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Insec(tc)ure*:
Are you insecure about your insect cures?

A UT Urban IPM Lab Newsletter for the Pest Management Industry

Increased Number of LaCrosse Neuroinvasive Disease in Eastern Tennessee

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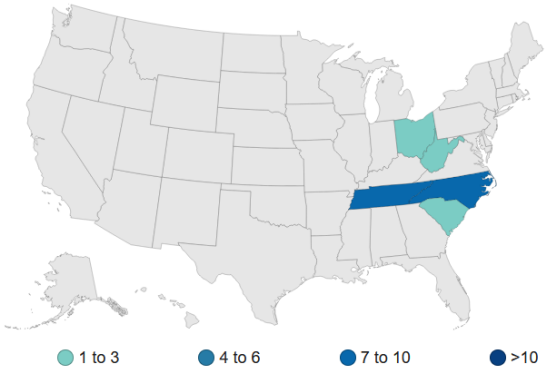
As of September 17, 2024, 19 human disease cases of La Crosse neuroinvasive disease have been reported in the US (Figure 1). This year, 9 (47%) of those cases occurred in eastern Tennessee, specifically Knox, Sevier, and Union Counties (Figure 2). It's essential to raise awareness about this disease while the mosquitoes are still active and people can take precautions to help prevent bites and lower the mosquito populations around homes, schools and other structures.



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Data Table - La Crosse virus human disease cases reported by state of residence, 2024

State	Reported Disease Cases
North Carolina	7
Ohio	1
South Carolina	1
Tennessee	9
West Virginia	1

Figure 1. La Crosse virus human cases reported by state of residence, 2024. Downloaded September 17, 2024 from https://www.cdc.gov/la-crosse-encephalitis/data-maps/current-year-data.html

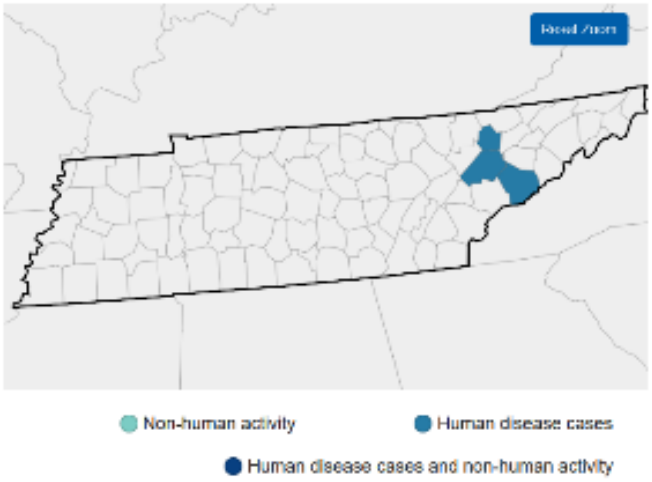

Figure 2. La Crosse virus human and non-human cases by county of residence, 2024. Downloaded September 17, 2024 from https://www.cdc.gov/la-crosse-encephalitis/data-maps/current-year-data.html

If you're doubting that mosquitoes are still active in eastern Tennessee because it's been so dry your lawn is turning brown, this paper from a mosquito oviposition trap with more than 100 eggs should change your mind (Figure 3 and 4).

Figure 3. Mosquito egg paper removed from an ovipostion trap on September 20 after being set a week ago on an East Tennessee elementary school's property. Credit: R. Trout Fryxell.

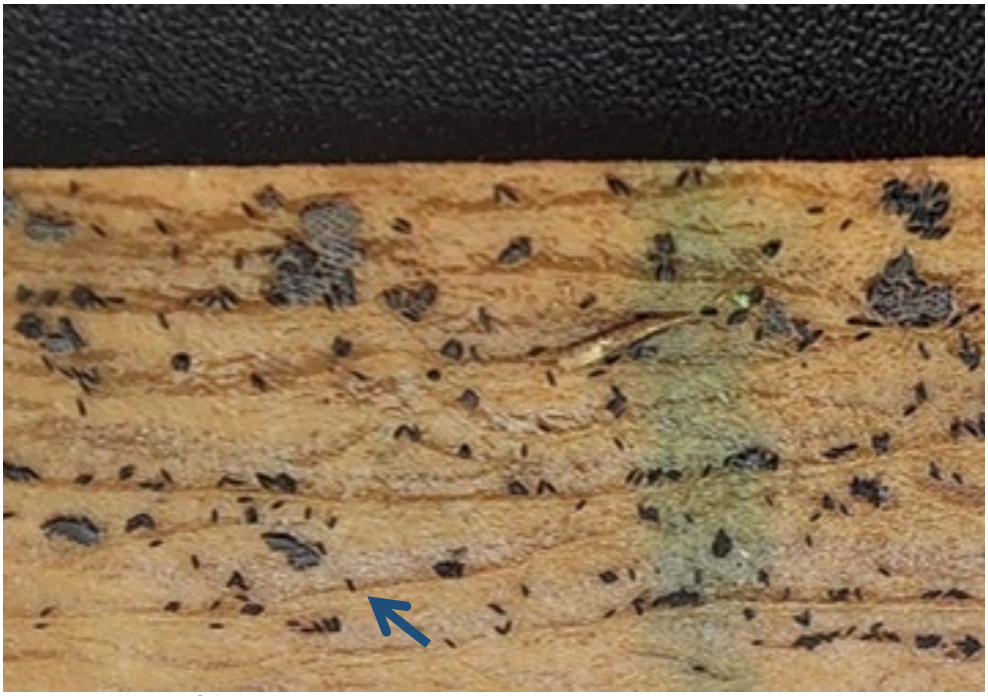

Figure 4. Close up of the mosquito egg paper. Probable Aedes *mosquito eggs are the dark eggs laid individually. One is identified by the dark blue arrow. Credit: R. Trout Fryxell.*

What is La Crosse Neuroinvasive Disease?

La Crosse virus (LACV) may be transmitted to humans by infected mosquitoes. It was first isolated in 1964 from preserved brain tissue from a child who had died in 1960 from encephalitis (inflammation of active brain tissues) in La Crosse, WI. La Crosse virus affects ~80 people in the eastern US every year, primarily children aged 16 and younger living in the Appalachian region. The following Tennessee counties are considered high risk for La Crosse virus transmission: Anderson, Campbell, Claiborne, Cocke, Cumberland, Fentress, Grainger, Hamblen, Jefferson, Loudon, Knox, Morgan, Overton, Sevier and Union (Day et al. 2023b). It may cause severe neuroinvasive (enters the nervous system) diseases that regularly result in encephalitis, paralysis and potentially long-term cognitive disorders that impede neurological development.

Transmission of Disease Pathogens

The complex transmission cycles of La Crosse virus are presented in Figure 5. Uninfected female mosquitoes can obtain La Crosse virus from the blood of infected animals such as chipmunks (called virus amplification hosts in which the virus can grow) and transmit the pathogen to humans when feeding on them. Female eastern treehole mosquitoes, *Aedes triseriatus,* directly transmit La Crosse virus to their eggs (called transovarial transmission). When infected eggs hatch, they remain infected through each developmental stage (egg, larva, and pupa). Infected adults can immediately transmit La Crosse virus after emergence from the pupa. Adult males that are infected by their mother by transovarial transmission can transmit La Crosse virus to uninfected females during mating (called venereal transmission).

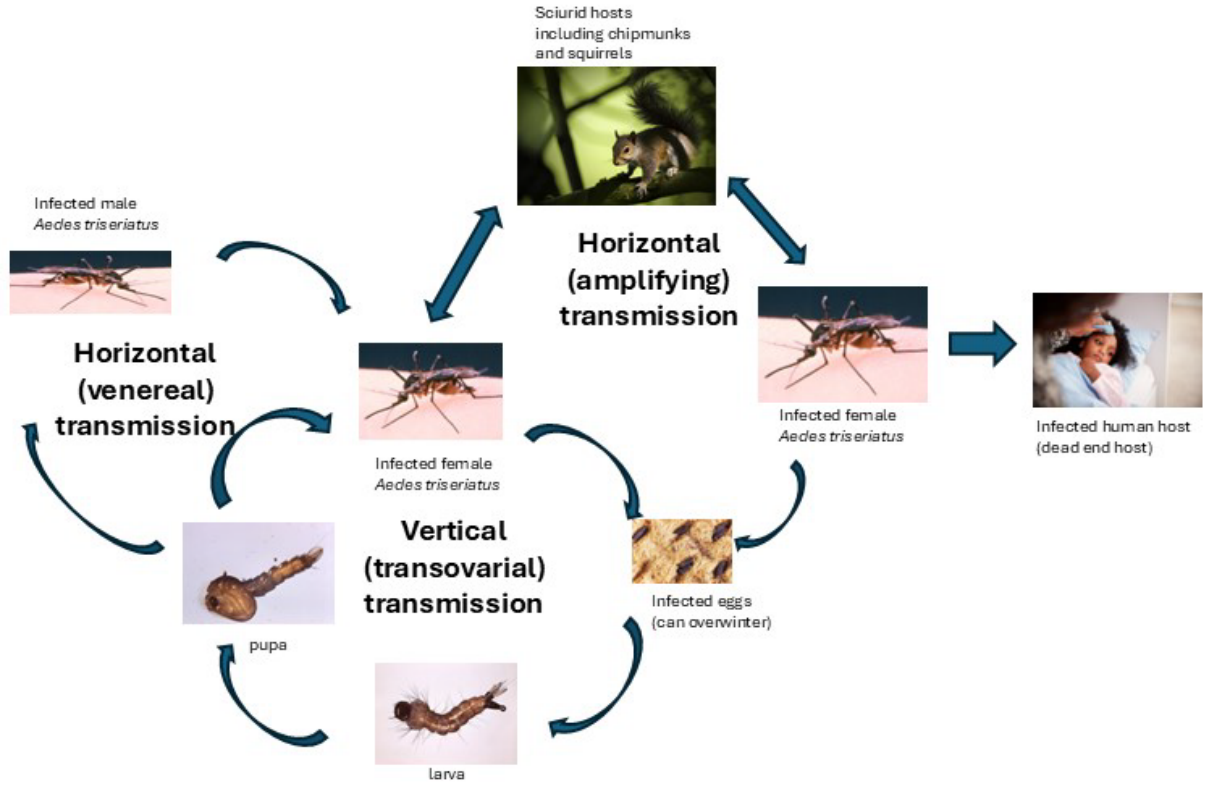

Figure 5: Eastern treehole mosquito transmission cycle for La Crosse virus (Adapted from Day et al 2023[a])

Mosquito Life Cycle

The eastern treehole mosquito is the primary vector, the main transmitter of La Crosse virus. The Asian tiger mosquito, *Aedes albopictus*, and Asian bush or rock pool mosquito, *Aedes japonicus*, are secondary vectors. Secondary vectors are capable of transmitting La Crosse virus and are less effective than the primary vector. All three mosquito species are found in the same areas and are considered container mosquitoes.

Eggs are laid by the adult female in artificial containers such as tires and planter bottoms or in natural containers such as tree holes in areas close to a hardwood forest. If sufficient water and organic matter in the containers, the larvae will develop into adults.

These adult mosquito species are active during the day. Both sexes will feed on sugar sources to gain carbohydrates for flight. Females, however, require a blood meal to gain the protein for successful egg production. Blood meal sources for the female include deer, chipmunks, squirrels, humans, and dogs. The eastern treehole mosquito is also known to feed on amphibians and reptiles.

Figure 6. The eastern treehole mosquito, Aedes triseriatus*, the primary vector of the La Crosse virus (left) and the tiger mosquito,* Aedes albopictus*, a commonly encountered peridomestic mosquito that is a secondary vector (right). Credit: Susan Ellis, bugwood.org.*

Signs and Symptoms of La Crosse Virus

Children are more commonly diagnosed with La Crosse virus infections than adults. Most infections are asymptomatic and go unnoticed. When symptoms do occur, they are likely to occur in late spring to early fall. In less severe cases, initial symptoms are like influenza or the common cold, and individuals are expected to recover without complications. In more severe cases, La Crosse virus is neuroinvasive and enters the central nervous system. This results in severe diseases including meningitis and encephalitis. Typical symptoms of neuroinvasive La Crosse virus infections include:

- Fever
- Headache
- Vomiting
- Seizures
- Disorientation
- Paralysis or semi-paralysis

Medical Testing and Treatment of Neuroinvasive La Crosse virus Infections

Individuals that present with encephalitis, hyponatremia (low sodium in serum), and/or meningitis in areas where La Crosse virus is known should be tested to rule out La Crosse virus; particularly if they play, work, or participate in activities such as hiking in or near woodland areas. Blood or spinal fluid samples can be tested for La Crosse virus. La Crosse virus disease can be diagnosed with serologic testing, https://www.cdc.gov/la-crosse-encephalitis/hcp/diagnosis-testing/index.html.

There are no specific treatments for La Crosse virus infections. In most cases bed rest, fluids, and measures to reduce fever will successfully reduce the common symptoms associated with La Crosse virus. In some more severe cases, hospitalization will be necessary to receive supportive treatment for seizures, encephalitis, and other more serious symptoms of La Crosse virus. Individuals with more severe neuroinvasive cases often require long-term physical and occupational therapy and/or educational support.

Control Measures for Mosquitoes

The first and most important step for reducing exposure to mosquitoes is to remove habitats where they lay eggs and develop as larvae (Figure 7). So, either suggest your clients remove standing water around homes or businesses or incorporate this into your services.

<u>Eliminating Standing Water</u>

- Anything that can hold water can act as a development site for mosquitoes, including swings, tires, buckets, toys, playground equipment, trash (e.g., cans, bottles, bottle caps, or cups on the ground after a sporting event), etc. These sources should either be removed or water from these sources should be drained immediately and/or have holes drilled into the bottom to promote drainage.
- Do not allow water to remain in bird baths, flower pot bases or pet dishes for longer than a week.
- Clean gutters, downspouts, roofs, etc. to remove leaves and other debris that may hold standing water. At some residencies, it may be best to recommend replacing damaged gutters.
- Remove *Magnolia* or other cup-shaped leaves on the ground.
- Water in bird baths and children's wading pools should be changed at least once a week.
- Tree holes or stumps often contain water. Recommended arboricultural practices include covering holes with an aluminum or stainless steel exclusion plate or filling holes with waterproof expanding foam (not concrete) to prevent water buildup.
- Water the landscape to prevent standing water from accumulating for more than a few days.
- Inspect animal water troughs and surrounding ground for larval mosquitoes and change water if necessary.
- Fill or drain depressions left by tires.
- Stock a small garden pool or ornamental pond with mosquito-eating fish such as native top-feeding minnows or goldfish.
- Make sure covers on pools and boats do not retain water.
- Cover rain-collecting barrels with a 16-mesh screen.

Because container mosquitoes will fly about a city block or so, solicit neighbors to participate in mosquito control efforts. Encourage a neighborhood cleanup and remove useless containers such as cans, bottles, buckets, tires and anything else that can hold water. If neighbors do not remove potential standing water in their yard, your client may end up with their bumper crop of mosquitoes.

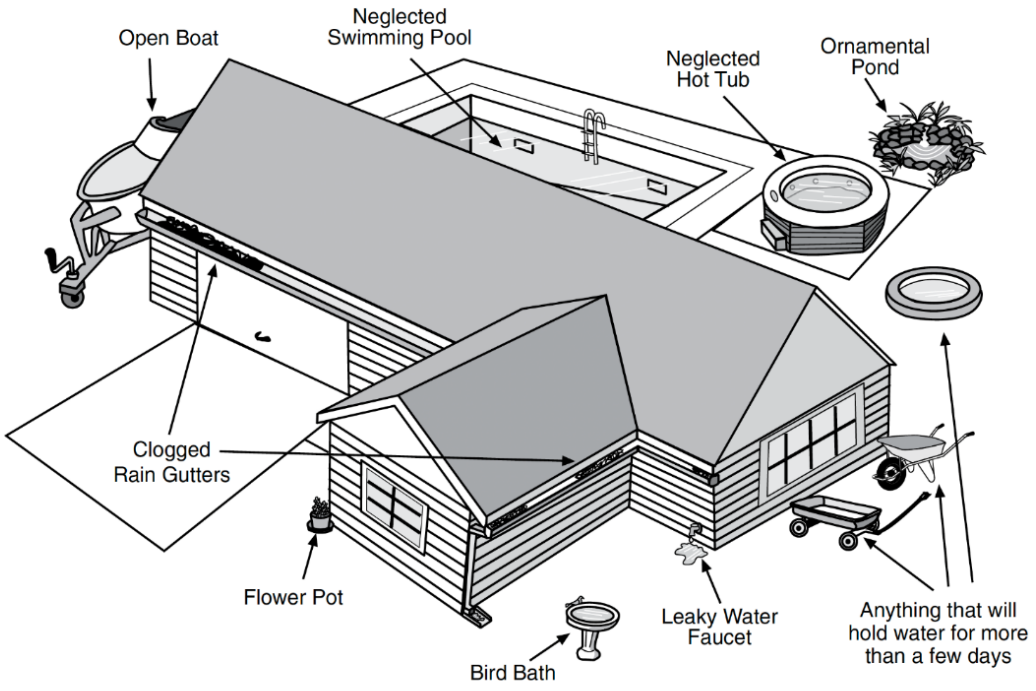

Figure 7. Potential mosquito larval sites found around homes. Credit: Vail et al. 2016.

The following includes some of the most common mosquito control practices used by pest management professionals in the area. While this is a very brief introduction to mosquito management, see the American Mosquito Control Association's Best Practices for Integrated Mosquito Management, (https://www.mosquito.org/assets/pdf/hr_november_2021_amca_bmp_ma/, for a more detailed explanation.

Larviciding

Larvicides may be necessary to kill larval mosquitoes in standing water that cannot be removed. Larvicide active ingredients include *Bacillus thuringiensis israeliensis* (Bti), the insect growth regulators (IGRs methoprene and pyriproxyfen), and others. Toxins derived from the Bti bacterium have little effect on organisms other than Diptera (flies, mosquitoes, etc). The IGRs mimic juvenile hormones and prevent the immatures from reaching the adult stage.

Autodissemination

Larviciding presents challenges because it is difficult to locate all of the hidden locations where mosquitoes may be developing or where potential habitat exists. The In2Care Mosquito Station (Figure 8) is one system that takes advantage of female mosquitoes' behavior of seeking oviposition (egg-laying) sites to disseminate the active ingredients. Yeast water in the 5-L black bucket attracts females that land on the floating gauze coated with two active ingredients, pyriproxyfen and the insect-killing fungus, *Beauvaria bassiana*. As she deposits her eggs into the station, she picks up the active ingredient and unintentionally spreads the IGR to the next oviposition sites visited. Thus, treating future oviposition sites and also preventing immatures from completing development while she slowly dies from the fungal infection. The label recommends placing 10 stations per acre. Recent research on In2Care against *Aedes aegypti* and *Culex quinquefaciatus* indicated that reducing the number of stations to 3 per acre failed to suppress mosquito numbers when used as a stand-alone treatment or with other larviciding techniques (McNamara et al. 2024). However, in another study, 6 In2Care stations per acre reduced *Ae. aegypti* numbers (Buckner et al. 2021). So while it may be tempting to reduce the number of stations deployed, there's a limit. In2Care Mosquito Station is a relatively new technology, and researchers are still developing protocols to maximize the effectiveness of these stations. In the future, recommendations on the density of stations may be based on the density of competing oviposition sites and other factors.

Figure 8. In2Care station placed in landscape. Credit: Waynes Pest Control

Adult Resting Sites and Adulticiding

Another way to reduce mosquitoes in or around homes is to minimize dense vegetation and keep lawns mowed to reduce available resting sites for the adults. Many pest management professionals apply appropriately labeled insecticides with mist blowers to shrubbery and other potential mosquito-resting sites listed on the label.

More details specific to mosquito management around schools and childcare facilities can be found at https://tiny.utk.edu/schoolmosquitoes, and a new UT Extension publication, *Container Mosquitoes*, should be available soon at https://utextension.tennessee.edu/publications/ .

Steps to Prevent Mosquito Bites

Since there is no vaccine for La Crosse virus, it is necessary to prevent mosquito bites which can reduce the potential for transmission of La Crosse virus. The amount of time spent outdoors without protective clothing or use of

repellents will increase the risk of acquiring La Crosse virus. Since mosquitoes may fly indoors, preventing them from entering homes or businesses is also essential.

- Maintain intact screens on windows and doors
- Avoid known mosquito-infested areas when mosquitoes are active
- Wear protective clothing such as long-sleeve shirts and long pants when outdoors
- Use EPA-approved repellent and reapply if necessary (https://www.epa.gov/insect-repellents/find-repellent-right-you)

East Tennessee Study

One author (RTF) has been working closely with the Knox County Health Department and the guardians of Knox County residents diagnosed with La Crosse virus. With permission, she has been and will continue to monitor mosquitoes at these case sites. Additionally, with the help of Wayne's Pest Control, treatments have also been applied to these sites. Specifically, Wayne's Pest Control applied a barrier spray to potential resting sites at each property (Figure 9) and deployed two In2Care stations (Figure 8). Over the next few weeks, RTF will continue to monitor the mosquitoes to assess if there is a reduction thanks to their efforts. RTF is currently using a combination of host-seeking traps, gravid traps, and ovitraps. Ovitraps from the case sites will be compared to other ovitraps placed around the county and at schools. You can see how she prepares the oviposition traps used in her monitoring program by watching this video https://www.youtube.com/watch?v=m0QCGKVXMZE, prepared for teachers and students participating in the MEGA:BITESS program, https://www.megabitess.org/. Monitoring should continue for a few more weeks, so watch for updates on this study's results in future newsletters. MANY THANKS to Sam Walker (Figure 9) and Will Bullard at Waynes Pest Control for donating the products and services to treat these homes.

Figure 9. Sam Walker of Waynes Pest Control applying adulticide to potential adult mosquito resting sites using a mist blower. Credit: Waynes Pest Control

Conclusion

The mosquito season is still active in eastern Tennessee and will likely continue through October as a new La Crosse case was recorded last week. Please do not stop mosquito management efforts until mosquito activity is no longer detected, likely after the first frost. Remind clients of the steps to help prevent mosquito bites, especially wearing repellents when outdoors, and reducing mosquito habitat (standing water and dense vegetation) around their structures. By working together, we can reduce the incidence of this childhood disease.

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Call for PMP Volunteers

The VectorEd Network, https://www.vectorednetwork.org/, a vector-borne disease training center, has a CDC funded project to evaluate the needs of PMPs related to vectors and vector-borne diseases. The primary objective is to assess knowledge and implementation of best practices for vector management (with a focus on ticks and mosquitoes) and correct knowledge gaps or misconceptions.

We are seeking manager (service, technical and/or training) volunteers for a one-hour interview. The interviews are confidential and will help refine survey questions for managers and applicators (licensed or unlicensed). The surveys will likely be sent out through the Tennessee Pest Control Association and/or National Pest Management Association (NPMA).

A report of the general findings will be available after the survey is completed and analyzed. A toolkit will be developed to address gaps which are identified. A working focus group will be formed to provide additional feedback on the toolkit and test the effectiveness of the toolkit prior to general release and/or availability.

If you have additional questions, would like to volunteer for an interview, and/or want to join the focus working group please reach out to the UT vector training specialist, Angela Tucker PhD, BCE, atucke51@utk.edu, or the VectorEd Network program manager, Olivia Bognanni, opb5042@psu.edu.

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