

# Mosquitoes

## (Culicidae)

### General Information

Mosquitoes are infamous for their animal-biting habits resulting in nuisance and disease to humans. Worldwide, there are over 3,000 mosquito species found in diverse habitats spanning from the tropics to the near arctic regions. Mosquitoes are known to transmit a number of pathogens that cause serious human and animal diseases such as malaria, dengue, yellow fever, Rift Valley fever, heartworm and encephalitis.

### Identification and Life History

Mosquitoes are small slender flies that belong to the order Diptera (true flies). Like other members of this group, mosquitoes possess only a single pair of functional wings. They are distinguished from other flies by the following characteristics: the presence of scales (on thorax, legs, abdomen and wings), extended mouthparts (proboscis) and narrow wings (Fig.1).

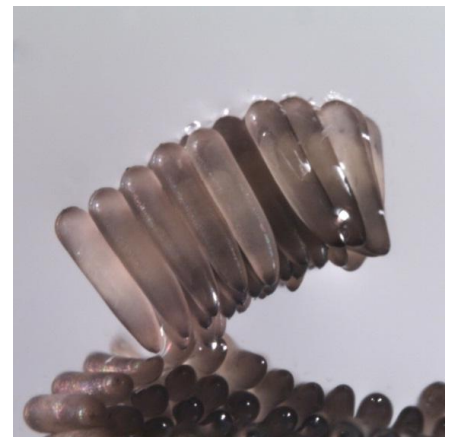


**Figure 1:** Female *Culex quinquefasciatus*. Photo by Stephanie Leon. UC Riverside

Both male and female mosquitoes feed on nectar and plant juices. However, the mouthparts of most female species are adapted for blood feeding; the blood of an animal host is required to develop eggs in most species. Although a single mosquito will only take a small amount (2 to 8 milligrams) of blood from their animal host, blood loss from the host can be quite significant when biting mosquitoes are numerous. Mortality of livestock and pets exposed to massive mosquito attacks has been reported.

The mosquito life cycle consist of four different stages: egg, larva, pupa and adult. The female mosquitoes of most species deposit their eggs on water

surfaces in various habitats such as tree holes, salt marshes, lakes or ponds, artificial containers, polluted water retention systems (e.g., storm drains and settling ponds), or nearly any other location where rain water accumulates. Some mosquito species deposit their eggs on moist soil in flood prone areas with eggs hatching only after a flood event. The number of eggs deposited varies among the species, ranging from 30 to 300 during each egg-laying period. For example, southern house mosquitoes (*Culex quinquefasciatus*) lay their eggs in rafts loosely cemented together with 50 to 100 eggs per raft. Eggs are typically <1mm in



**Figure 2:** *Culex quinquefasciatus*. Egg raft. Photo by Stephanie Leon, UC Riverside

length and are initially white when laid, but quickly darken ranging from brown to black in color (Fig 2). Larvae typically hatch from these eggs within 2 days (Fig. 3).



**Figure 3:** *Culex quinquefasciatus* larva. Photo by Stephanie Leon, UC Riverside

Larvae are restricted to an aquatic habitat where they acquire food by filtering bacteria and small organisms from the water using specialized palatal brush-like mouth parts. All mosquito larvae have a breathing apparatus (siphon) located at the tail end of the body. In most species, larvae must project this siphon into the air above the water surface in order to breathe. For this reason, larvae spend most of their time floating at the surface. Larvae are sometimes called “wrigglers” due to their movement near the water surface when they are disturbed. Larvae complete four larval instars before reaching the pupal stage. Pupae are also restricted to the water, but do not feed, and they acquire

oxygen through respiratory trumpets instead of a siphon (Fig. 4). Depending on the temperature and other environmental factors, mosquitoes can complete their life cycle from egg to adult as little as 7 to 14 days.

### Damage

The blood feeding habits of mosquitoes has a significant impact on the health and quality of life for humans, pets and livestock. In some developing countries, individuals can receive 50 to 100 bites per night! When poorly managed, significant numbers of biting mosquitoes will negatively affect economies that depend on outdoor activities (tourism, camping, fishing, golfing and beaches). More importantly, mosquitoes are also responsible for transmitting pathogens that cause several important human and animal diseases; such as malaria, dengue, yellow fever, and encephalitis (e.g., West Nile virus, eastern equine encephalitis and St. Louis encephalitis). Malaria alone has an incredible impact on the world, with 216 million malaria cases worldwide reported by the World Health Organization!

### Integrated Pest Management

**Monitoring:** Surveillance of mosquito activity is key to establishing a successful mosquito management program. Surveillance provides important information including the species of mosquito present in an area, the location of immature breeding sites, changes in species abundance, prevalence of mosquito infection with important human and animal pathogens, and whether control methods are having an impact on mosquito populations. Two of the most common traps used to survey adult mosquitoes are the light trap and the gravid trap. Light



**Figure 4:** *Culex quinquefasciatus* pupae. Photo by Lee McPhatter, UC Riverside

traps baited with dry ice (and with or without the light) are often used to capture host-seeking female mosquitoes, while gravid traps are used to selectively sample female mosquitoes that are gravid (ready to lay eggs). To sample immature mosquitoes from their aquatic breeding sites, a mosquito dipper (white plastic cup attached to a 3 foot handle) is the most common method utilized. This method of sampling is both labor intensive and time consuming, but control efforts directed at immature mosquitoes are more efficient and effective relative to control efforts aimed at adult mosquitoes.

*Management:* The goal of a mosquito management program is to keep mosquito populations from becoming a nuisance and to minimize disease risk. Methods to control mosquitoes include cultural, biological, or chemical control as well as exclusion of biting adult mosquitoes.

**Cultural control:** Human behaviors often contribute to mosquito abundance. Water filled containers such as bird baths, decorative fountains, swimming pools, rain gutters, flower pots, automotive tires, tarps and watering troughs are all potential breeding sites for mosquitoes if water is left stagnant in these containers for a week or more. It is recommended that standing water in any outdoor container is emptied, treated or changed at least weekly during the hotter summer months. This will prevent mosquitoes from completing their development from egg to the adult stage, and emerging as hungry adults. Plumbing leaks and pooled water from air-conditioners can also provide viable mosquito breeding habitats. Water leaks that result in pooling of water should be taken care of as soon as possible.

**Biological control:** Natural mosquito enemies such as fish are commonly used to control immature mosquitoes in their aquatic habitats. For example, small fish called “mosquitofish” (*Gambusia affinis*) can be placed in man-made ponds and other water features that do not drain into natural water systems. These fish feed on mosquito larvae and are useful even in ornamental fountains or animal watering troughs. Mosquitofish can usually be obtained by contacting the local mosquito abatement or environmental health office in your county. Another form of biological control is the use of bacteria that carry toxins specific to insects and thus kill insects without harming other living organisms in the aquatic environment. The bacterium (*Bacillus thuringiensis israelensis* or Bti) is proven to be very effective for selectively killing mosquito larvae. When placed into an aquatic habitat and consumed by mosquito larvae, a toxic protein produced by the bacteria damages the mosquito gut and ultimately kills the mosquito.

**Chemical control:** When immediate control of adult mosquitoes is required to protect public health, the use of chemicals may be the only option available to reduce mosquito bites. Area-wide chemical applications to reduce mosquitoes are conducted by local health agencies or licensed pest control companies operating under state and federal guidelines. Residual insecticides can be applied to common mosquito resting sites such as trees, walls, shrubs and other vegetation where they will continue to kill resting mosquitoes for several days. Non-residual chemicals that kill adult mosquitoes on contact but do not persist long in the environment can be applied using foggers and blowers or by aerial application to disseminate the insecticide throughout the airspace. To be most effective, non-residual applications should

occur when mosquitoes are actively flying (evening or early morning) and not protected within their daytime resting sites in vegetation.

Surface films (oils or mono-molecular films) applied to an aquatic breeding site can also be used to control immature mosquitoes. Surface films are typically added in small quantities to aquatic habitats (e.g., ditches, and ponds) where they quickly spread to form a thin layer covering the entire water surface. The film prevents mosquito larvae from thrusting their breathing siphon into the air above the water surface, subsequently suffocating the immature mosquitoes. Surface films work best in small bodies of water that have little or no vegetation. Many oils and mono-molecular films will persist in the aquatic habitat for only a few days so reapplication may be needed throughout the mosquito season.

**Exclusion:** You can limit the number of mosquitoes that enter your home by using mechanical barriers. Wire mesh screen that is 18 x 18 mesh per inch or smaller serves as an effective barrier for mosquitoes. Common window and door screens effectively exclude mosquitoes as well as many other pest insects. Replace screens that have holes or tears and keep unscreened windows and doors closed between dusk and dawn.

**Personal Protection:** Insect repellent applied to the skin or clothing is recommended for protection from mosquito bites when outdoors during the mosquito season. The CDC recommends repellents that contain active ingredients registered by the U.S. Environmental Protection Agency (EPA); these include DEET, Picaridin, and Oil of Lemon Eucalyptus. Clothing impregnated with chemicals that are repellent to mosquitoes can also be purchased at many outdoor clothing or camping stores.

### *References for more information*

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