Chapter 5: Aquatic Plants, Mosquitoes and Public Health

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Introduction

Approximately 200 species of aquatic plants are classified as weeds in North America and nearly 50, or 25%, are considered to be of major importance. Aquatic plants become weedy or invasive when they exhibit rapid growth and produce dense monocultures that displace more desirable native plants, reduce biodiversity, interfere with flood control, impede navigation and create breeding sites for disease-vectoring mosquitoes.

Mosquitoes are insects that belong to the family Culicidae in the order Diptera, or true flies. They are similar in appearance to other flies except they have fragile bodies and their immature stages (eggs, larvae and pupae) develop entirely in aquatic environments. These insects are serious pests that have plagued civilizations throughout human history. In addition to their annoying and often painful bites, they transmit some of the world's most devastating diseases – dengue, encephalitis, yellow fever, dog heartworm and the dreaded malaria. According to a recent report from the University of Florida, more than 500 million new cases of malaria are reported worldwide each year, resulting in about 1 million deaths. Most of the deaths that are caused by malaria are in children under 10 years of age. The importance of mosquitoes from a nuisance and public health perspective cannot be overstated.

Malaria

Malaria was endemic in the US until around 1950 when window screens, air conditioning and mosquito control efforts essentially eliminated malaria in this country. Malaria is caused by four species of a protozoan parasite in the genus *Plasmodium*. This parasite, which is transmitted by a mosquito bite, destroys red blood cells and causes fever, chills, sweating and headaches in infected humans. If not treated, individuals that have become infected with malaria may go into shock, experience kidney failure and eventually slip into a coma and die. The disease is transmitted by several species of *Anopheles* mosquitoes, which are permanent water mosquitoes (see below). These species are widespread and are most abundant from early spring (April) to early fall (September). Until recently, reported cases of malaria in the US were from travelers and returning military personnel who contracted the disease outside the country. However, cases of malaria occur periodically in the US when indigenous *Anopheles* mosquitoes transmit the disease from an infected human who traveled abroad to an uninfected human.

Dengue fever

Dengue is a viral disease, often referred to as "breakbone fever". Symptoms of this mosquito-transmitted disease include headaches, high fever, rash, backache and severe pain in the joints. The

excruciating joint pain gives rise to the common name. Disease symptoms usually occur about a week after a susceptible human has been bitten by an infected mosquito and rarely result in death. However, because four strains of dengue virus are recognized, exposure of a previously infected individual to a different strain of dengue virus may result in a more severe case of dengue known as dengue hemorrhagic fever (DHF). There has been an increase in the incidence of DHF in the Western Hemisphere during the last 20 years, with outbreaks occurring in the Caribbean region. Ideal conditions for dengue transmission are present in the southern US. The virus often is "imported" by people entering the country from the tropics. Also, the potential mosquito vectors (yellow fever mosquito, *Aedes aegypti*, and the Asian tiger mosquito, *Aedes albopictus*) are commonly found in close association with humans, breeding in natural and artificial water-holding containers near homes and businesses.

Encephalitis

Encephalitis means inflammation of the brain and is a disease of the central nervous system. Although there are several possible causes for encephalitis, one of the most important involves mosquitoes. Mosquito-transmitted viruses are commonly referred to as arthropod-borne or arboviruses. There are six major types of arboviral encephalitis in the US: California encephalitis (CE), Eastern equine encephalitis (EEE), St. Louis encephalitis (SLE), Venezuelan equine encephalitis (VEE), Western equine encephalitis (WEE) and West Nile virus. These viruses are normally diseases of birds or small mammals and each is caused by a different virus or virus complex. Humans and horses are considered "dead end" hosts for these viruses as there is little chance of subsequent disease transmission back to mosquitoes. However, human and horse cases of arboviral encephalitis range from mild to severe, with permanent

damage to the central nervous system or even death. Mosquito genera involved in the transmission of arboviruses include *Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Ochlerotatus*, *Coquillettidia* and *Psorophora*.

Yellow fever

Like dengue fever, the yellow fever virus is transmitted primarily in urban areas by the container- breeding mosquitoes *Aedes aegypti* and *Aedes albopictus*. But unlike dengue, the effects on humans are more severe. During outbreaks, the human fatality rate often exceeds 50% of the affected population. Fortunately, the yellow fever virus is restricted to parts of Africa and South America. The likelihood of the yellow fever virus causing an epidemic in the US is extremely low for several reasons. First of all, yellow fever is a quarantinable disease; the Centers for Disease Control and Prevention in Atlanta continually monitor disease outbreaks in the Western hemisphere. Secondly, travelers planning to visit parts of Africa and South America where the virus is endemic are vaccinated to prevent infection. Finally, humans moving to virus-free areas from locations where the virus occurs naturally are required to be vaccinated to prevent transmission.

Heartworms

The filarial nematode (microscopic worm) *Dirofilaria immitis* is responsible for dog heartworm, a serious mosquito-transmitted disease that affects all breeds of dogs. Although the disease occurs in temperate regions of the US, it is more of a concern along the Atlantic and Gulf Coasts from Massachusetts to Texas. If left untreated, the infection rate in dogs can range from 80 to 100%. Foxes and coyotes probably serve as reservoirs for the disease. Cats and humans also can be infected but the parasite is unable to complete its development in humans. Mosquitoes in most of the common genera, including *Aedes*, *Anopheles*, *Culex*, *Ochlerotatus*, *Mansonia* and *Psorophora*, are capable of transmitting the disease. The life cycle of dog heartworm begins when an infected mosquito feeds on a dog. Juvenile worms (microfilariae) emerge from the mouthparts of the feeding mosquito and enter the dog's skin. The worms migrate in the muscle tissue for 3 to 4 months, penetrating blood vessels and eventually making their way to the right ventricle of the dog's heart, hence the name "dog heartworm". The worms reach maturity in around 5 months; adult female worms measure about 1 foot in length whereas males are only 6 inches long. The life cycle is completed when the adult female produces microfilariae that circulate in the blood and are ingested by a mosquito during a blood meal. Medication for preventing dog heartworm is available from veterinarians.

The role of aquatic plants in mosquito outbreaks

The aquatic stages of most mosquitoes are not adapted to life in moving waters. They require quiet pools and protected areas where they can obtain oxygen at the water surface via a single air tube (or siphon) in the larval stage or two tubes (or horns) in the pupal stage. Aquatic weed infestations create ideal habitats for mosquito development because the extensive mats produced by many weeds reduce the rippling effect of the water surface. Some mosquito species even have a modified air tube that they insert into the roots of aquatic plants to obtain oxygen. This protects them from light oils that are applied to the water surface for mosquito control.

From a mosquito control perspective, there are two major larval habitat categories that are of concern to aquatic plant managers: standing water (permanent and temporary) and flood water (detention and retention areas). Permanent water mosquitoes (e.g., species in the genera *Anopheles*, *Culex*, *Coquillettidia* and *Mansonia*) are associated with aquatic plants in freshwater marshes, lakes, ponds, springs and swamps. Temporary water mosquitoes (e.g., species in the genera *Culiseta*, *Ochlerotatus* [=*Aedes*] and *Psorophora*) are associated with vegetation in saline or brackish ditches, borrow pits and canals and freshwater drainage ditches which alternate between wet and dry based on water use and rainfall events.

Permanent water

The amount and type of vegetation occurring in a permanent water body is a good indicator of its potential to produce mosquitoes. For example, the presence of floating mats of cattails, torpedograss, alligatorweed or para grass suggest that larvae of permanent water mosquitoes are likely to be present. Also, dense stands of aquatic plants create ideal conditions for mosquito development by restricting water flow in drainage and irrigation ditches.

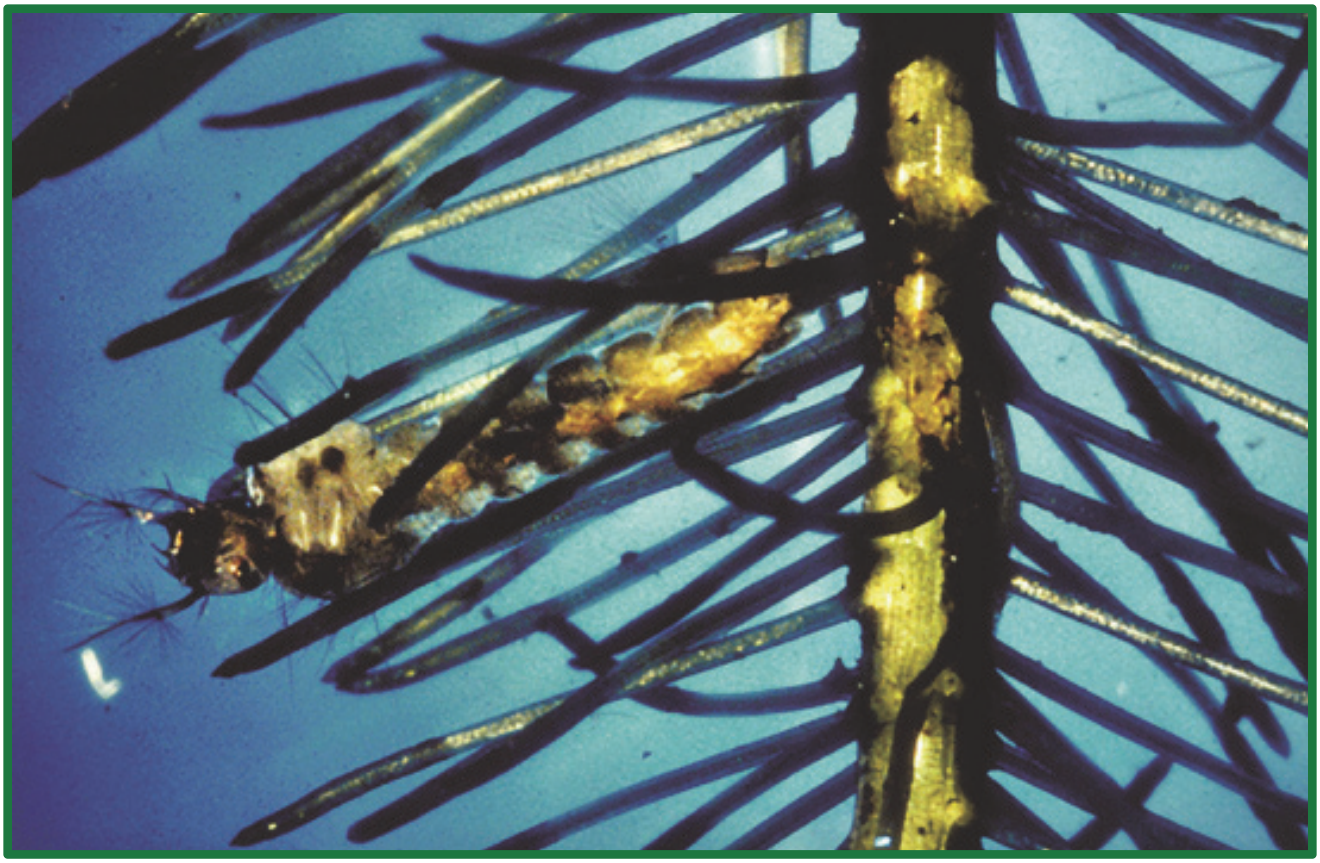
Flood water

Detention and retention systems are artificial ponds designed to capture flood water from rainstorm events and filter it before it enters natural systems. Construction of storm water detention/retention areas has increased dramatically throughout the US and they are often required by law for all new commercial and residential developments. Detention ponds differ from retention ponds by the length of time they are "wet." Detention ponds dry out only during drought conditions, whereas retention ponds are designed to dry out rapidly, usually within 72 hours. Under the right conditions, both types of flood control systems can produce aquatic vegetation that can foster mosquito outbreaks. Unless they are properly managed, detention/retention areas overgrown with aquatic vegetation can lead to serious mosquito problems. Detention ponds normally do not produce many mosquitoes unless they alternate between the wet and dry cycles that are required to produce floodwater mosquitoes.

However, if they are not properly managed, they often are invaded by floating and rooted aquatic plants. The only way to prevent a mosquito problem in residential and commercial detention/ retention areas that contain these mosquito-producing plants is to control the plants.

Mosquitoes associated with specific aquatic plants

Some species of mosquitoes are associated with certain species of aquatic plants. For instance, the permanent water mosquito species *Coquillettidia pertubans*, *Mansonia dyari* and *M. titillans* are always associated with waterlettuce (Chapter 15.8), waterhyacinth (Chapter 15.7) and cattails. The extensive fleshy root systems of these species provide an ideal substrate for *Mansonia* larvae to



attach and obtain oxygen through air tubes they insert into the plant roots. Also, the fleshy root system of cattail often harbors larvae of *Coquillettidia* mosquitoes. The roots of cattails and other plants also afford mosquito larvae some measure of protection from predators (including fish), as they are hidden from them. Other plants are good indicators of areas likely to produce floodwater mosquitoes. For example, sites with grasses, sedges and rushes often host enormous numbers of *Psorophora* mosquitoes that are vicious biters. On the other hand, the presence of extensive mats of duckweed (Chapter 15.10) or salvinia (Chapter 15.9) is indicative of low mosquito production areas. Although the root system of salvinia is highly branched, this floating aquatic plant is not a preferred host for mosquito larvae.

Summary

The association between aquatic plants and certain species of mosquitoes has evolved over millions of years. The uncontrolled growth of invasive plants often provides an undisturbed habitat that mosquitoes prefer and where they can proliferate. Mosquitoes can colonize virtually any type of water body and aquatic vegetation provides a perfect environment for mosquitoes to thrive. Management of dense surface-growing exotic and native aquatic plants in permanent and temporary water systems is critical to reduce the habitats suitable for mosquito development. After all, "…Without aquatic plants, most of our freshwater mosquito problems would not exist…" (Wilson 1981).

For more information:

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•Hoover A. 2008. First global malaria map in decades shows reduced risk. University of Florida News. http://news.ufl.edu/2008/02/26/malaria-map/

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•O'Meara G. 2003. Mosquitoes associated with stormwater detention/retention areas. UF/IFAS Cooperative Extension Service, Gainesville FL. ENY627/ MG338. http://edis.ifas.ufl.edu/MG338.

•Wilson F. 1981. The aquatic weed-mosquito control connection. Aquatics Fall 3:6, 9-11, 14.

Photo and illustration credits:

Mosquito life stages photos (all from University of Florida IFAS Medical Entomology Laboratory)

Page 31: *Anopheles quadrimaculatus* eggs; Roxanne Connelly

Page 32, upper: *Culex salinarius* larva; Michelle Cutwa-Francis

Page 32, lower: Mosquito pupa; James Newman

Page 33: *Culex quinquefasciatus* adult; James Newman

Page 35: Mosquito larva attached to root of waterlettuce; T. Loyless, Florida DACS