, eastern and western equine encephalitis, and West Nile virus. Nearly 40,000 people in the U.S. have become infected with West Nile virus with over 1,600 deaths recorded to date. The elderly and children are at particular risk of developing serious illness.

The economic impact of mosquito-borne illness is devastating. The cost of treating West Nile virus infections has been immense, with Louisiana alone estimating $70 million in 2002. Many of these viruses also threaten the equine industry. The mortality rate of horses infected with West Nile virus is 34 percent; the rate for those with eastern equine encephalitis is 100 percent. In 2000, the estimated loss in New Jersey due to equine cases of West Nile virus was $6 million. Tourism is also impacted by outbreaks of mosquito-borne disease.

Despite medical advances over the years, there are no vaccines, antibiotics, or treatments for most of these viral infections. Instead, mitigation focuses on controlling the mosquitoes that transmit the diseases. Scientists must provide safe, affordable, effective ways to prevent and control outbreaks of diseases transmitted by mosquitoes.

Aedes albopictus. Photo by the Connecticut Agricultural Experiment Station. In a laboratory, mosquitoes are identified under a microscope. Some species can disease-causing viruses. Washington Department of Health.

Multistate Research Project Helps Manage Mosquitoes & Disease

Since forming in 2007, Multistate Research Project NE-1043, "Biology, Ecology & Management of Emerging Disease Vectors" has shared resources and coordinated research to provide valuable insights, data, and tools to help manage mosquito-borne disease. During the last five year period of the project, researchers' work on these objectives has led to many meaningful impacts.

Strengthened research and improved knowledge. Unraveling ecological relationships between pathogens, vectors, hosts, and the environment has helped develop economical and effective management programs for mosquitoes. This information has also saved pest control agencies time and money by helping them know which strategies to devote resources to.

- Research led to an enhanced understanding of mosquito biology and interactions between hosts and mosquitoes across an array of ecosystems.
- Determined that the invasive mosquito species *Ae. j. japonicus* has potential to be a bridge vector because of its high prevalence of human blood feeding, local abundance, and repeated detection of West Nile virus.
- Research resulted in a better understanding of the host selection patterns of *Culex pipiens* mosquito populations, which are the primary vector mosquito species for West Nile virus.
- Obtained new insights on how mosquito-borne viruses overwinter, persist, and circulate in mosquito populations in the northeastern U.S.

Developed more detailed and reliable models. Models and the information they display have helped pest control agencies predict disease outbreaks and spread, making it possible for them to ward off or prepare for epidemics. Improved

models have also saved time and money by showing pest control agents which mosquitoes and areas to target. For example, members of NE-1043 developed:

- A risk model for eastern equine encephalitis and made it available via a website, making it easier for users to predict and control the disease.
- A model for predicting West Nile virus foci and transmission.
- A climate-based model to evaluate the epidemic potential of Chikungunya virus if it is introduced to the U.S.

Enhanced surveillance and monitoring. Improved detection strategies have helped stall the spread of mosquitoes and the diseases they carry. Mosquito and virus surveillance programs have provided an early warning system for interventions by local mosquito control agencies, helping them catch problems before they get out of hand. NE-1043 has also made sure that surveillance and monitoring equipment is easier to use and maintain. In addition, by making sure that tools for disease detection are fast and accurate, NE-1043 has helped identify hot spots and outbreaks before they spread very far. For example, NE-1043:

- Evaluated new methods for mosquito trapping in the field.
- Validated the Rapid Analyte Measurement Platform system as a fast and reliable tool for detecting West Nile virus.

Improved mosquito control options. NE-1043's research and recommendations have encouraged scientifically based, environmentally sound control by local mosquito control agencies.

- Moved novel technologies and new chemical insecticides from the bench to operational use.
- Discovered new biological control agents and evaluated existing biologic agents in a variety of mosquito breeding habitats.
- Developed new bacterial toxins with enhanced virulence against mosquito larvae and the potential to be produced commercially as a low risk biological insecticide.
- Used cutting-edge molecular methods to identify critical proteins and utilized gene silencing (RNA interference) to disrupt mosquito survival and reproduction for population control.

Widened the reach of information and training. NE-1043 have participated in graduate student and postdoctoral training programs and reported their research findings within the scientific community and with the general public, helping to encourage the widespread adoption of sustainable mosquito and disease management.

Monitoring area mosquitoes can help detect the presence of viruses before they spread to humans. In the top photo, a researcher surveys rock hole beeding sites for *Aedes japonicus*. Mosquito traps like the one shown in the photo above utilize attractants like light and heat, light and carbon dioxide, or hay-infused water. Once the adult mosquito is lured in by these traps, it is then blown into the net by a fan. Photos by the Connecticut Agricultural Experiment Station.

Want to know more?

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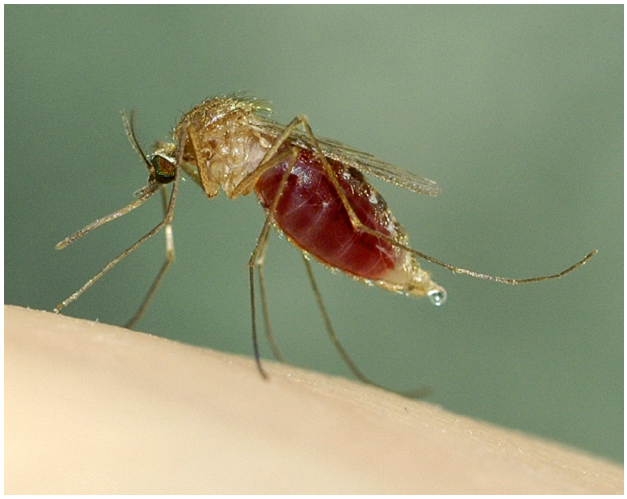

Culex pipiens. Photo by the Connecticut Agricultural Experiment Station.