

# Mosquito Biology and Control

**D**uring the summer months, mosquitoes are as common as backyard barbecues and swimming pools. Unfortunately, they bring with them not only the discomfort of the occasional bite, but also the possibility of transmitting human and animal diseases. Knowledge about mosquito biology and habitat can help us better control these pests. Individual homeowners can play a significant role in this process, but sometimes a community effort is needed. Regardless, you can do many things, including using insect repellents, to reduce your chance of being bitten by a mosquito. This publication describes the biology and habitat of mosquitoes. It outlines strategies for eliminating breeding sites and reducing mosquito bites around the home, and it discusses the safe use of DEET and other insect repellents.

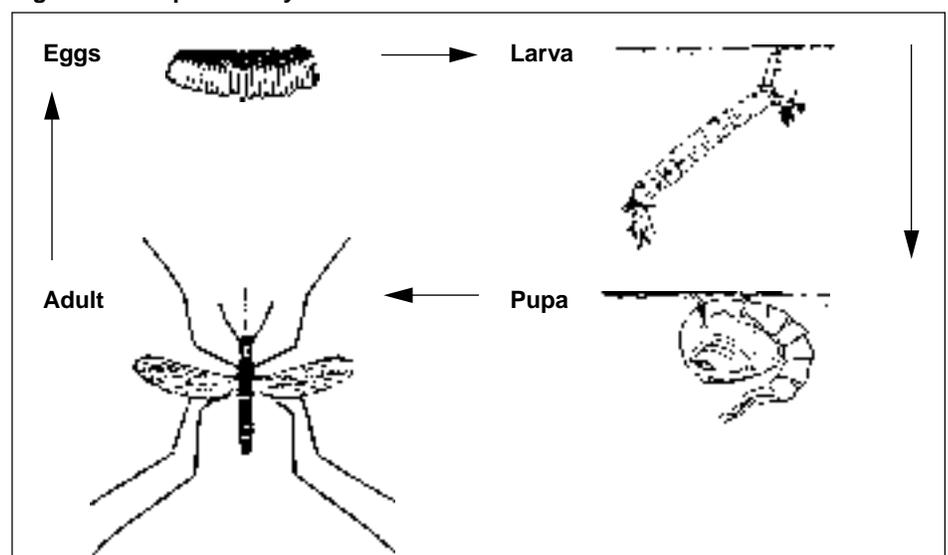
## Mosquito Biology

Mosquitoes are small, primitive flies that breed in standing water. During their life, they pass through four distinct stages: egg, larva, pupa, and adult (Figure 1). The eggs, which are laid in or near water, hatch into larvae (wigglers) within a few days. In many cases, the eggs are laid in bunches in distinct, raftlike structures, but they also may be laid singly. The wigglers feed on microscopic plant life, molt several times as they grow, and become tumblers, or pupae, that subsequently turn into adults. The entire process for some species can take place in as short a time as 7 to 10 days.

## Why Mosquitoes Bite

Adult female mosquitoes feed on blood, whereas adult males do not. In fact, females usually must take a blood meal before they can lay eggs. It is their persistent search for blood that brings females into households and yards, where they cause considerable annoyance. The bite of a mosquito, in itself, causes little harm, though persons may show an inflammatory response to mosquito saliva at the site of the bite.

Figure 1. Mosquito life cycle.



## Mosquito Habitat

Adult mosquitoes originate mainly from two sources: either local standing water in which the mosquitoes have bred or more distant breeding sites. Many mosquito infestations can, in fact, be traced to backyard containers filled with water—for example, toys, pots and cans, tire swings, urns, animal tracks, and plugged rain gutters. More distant breeding sites include cemetery pots, construction sites, and trash dumps. Most mosquitoes remain within a half-mile of their breeding site, but some can fly many miles.

Numerous mosquito species are found in Pennsylvania. They can be classified according to similarities in the habitat preferences of their larvae, which in themselves provide information about other aspects of the mosquitoes' ecology. The species can be conveniently grouped into four categories: (1) the permanent pool group, (2) the transient water group, (3) the floodwater group, and (4) the artificial container and tree-hole group.

### The Permanent Pool Group

Mosquito species in this group are generally found in fresh, still water exposed to sunlight and containing an abundance of vegetation at the air-water interface. Typical habitats include shallow margins of ponds, lakes, and small impoundments; the shared characteristic of all being a degree of permanency. Such habitats are particularly suitable for *Anopheles* spp., *Culex* spp., and *Mansonia* spp.

The mosquito species in these habitats deposit their eggs on the surface of the water; *Anopheles* spp. lay eggs singly, while *Culex* spp. and *Mansonia* spp. lay eggs in rafts. Typical egg-laying sites are sheltered from wave action and have abundant vegetation that protects larvae

or serves as a site for their attachment. These mosquitoes generally breed continuously and therefore pass through many generations per year. The adults fly only short distances, remaining within a mile of the breeding area.

### The Transient Water Group

This group consists of mosquitoes in two genera: mainly *Culiseta*, and to a lesser extent, *Culex*. Their habits are similar to those of mosquitoes in the permanent pool group, but they are more often found in temporary pools rather than ponds and lakes. Typical breeding sites include roadside ditches, canals, ground pools, clogged streams, and irrigated land. These mosquitoes, like those in the permanent water group, fly only a short distance from a breeding site.

### The Floodwater Group

The floodwater group includes mosquitoes in the genera *Aedes* and *Psorophora*. The salt marsh mosquito, *Aedes sollicitans*, is also included in this group. These mosquitoes deposit their eggs singly on damp soil in grassy or woodland depressions or along vegetated shorelines that are intermittently flooded. Eggs may remain dormant and viable on the soil for some time until the area is flooded.

Typically, large numbers hatch simultaneously. The larvae develop synchronously, and adults begin to appear as early as 7 days after flooding. Some species produce only a single brood per year, while many others produce multiple generations. Mosquitoes in this group can fly several miles.

## The Artificial Container and Tree-Hole Group

This group includes members of the genus *Aedes*, which have unique habits. Adult females lay eggs singly on the inside wall of a container, at or above the waterline. Following a period of desiccation, the eggs hatch after becoming submerged in water. These mosquitoes overwinter in the egg stage. Breeding sites include natural cavities holding water, such as tree holes, and artificial containers bearing leafy sediment or decaying leaves. These mosquitoes do not fly more than one-half mile from their breeding site.

## Mosquito Control

Maintaining a strong mosquito control program is vital because mosquitoes transmit a variety of microorganisms that may cause human and animal diseases. *Culex pipiens* and *Aedes japonicus*, for example, are vectors of the West Nile virus that can cause West Nile encephalitis in humans and horses. *Culiseta melanura* is the vector of the Eastern Equine encephalitis virus, and *Aedes* spp. are vectors of dog heartworm. The Western Equine and St. Louis Equine encephalitis viruses are spread primarily by *Culex* spp. and *Culiseta* spp. Some of these diseases are present only sporadically, but when they do occur, outbreaks can be severe.

## Controlling Mosquito Breeding Sites

Homeowners, by eliminating mosquito breeding sites on their property, can reduce the number of mosquitoes in their neighborhood. Check not only your own property but surrounding areas as well, reporting any trouble spots to relevant municipal authorities. Community action is essential for controlling mosquitoes that can migrate distances greater than one-half mile. Homeowners can take the following actions:

- Dispose of anything outside that can hold water such as broken toys, tin cans, containers, ceramic pots, and in particular, used tires, which have become the most important mosquito breeding sites in the country.
- Drill holes in the bottoms of recycling containers left outdoors.
- Clean clogged roof gutters every year, especially if leaves tend to plug the drains.
- Turn over plastic swimming/wading pools and wheelbarrows when not in use.
- Do not allow water to stagnate in birdbaths, ornamental pools, water gardens, and swimming pools or their covers. Ornamental pools can be aerated or stocked with fish, and swimming pools should be cleaned and chlorinated when not in use.
- Empty accumulated water from boats and cargo trailers.
- Alter the landscape of your property to eliminate standing water. *Keep in mind that during warm weather, mosquitoes can breed in any puddle of water.*

## Reducing Mosquito Bites

Even if your property is free of mosquito breeding sites, you may still be bitten in your yard; many mosquitoes can travel miles from their breeding site in search of a blood meal. Follow these tips to reduce your likelihood of being bitten:

- Make sure window and door screens are “bug tight.”
- Use the proper type of lighting outside: incandescent lights attract mosquitoes, while fluorescent lights neither attract nor repel them.
- Stay indoors at dawn, dusk, and in the early evening, the times at which mosquitoes are most active. If you must go outdoors, wear long-sleeved shirts and long pants.
- Mosquitoes are repelled by high winds, so electric fans may provide some relief at outdoor events.
- If you must, fog with pesticides in the evening when mosquitoes are active. Follow all directions on the label.
- Insect repellents applied judiciously to exposed skin deter mosquitoes from biting. Spray clothing with insect repellents, since mosquitoes can bite through thin clothing. Be sure to follow all directions on product labels.
- Vitamin B and “ultrasonic” devices have not been proven effective in preventing mosquito bites.

## Using Deet Insect Repellents

Insect repellents can provide some relief from mosquitoes. Repellents containing the active ingredient *N,N*-diethyl-*meta*-toluamide (*N,N*-diethyl-3-methylbenzamide)—better known as DEET—are effective in repelling mosquitoes. DEET has been available to the general public since 1957. DEET repels not only mosquitoes but also other biting flies, chiggers, fleas, and ticks. According to the EPA, DEET is used annually by almost 40 percent of Americans and by about 200 million persons worldwide.

### Choosing an Appropriate Concentration of DEET

A variety of products (lotions, creams, gels, aerosols, pump sprays, and impregnated towelettes) can be purchased containing DEET in concentrations ranging from 4 to 100 percent. For most persons, products containing 10 to 35 percent DEET will provide adequate protection under most conditions. The American Academy of Pediatrics does, however, recommend that repellents used on children contain no more than 10 percent DEET.

Products containing a higher concentration of DEET generally provide longer-lasting protection. These products are more suitable when mosquitoes are present in large numbers and when conditions lead to rapid loss of repellent from the skin—for instance, when the temperature and humidity are high, causing significant perspiration.

People do differ, however, in how attractive they are to mosquitoes, so the efficacy of a repellent varies from one person to the next. Usually, repellents remain effective for 1 to 5 hours. The length of time depends on several factors, among them the degree to which a person has perspired, the extent to which a person has rubbed his or her

skin, and the amount of repellent that has been applied. Nevertheless, it is wise to use the lowest concentration of DEET that you have found to be personally effective. *To use a repellent safely, one must use it properly.* To do so, read the product's label and follow its directions.

### Is DEET Safe?

Having been in use for over 40 years, DEET has a remarkable record of safety. As with all products used against insects, however, concerns have been raised about DEET. Laboratory testing has shown that DEET is absorbed through the skin, but once in the body, it is readily eliminated in the urine, with the highest urinary concentrations occurring several hours after application. Studies on both animals and people indicate that DEET does not accumulate in the body. That having been said, though, it should be noted that cases of illness caused by DEET have been reported in the medical literature. But in most of these cases, DEET was used inappropriately, excessively, or repeatedly over a long period.

### Guidelines to Follow for Safe Application

Follow these guidelines when using insect repellents containing DEET, especially when applying them to children:

- Verify that the product has an EPA registration number; its presence on the label means the product was approved for use by the EPA.
- Before using any product, read and understand the directions on its label.
- Do not spray a repellent in an enclosed area or near food, and do not inhale aerosol formulations.
- Repellents should not be applied to infants or used by pregnant women.
- Use just enough repellent to lightly cover exposed skin and clothing. Never apply repellents to cuts, wounds, or inflamed and irritated skin. Do not saturate the skin or apply beneath clothing.
- To apply a repellent to your face, first dispense or spray it onto your palms and rub your hands together. Then, apply a thin layer to the surface of your skin. Do not place repellent in your eyes or mouth.
- Do not allow children to apply DEET by themselves.
- Do not apply a repellent directly to a child's skin. First, apply it to the palms of your own hands and then apply it to the child. Do not apply repellent to children's hands, as children may touch their eyes and mouth, causing irritation.
- DEET can damage some plastics, synthetic fabrics, leather, and painted or varnished materials. DEET does not damage natural fibers such as cotton or wool.
- After applying a repellent, wipe or wash it from your hands.
- A single application of a repellent is sufficient under most conditions. Avoid prolonged or excessive use of DEET.
- Once indoors, wash all treated skin and clothing with soap and water. Wash treated clothing before wearing it again.
- If you suspect that you or your child is reacting negatively to an insect repellent, discontinue its use, wash treated skin, and call the local Poison Center (see back cover). If you must see a doctor, take the repellent with you.
- A very small segment of the population may be sensitive to DEET and/or other insect repellents. For more information about DEET, contact the National Pesticide Telecommunications Network at 1-800-858-7378.

### Are There Alternatives to DEET?

If you wish not to use DEET, or if your physician advises against its use, other products are available that can provide limited protection.<sup>1</sup>

- **Avon's Skin-So-Soft** bath oil received considerable media attention several years ago when many consumers reported it to be an effective mosquito repellent. Various laboratory studies showed, however, that the original Skin-So-Soft formulation provided not even an hour of protection. It is worth noting, though, that Avon now sells products under this name that contain citronella oil, an EPA-recognized repellent.
- **Bite Blocker** is a plant-based repellent consisting of soybean oil, geranium oil, and coconut oil. The results of several studies indicate that this product provides good protection for at least 3 hours.

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1. For more information, please see the article by Mark S. Fradin, M.D., "Mosquitoes and Mosquito Repellents: A Clinician's Guide," in *Annals of Internal Medicine*, June 1, 1998, 128:931-940. This article includes a table showing repellents containing DEET and a table listing plant-derived repellents and permethrin insecticide sprays. Information in these tables includes the repellent's manufacturer, location, telephone number, product brand name, formulation, and DEET concentration or active ingredient, if not DEET.

- **Citronella oil** is the active ingredient most commonly found in “natural” or “herbal” insect repellents. Citronella can be an effective repellent, but DEET provides longer protection.
- **Permethrin** is a powerful, rapidly acting insecticide. It does not repel insects but kills them or knocks them down. Permethrin never should be placed directly on the skin, but only on clothing. Read the product label to ensure you are using this insecticide safely.
- **Plant-derived repellents** have not been demonstrated to have the broad and substantial efficacy of DEET—although thousands of plants have been tested as potential sources of insect repellent. A few plants whose essential oils have shown repellent activity against insects include citronella, cedar, verbena, pennyroyal, geranium, lavender, pine, cajeput, cinnamon, rosemary, basil, thyme, allspice, garlic, and peppermint. Most of these oils give short-lasting protection, generally less than 2 hours.

## Summary

Summertime, with its long warm days, naturally brings about an increase in outdoor human activity. Unfortunately, mosquitoes also appear in the summer. They are certainly a nuisance, but worse, they can and do transmit human and animal disease. Therefore, it is essential for homeowners to do what they can to eliminate mosquito breeding sites around their property. Such vigilance does not guarantee freedom from bites, however, for some mosquitoes can fly up to several miles from a breeding site. Nevertheless, by dressing appropriately and reducing your time outdoors, you can decrease the chance you will be bitten. Moreover, repellents can provide excellent protection against mosquitoes.

## For More Information

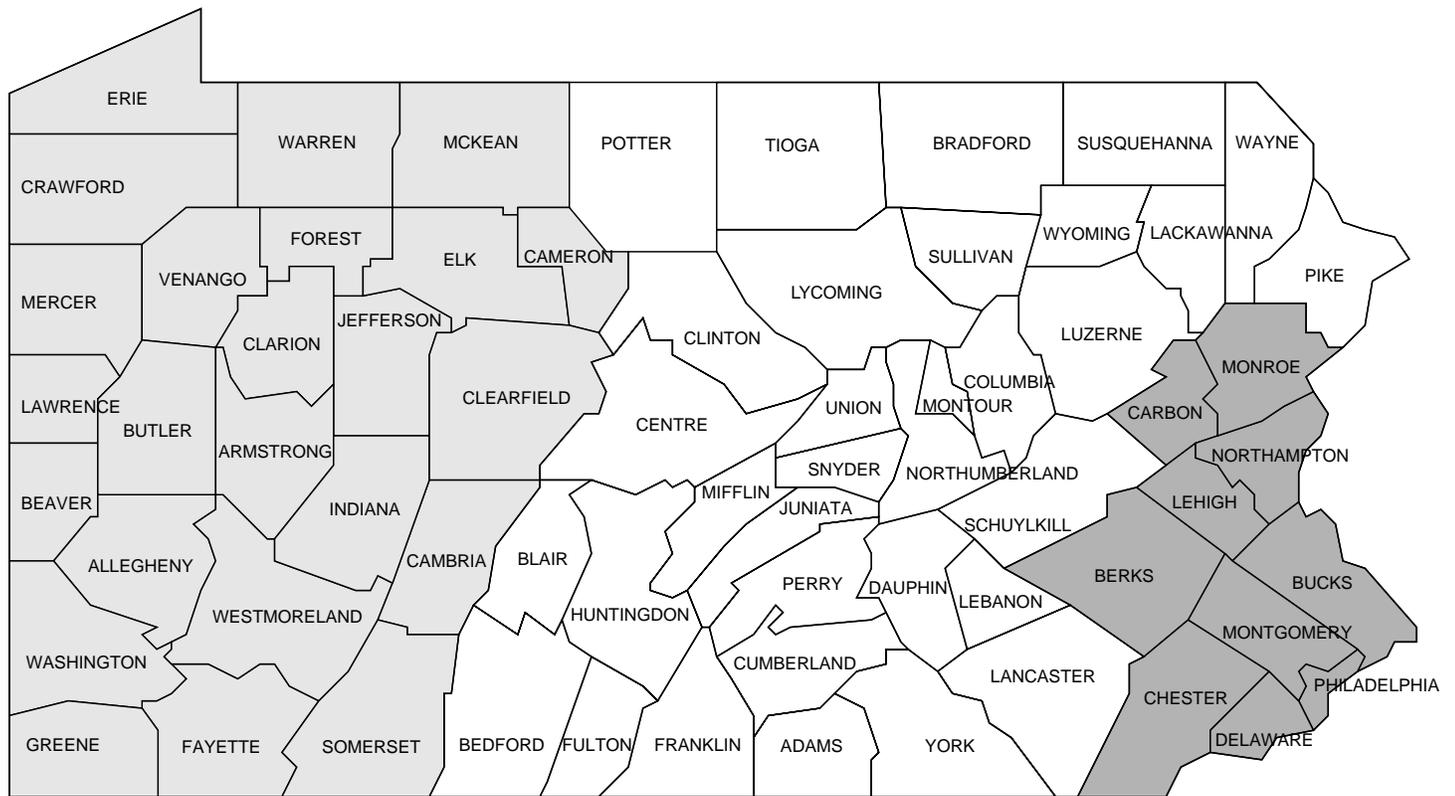
PA Department of Health:  
<http://www.westnile.state.pa.us/>  
 1-877-PA-HEALTH (or 877-724-3258)

Penn State Pesticide Education Program:  
<http://www.pested.psu.edu/spWestNile.html>

Centers for Disease Control and Prevention:  
<http://www.cdc.gov/ncidod/dvbid/westnile/index.htm>

“Mosquitoes and Mosquito Repellents: A Clinician’s Guide” in *Annals of Internal Medicine*:  
<http://www.acponline.org/journals/annals/01jun98/mosquito.htm>

## Poison Centers in Pennsylvania Regions



**Pittsburgh Poison Center**  
Children's Hospital of Pittsburgh  
412-681-6669

**Central Pennsylvania Poison Center**  
Milton S. Hershey Medical Center  
800-521-6110

**The Poison Control Center**  
The Children's Hospital of Philadelphia  
800-722-7112

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