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## G74-154 Mosquito Control Guide (Revised 1974)

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## Mosquito Control Guide

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The life cycle, control, and impact of mosquitoes common to Nebraska are discussed.

Mosquitoes are insects belonging to the order Diptera. Although there are some 50 species of mosquitoes in Nebraska, fewer than a dozen are important.

Historically mosquitoes are one of the most important insects encountered by man because they are vectors of human diseases such as malaria (protozoa), filariasis (nematodes), yellow fever, dengue fever, and the encephalitis viruses, including the West Nile virus. It has been estimated that half of all human deaths prior to 1950 (the dawn of miracle insecticides) resulted from mosquito-transmitted diseases. Disease transmission by mosquitoes is termed “biological transmission” because the disease organisms multiply and complete some or all of their life cycle within the mosquito.

### Life Cycle

Eggs from most mosquito species are deposited singly or in rafts in or near water (*Figure 1a*). All eggs must be in water to hatch, as larvae and pupae live in water; however, eggs from some floodwater mosquitoes can remain dormant and viable for one to three years even without water. *Aedes vexans*, a daytime feeder common to Nebraska, is an example. In contrast, *Culex tarsalis* eggs are deposited in water and hatch within a couple of days. These two species also differ in overwintering. *A. vexans* overwinters as an egg while *C. tarsalis* overwinters as a fertilized hibernating female. West

Nile virus may remain viable in an overwintering adult female *Culex* spp.

The larvae (wigglers) of most species have a prominent breathing tube or “siphon.” The larvae (*Figure 1b*) rest suspended diagonally from the water surface from the end of the siphon penetrating the surface. A few species can remain under water obtaining oxygen by diffusion through their “skin” (or cuticle), and some have short, sharp siphons that pierce the stems of aquatic plants where they obtain air. Larvae feed on microscopic organisms in the water. Larvae molt four times and transform to the pupa stage (“tumbler”) at the last molt (*Figure 1c*). The larval stage may last a week or longer. The pupal stage usually lasts only two or three days before the adult mosquito emerges (*Figure 1d*).

When disturbed, mosquito larvae dive for deeper water and move by flexing their bodies, a habit which has earned them the label “wiggler”. Pupae tumble by rotating the head and tail region as they move to the safety of deeper water.

Adult mosquitoes mate as they fly in swarms. While male mosquitoes will feed on nectar, fertilized females will seek a blood meal, which is needed for maximum egg maturation. Most species feed on either warm- or cold-blooded animals, with birds often being the host. Birds also may be a reservoir for some of the encephalitis and avian malarial disease agents and West Nile virus. Mosquitoes probably live about two weeks. In Nebraska, some species can develop several generations per year, while others may have only one.

The most numerous mosquito species in Nebraska are *A. vexans*, *C. tarsalis*, *Ochlerotatus trivittatus*, *O. dorsalis*, *O. triseriatus*, *O. melanimon* and *Culiseta inornata*. Of these, *C. tarsalis* is probably the most important because it is an

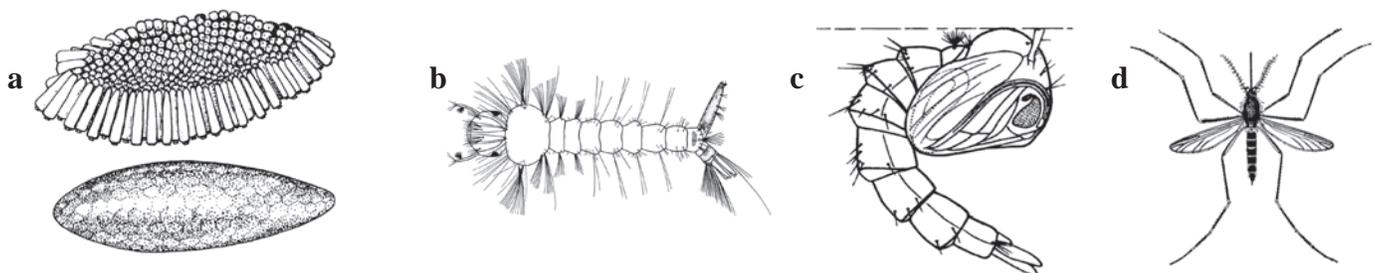


Figure 1. (a) Mosquito eggs may be laid singly or in a raft, depending on the species. *Culex tarsalis* eggs are laid in a raft formation in water; (b) Larva (wiggler) stage; (c) Pupa (tumbler) stage; (d) adult mosquito.

efficient vector of encephalitis and the West Nile virus. The Asian Tiger mosquito (*A. albopictus*), also an efficient disease vector, has recently been introduced into Nebraska, but its level of establishment and status are unclear. Epidemiologists classify *C. tarsalis* as a very efficient vector of West Nile virus and *A. vexans* as a moderately efficient vector that probably serves as a bridge between birds and mammals in the transmission cycle.

### Encephalitis and West Nile Virus

Encephalitis and West Nile virus generally are involved in a mosquito-bird cycle, with both hosts serving as reservoirs; however, humans, horses or other animals may be accidental end points with occasionally serious consequences. Western Equine and St. Louis are the two strains of encephalitis found in Nebraska. Generally, encephalitis is not clinically apparent. Clinical signs include fever and a severe headache, often followed by rapid complete recovery. Older people, however, may have a high fever, nausea, vomiting, chills, severe headache, convulsions, speech problems, confusion and drowsiness. Small children are likely to suffer severe consequences with Western Equine encephalitis, while older people are more likely to suffer a grave illness with St. Louis encephalitis. Recovery is often dramatic and rapid, without complications; however, in a few patients, weakness, dulled mentality and paralysis may be side effects. In rare cases, death may occur. Positive diagnosis can only be made serologically or by recovery of the virus.

Nebraska was the epicenter for the West Nile virus in the Midwest in 2002, with 174 human cases (8 fatalities) and over 1100 cases of horses diagnosed with the disease. The rate of fatalities from this virus in horses ranges from 25 to 30 percent with foals and older horses most likely to suffer severe symptoms. West Nile virus is similar to St. Louis encephalitis in symptoms and transmission cycle. Most humans infected with West Nile will have no symptoms, but 10 percent may develop fever, headache and other body aches, occasionally with a rash on the trunk of the body, swollen lymph glands or other symptoms. The literature indicates that less than 1 percent of infected humans will develop severe symptoms (West Nile virus encephalitis or meningitis), but in 2002 over 6 percent of the 4100 human cases resulted in death. Severe symptoms include an intense headache, high fever, stiff neck, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis and possible death.

Older people or people with compromised immune systems are most likely to experience severe symptoms. The incubation period in humans (time from infection to disease onset of symptoms) is estimated at 3-14 days. Vaccines are available through veterinarians for encephalitis strains and West Nile virus for horses, but not for humans. The West Nile equine vaccine requires two injections about two weeks apart to be effective, and then an annual booster. This vaccine is estimated to be 90-95 percent effective; the other encephalitis vaccines are somewhat less effective.

Heartworm disease of dogs, caused by *Dirofilaria immitis*, is also transmitted by mosquitoes. Adult worms

live in the heart and pulmonary arteries. High numbers may form tangled knots leading to embolism, asphyxia or heart dilation, killing the dog. Many species of mosquitoes can carry and transmit this filariasis. The worms can be controlled with drugs administered by veterinarians; however, the dead parasites can clog the pulmonary vessels, killing the animal. In heartworm endemic areas, dogs can be put on a heartworm preventative program under the supervision of a veterinarian.

### Control

A major mosquito outbreak following heavy rains and extensive flooding of streams and rivers requires a city, county or state mosquito abatement program. Individuals also can help limit mosquito breeding and take precautions to prevent mosquito feeding on themselves and members of their families. Mosquitoes breed in standing water and around both rural and urban homes. These sites might include wading pools, bird baths, leaf-clogged gutters, low areas in yards and alleys, potted plants, poorly drained curbs leading to storm sewers, old tires or any other containers which will hold water. Farmers should check irrigation re-use pits and areas where drainage from irrigation or heavy rains drain to roadside ditches. Homeowners should make sure screens covering windows and screen doors are in good condition. When mosquitoes are present, outdoor activities should be curtailed if possible. Light-colored clothing which is less attractive to mosquitoes should be worn to cover most of the skin. Repellents containing DEET (n-n-diethyl-m toluamide) should be used on exposed skin; however, some people, especially small children, may be sensitive to repellents. Generally, the higher percentage of active ingredient in the repellent, the longer the residual activity, up to five or six hours with the strongest. Permethrin, a synthetic insecticide, both repels and kills mosquitoes and has been incorporated into clothing used by the military, sports clothing and mosquito netting. It can be sprayed on clothing, but not on skin.

Insecticides can be used as residual sprays for mosquitoes that rest in shrubs, flowers and trees. Check labels for rates and plant phytotoxicity. There also are insecticide treatments for immature mosquitoes in the aquatic habitat. These can be applied as granules, pellets, briquettes or sprays. Some are standard organophosphate or petroleum insecticides. Others are classified as biologicals and would include a strain of the bacterium *Bacillus thuringiensis* or two hormone products. Methoprene, a juvenile hormone, interferes with the mosquito's transformation from the juvenile to adult life stage, and dimilin interferes with chitin formation, which is necessary to harden the exoskeleton of the insect after it molts. There are also mosquito-feeding fish, *Gambusia affinis*, and killfish, *Fundulus* spp., which can be released in mosquito-infested water. Generally, these fish do not survive Nebraska winters, so releases must be made annually. Insecticides also are registered for control of adult mosquitoes. Generally, these are applied by ground equipment or aircraft as a ULV (ultra low volume) formulation. They probably should be applied by employees of a political subdivision, who must be certified

by the Nebraska Department of Agriculture in Category 09, Public Health Pest Control.

The main emphasis should be on reducing breeding sources, which requires engineering technology and often heavy equipment and easements. Mosquito control crews need training in mosquito surveys, taxonomy, mosquito identification, survey techniques and in control tactics for

both immature and adult mosquitoes. Many municipalities have stopped mosquito control programs because of cost, particularly for liability insurance, but these programs may be reinstated considering the seriousness of West Nile disease, especially where mosquitoes are numerous and disease incidence is high.

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