ENTO-040
3/16

Texas A&M AgriLife Extension

Mosquitoes
and the Diseases They Transmit

Sonja L. Swiger, Assistant Professor and Extension Entomologist
The Texas A&M University System

Mosquitoes affect the health of people and animals more than any other insect pest worldwide. Biting female mosquitoes transmit many infectious agents that cause diseases such as encephalitis, malaria, dengue, chikungunya, Zika virus, and yellow fever. Mosquito populations exist throughout Texas, and some species are known to be disease vectors (carriers).

To control mosquitoes the most effectively and economically, you need to:

- Understand their life cycle
- Be able to identify the mosquito species in your area
- Know the management steps that provide the best control for different species and at specific locations

Identifying mosquitoes

Adult mosquitoes are small, long-legged flies that have two wings. They are distinguished from all other flies by three characteristics:

- Long, many-segmented antennae
- A piercing and sucking mouthpart system elongated into a distinctive beak or proboscis, at least in the females
- Scales on the wing veins and margins

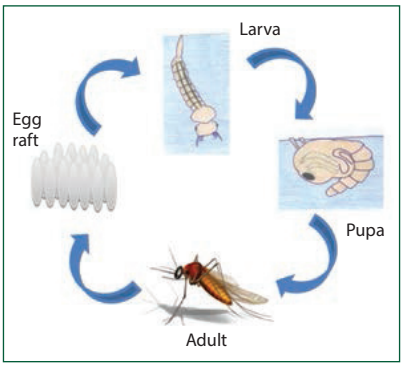

Figure 1. Mosquito life cycle, including the egg, larval, pupal, and adult stages. Source: Molly Keck

At least 85 species of mosquitoes occur in Texas. They vary considerably in larval breeding sites, time of day when they bite, and flight distances of the adults. Table 1 summarizes this information for the most common Texas species.

It can be difficult to identify some species of mosquitoes at the larval or adult stages. To determine the species in your area, send samples to an identification lab or contact a mosquito control district, university, or pest control operator.

Life cycle

The mosquito life cycle has four distinct stages: egg, larva, pupa, and adult (Fig. 1). The

adult stage can fly and lives on land; the other stages are aquatic.

Under favorable conditions, some mosquitoes can develop from egg to adult in 8 to 10 days. The amount of time to complete the life cycle varies according to the mosquito species, food availability, and weather conditions.

Egg

Eggs are laid in areas where present or future water will provide habitat for the immature stages, and different mosquito species have different types of egg-laying strategies, including in:

- Clusters of eggs called *rafts* on the water surface (Fig. 2)

Table 1. Biological data on 20 common species of mosquitoes found in Texas

Mosquito species	Larval habitat(s)	Biting time	Flight range
Aedes aegypti	AC	C, D	under 100 yards
Aedes albopictus	AC, TH	C, D	100–300 yards
Aedes atlanticus	WP	C, D	0.25–0.5 mile
Aedes canadensis	WP, DD, FS	C	0–0.25 mile
Aedes sollicitans	SM	C, N, D	5–40 miles
Aedes taeniorhynchus	SM	C, N, D	5–40 miles
Aedes triseriatus	H, AC	D	0.5–1 mile
Aedes vexans	FW, GP, IP	C, N	10–25+ miles
Anopheles punctipennis	WP	C, N	0–0.25 mile
Anopheles quadrimaculatus	FW, GP, LM	C, N	0.5–1 mile
Culex erraticus	WP	N	0–0.25 mile
Culex nigripalpus	GP, FW, DD	C	0.5–1 mile
Culex quinquefasciatus	AC, SCB, GRP	C, N	0.25–0.5 mile
Culex restuans	WP, GRP, DD	C, N	1–2 miles
Culex salinarius	GP, LM, FS, SM	C, N	0.25–5 mile
Culiseta melanura	FS, WP	C, N	0.5–1 mile
Psorophora ciliata	IP, RF, GRP	C, N	5–10 miles
Psorophora columbiae	IP, RF, GRP	C, N	5–10 miles
Psorophora ferox	WP	C, N	1–2 miles
Psorophora howardii	WP, coastal pools	C, N	1–2 miles

AC: Artificial containers
DD: Drainage ditches
FS: Freshwater swamps
FW: Flood waters
WP: Woodland pools
C: Crepuscular (dusk and dawn)

GP: Grassland pools
GRP: Ground pools
IP: Irrigated pastures
LM: Lake margins
TH: Tree holes
D: Day

RE: Rooted emerged vegetation
RF: Rice fields
SCB: Sewage catch basins
SM: Salt marshes

N: Night

Figure 2. Mosquito eggs. Source: Mike Merchant

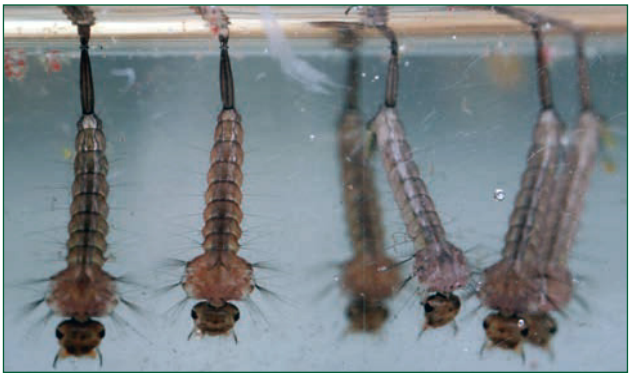

Figure 3. Mosquito larvae. Source: Mike Merchant

- Singly on the water surface
- Dry areas that are flooded periodically

Although white when first laid, the eggs within a few hours become dark brown to black. Their shape and size vary, with most being football-shaped or boat-shaped and 0.02 to 0.04 inch long.

In warm water, the eggs may hatch in 2 to 3 days. Some mosquito eggs can remain dormant in dry conditions for many months to 2 years.

Larva

Mosquito eggs hatch into larvae called wigglers, which are seldom more than ½ inch long. Wigglers have three body sections: a small head, an enlarged middle section (the thorax), and a long, cylinder-shaped abdomen (Fig. 3).

Wigglers live only in water and feed on microscopic plants, animals, and organic debris suspended in the water or growing in a biofilm (a thin, slimy layer of bacteria growing on a surface). They filter the food particles from the water with their brush-like mouth parts. The larvae of some mosquito species feed on larvae of other mosquito species.

Most mosquito larvae mature in 4 to 10 days, passing through four growth stages (instars) before transforming into pupae. The length of the larval development period depends on the species, temperature, and availability of food.

While feeding or breathing, mosquito larvae assume distinctive positions in the water. For most species, the larva breathes through an air tube near the end of the abdomen, projecting the tube through the water surface and hanging its head down at an angle to the surface. Only the tip of the breathing tube contacts the water surface.

An exception is the *Anopheles* larvae, which lack air tubes and tend to lie flat against the water surface.

Pupa

The pupal stage is the transitional stage between the larvae and the adults. Mosquito pupae are sometimes called tumblers because of the tumbling motion they exhibit in water when disturbed. Mosquito pupae do not eat. Most of the time they lie at the water surface and tend to move only when disturbed.

The pupae are comma-shaped and, like the larvae, breathe through air tubes at the water surface. The front of the pupa's body is greatly enlarged, consisting of a fused head and thorax (Fig. 4). A pair of breathing tubes, or trumpets,

Figure 4. Mosquito pupa. Source: Mike Merchant

extends from the back of the thorax. The pupal abdomen or tail consists of several segments that move freely.

The pupal stage may last from 1 to 10 days or more, depending on the species and temperature.

Adult

Adult mosquitoes are small to medium-sized with wings, long legs, and elongated abdomens (Fig. 5). The coloration varies. Male mosquitoes have feathery antennae; the females' antennae have short, sparse hairs.

Male mosquitoes feed only on nectar, plant juices, and other sources of liquid carbohydrates. They usually emerge a few hours up to a few days before the females emerge. The males rest in the vegetation surrounding the emergence site, waiting for the females to emerge.

Female mosquitoes also feed on nectar, plant sap, and other sources of plant carbohydrates for energy. However, the females of most species must have a blood meal as a source of protein before they can produce eggs.

Mating usually occurs quickly in the air near the emergence site. All of the eggs can be fertilized after a single mating because the females can store the sperm internally. Male mosquitoes usually die soon after mating.

Adult female mosquitoes typically live for about a week to a month, depending on the environment. Some species spend the winter as adults that may live 6 months or more.

Inactive females rest in protected areas that are typically dark or shaded, humid, and cool in the summer or warm in the winter.

Figure 5. Mosquito adult. Source: Winfield Sterling

When a mosquito takes a blood meal, it uses its mouthparts to puncture the host's skin and injects a bit of saliva before drawing blood. The saliva makes penetration easier and prevents the blood from clotting during feeding. It is during saliva delivery that infected mosquitoes transmit disease agents such as viruses.

In most cases, the itching and swelling caused by the saliva subside within a few hours.

The adult mosquitoes around your home may have come from a breeding site near or far away, depending on the species, wind patterns, and the flight habits of the females:

- *Aedes aegypti* and *Aedes albopictus* breed primarily in and around human habitations and fly short distances, usually only about 200 yards.
- Most *Anopheles* mosquitoes have a flight range of about 1 mile. *Psorophora* species have flight ranges of at least 5 miles.
- Some salt-marsh mosquitoes in the genera *Aedes* can disperse with the prevailing winds for 20 to 40 miles or more away from the larval development sites.

Knowing these flight distances can help you find the source of mosquito problems and choose the appropriate management strategies. If the mosquitoes originate away from your property, you may need to cooperate with others to control the insects. In some cases, you may not be able to control them at all.

Mosquito groups

Mosquito species are divided into groups based on where the females lay their eggs and where the larvae develop. The control strategies differ for each group. The Centers for Disease Control and Prevention (CDC) divides mosquitoes into four groups according to the habitats where the larvae generally develop:

- Permanent pools
- Transient water
- Floodwater
- Artificial containers and tree holes

Table 2 lists the groups, breeding habitats, and general management approaches of the genera and/or species that cause the most problems.

Managing mosquitoes

To manage mosquitoes effectively long-term, use several complementary management techniques, including:

- **Sanitation:** Remove mosquito food, water, and shelter.
- **Habitat disruption:** Drain the water where mosquitoes breed (Fig. 6).
- **Biological control:** Use mosquito fish, nematodes, and *Bacillus thuringiensis israeliensis* toxin and *Bacillus sphaericus*.
- **Mechanical control:** Maintain window screens and alter building designs.
- **Personal protection:** Wear protective, light-colored, loose-fitting clothing; use repellents; and avoid activities outside when mosquitoes are active.
- **Chemical suppression:** Use insecticides against adults and/or larvae.

Mosquito management is often complex and expensive, requiring the cooperation of individ-

Table 2. Mosquito groups, their breeding sites, and management suggestions for each group

Mosquito group	Genera and/or species	Breeding sites	General management
Permanent pool	*Anopheles,* some *Culex, Culiseta, Coquillettidia, Mansonia*	Standing water that seldom dries, edges of ponds, lakes and smaller impoundments	Biological control—using mosquito fish, *Bacillus thuringiensis israeliensis* toxin, and *Bacillus sphaericus* Habitat disruption—draining the water or removing plants
Transient pool	*Culiseta,* some *Culex,* occasionally *Anopheles,* especially *Anopheles punctipennis*	Roadside ditches, excavations, canals, ground pools, catch basins, storm sewers, clogged streams, irrigated land	Biological control—using mosquito fish, *Bacillus thuringiensis israeliensis* toxin and *Bacillus sphaericus* Sanitation—removing food, water, and vegetation
Floodwater	*Aedes, Psorophora*	Flood plains, salt marshes, smaller sites, even animal footprints	Habitat disruption—draining the water where mosquitoes breed Chemical suppression—using insecticides against adults and/or larvae
Artificial container and tree-hole	Most *Aedes,* especially *Aedes aegypti, Aedes albopictus,* and *Aedes triseriatus*	Artificial containers, discarded tires, tin cans, flower pots, cemetery vases, roof gutters, treeholes, water caught in bromeliads, orchids, and other plants	Sanitation—removing food, water, and shelter Habitat disruption—draining the water in small containers

Figure 6. Artificial containers that can serve as mosquito egg-laying sites: (from top left) a garbage can lid, birdbath, plastic bucket of water, flowerpot, plastic container, and a clogged rain gutter. Sources: Mike Merchant and Michael Sanders

ual homeowners as well as organized areawide efforts led by groups such as local government agencies or private companies.

Some communities may have to take an areawide approach to mosquito management and hire permanent control personnel. These programs can provide workers and expertise that are usually unavailable to homeowners.

In these programs, trained personnel conduct mosquito surveys to identify the species, track the population levels, and decide how to manage them. Areawide management can provide relief from mosquito problems that develop miles away from your home.

Laws have been enacted in Texas enabling various groups to form mosquito control districts. The Texas Department of State Health Services in Austin monitors the mosquito-borne diseases that affect people and horses.

Homeowners can help reduce mosquito populations by looking for larval breeding sites and taking appropriate action to minimize these locations (Table 3).

The use of personal protection is strongly recommended for individuals planning to be outdoors for an extended period. Repellents provide protection from mosquito bites for 2 to 12 hours, depending on the product. They should be used during daytime and nighttime activities to protect against the various mosquito species that carry disease pathogens.

DEET provides the best repellent results. The American Academy of Pediatrics does not recommend using more than 30 percent on children and pregnant or breastfeeding women.

Read all labels prior to application. Some repellents are only for skin application; some are for application over clothing; and some can be applied to both. Picaridin, IR3535 and lemon of eucalyptus repellents are also recognized by the Center of Disease Control and Prevention as effective means of repelling mosquitoes.

How mosquitoes affect people and animals

Mosquitoes can affect people and animals directly or indirectly.

Direct effects: Mosquito species that feed on blood can annoy people, birds, mammals, and other vertebrates. They disrupt outdoor work and recreational activities. If enough mosquitoes are in an area, they can cause severe blood loss and slow the growth of livestock.

The bites often cause mild allergic reactions such as swelling and itching, which may continue to affect the hosts long after the female mosquitoes have gone. Although some people may react more strongly to the bites, severe reactions are uncommon.

Indirect effects: Mosquitoes indirectly affect people and animals when they transmit disease-causing agents. Each year worldwide, mosquitoes affect millions of people by transmitting the pathogens that cause several serious diseases.

Some of these mosquito-borne pathogens were once common in the United States; others appear occasionally because of international travel. The most common of these in Texas are West Nile virus, Eastern equine encephalitis virus, and dengue virus. Two new mosquito-borne viruses, Zika and chikungunya viruses,

Table 3. Possible mosquito sources around the home and other property and control options for the mosquitoes

Mosquito sources	How to reduce mosquitoes
Ponds	Stock the pond with fish. Use *Bacillus thuringiensis israeliensis* (such as Mosquito Dunks®). Remove excess vegetation.
Swimming pools	Keep water off the cover. Maintain water quality at all times.
Tree holes	Fill the holes with sand, or drill a drain hole.
Plastic pools	Drain the water when not in use, or cover the pool to prevent mosquitoes from laying eggs in the water.
Containers	Empty the water. Store the containers in an inverted position. Dispose of the containers. Cover the containers so mosquitoes cannot lay eggs in them.
Bird baths	Change the water at least once a week.
Standing water	Eliminate it by draining it. Fill in low areas.
Watering troughs	Stock the trough with fish. Change the water weekly.
Cooler drains	Prevent water from standing in the drain.
Street gutter or catch basins	Keep litter and garden debris out of the gutter. Do not overwater the yard.
Cesspool or septic tank	Seal and cover it so mosquitoes cannot lay eggs in it.
Roof gutters	Clean them regularly to remove debris.
Irrigated lawns or fields	Avoid over irrigation. Drain standing water.

Source: Modified from *UC Pest Management Guidelines,* http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7451.html

have emerged in recent years in the Americas and occur in many Central and South American countries, including Mexico. The potential for Zika and chikungunya viruses to be introduced and established in Texas remains unknown.

Mosquitoes also commonly transmit heartworm to dogs and cats, particularly in the humid areas of Texas. Dog heartworm, a type of parasitic roundworm, is a serious disease, especially for dogs. Symptoms include cough, weight loss, fainting, coughing up blood, and eventually congestive heart failure.

Mosquito-borne diseases

Mosquito-borne diseases can become a problem when these elements are present:

- **Pathogens,** the organisms that cause the disease
- **Reservoir,** the animals in which the pathogen lives and which serve as the source of the pathogen for the mosquitoes that transmit it
- **Susceptible hosts,** the people and/or other animals that can be infected by the pathogen
- **Dead-end hosts,** people or animals that get infected, sometimes have disease, but cannot infect mosquitoes
- **Vectors,** the organism that can transmit the pathogen, either mechanically or biologically, among vertebrates

For a mosquito-borne disease to continue to occur and cycle in a geographic location, the pathogen, susceptible hosts, and competent vectors must **all** be present.

Encephalitis

Encephalitis is an inflammation of the brain caused by certain viruses, some of which are transmitted by mosquitoes. Human cases of encephalitis range from unapparent or mild cases to very severe illnesses that can permanently damage the central nervous system or, in some instances, cause death. Symptoms include high fever, convulsions, delirium and other central nervous system problems. If these symptoms occur, seek medical assistance quickly.

These encephalitis viruses cause concern to the people and horses in Texas: West Nile virus (WNV), eastern equine encephalitis virus (EEEV), western equine encephalitis virus (WEEV), and St. Louis encephalitis virus (SLEV). These viruses are normally transmitted from bird to mosquito to bird and sometimes from bird to mosquito to human. EEEV, WEEV, and WNV can also be transmitted from bird to mosquito to horse. When the incidence of any of these viruses increases in the bird populations, it becomes more likely that people and horses will be infected.

Birds serve as reservoirs for the viruses that cause WNV, EEEV, WEEV, SLEV, and some less-common diseases. These diseases become a problem when transmitted to humans, horses, or other equines such as donkeys or mules.

In most cases, the human or equine host is a "dead-end host" for the virus, and probably will not transmit the disease because they cannot infect mosquitoes.

Similarly, horses may have mild, severe, or even fatal infections with WNV, EEE, or WEE viruses. Horses with the SLE virus show no outward sign of infection.

Birds may die of infection caused by some encephalitis viruses but not others. For example, deaths from the EEE virus have been reported in emus, pheasants, house sparrows, and red-winged blackbirds. The SLE virus, however, produces no outward sign of infection in birds.

WNV: West Nile virus threatens birds (wild and domestic), horses, and people. Wild birds are the primary reservoirs of this disease, and the pathogen can move with migratory birds.

Although about 40 percent of horses that contract WNV die, the disease is usually much less severe in humans. Direct contact with infected individuals does not appear to spread the virus from animals to humans or from human to mosquito to human (Fig. 7).

The vector of WNV in urban Texas areas is the southern house mosquito, *Culex quinq-*

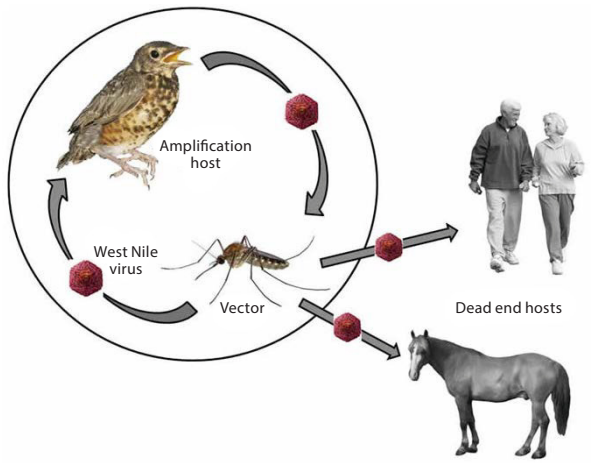

Figure 7. Diagram showing how West Nile virus is transmitted among *Culex quinquefasciatus,* birds, humans, and horses. Source: Gabriel Hamer

uefasciatus. Two forms of the virus can affect humans: West Nile fever (WNF) and West Nile neuroinvasive disease (WNND).

West Nile fever causes symptoms that are like those of many other viral illnesses—most people have a fever, and 20 to 50 percent develop a mild rash on their arms, chest, and back. Other symptoms include diarrhea, fatigue, headache, nausea, vomiting, abdominal pain, back pain, depressed appetite, and muscle aches.

West Nile neuroinvasive disease is much more severe. It affects the nervous system, requires medical intervention, and can be fatal. The early symptoms may be the same as those of WNF but usually do not include a rash.

Within a few days of developing WNF symptoms, a person infected with WNND can also develop encephalitis, meningitis, weakness or paralysis of muscles (generally on one side of the body), inflammation of the lining of the retina, or a combination of these.

The largest-ever U.S. outbreak of WNV occurred in the summer of 2012, with 5,674 cases and 286 deaths, according to ArboNET, a national arboviral surveillance system managed by the CDC and state health departments. In Texas that year, 1,868 cases of WNV and 89 deaths were reported by the Texas Department of State Health Services.

EEE virus: A mosquito that breeds in freshwater swamps, *Culiseta melanura,* is typically involved in the bird-to-mosquito-to-bird cycle of eastern equine encephalitis virus. Because this mosquito rarely bites humans or horses, other mosquitoes, such as *Coquilletidia,* probably play a role as a "bridge vector" in transmitting EEE virus to humans and horses.

EEEV has a 30 percent mortality rate in both horses and humans but is not typically seen throughout Texas every year.

WEE virus: The main mosquito vectors for the western equine encephalitis virus, particularly west of the Mississippi River, are *Culex tarsalis* and *Aedes dorsalis.* Other insects such as the swallow bug *(Cimicidae)* may also serve as overwintering hosts of the WEE virus.

SLE virus: The primary urban vectors of the St. Louis encephalitis virus are the northern house mosquito *(Culex p. pipiens)* and the southern house mosquito *(Culex p. quinquefasciatus),* with the latter species causing concern in Texas.

The chief vector in rural areas of the western United States is *Culex tarsalis;* in Florida and potentially in Texas, it is *Culex nigripalpus.*

SLEV is becoming less common in the United States, and research has suggested that the presence of WNV has contributed to this displacement.

VEE and CE viruses: The Venezuelan equine encephalitis (VEE) virus complex and the California encephalitis (CE) virus complex also have been recorded in Texas. These virus complexes can cause encephalitis in humans and sometimes in horses.

They differ from the other mosquito-borne encephalitis viruses in that their reservoirs are small mammals such as rodents rather than birds, and, in the case of VEE, sometimes horses serve as reservoirs.

The dark rice field mosquito, *Psorophora columbiae,* is the only mosquito that has been confirmed to transmit VEE from horse to mosquito to horse in Texas.

The tree-hole mosquito, *Aedes triseriatus,* is the primary vector of CE, and tree squirrels are the primary reservoirs. The La Crosse type of California encephalitis is the strain that occurs most often in humans, but only a few cases have been confirmed in Texas.

Zika virus

The Zika virus is a *Flavivirus* similar to the viruses that cause WNV and dengue fever. It was first isolated in 1947 from a rhesus monkey in the Zika forest of Uganda. It was originally confined to Africa, with occasional small outbreaks in Asia, but has since slowly spread east to South and Central America, along with isolated travelers bringing it to the Americas.

Zika virus is transmitted to humans primarily by the bite of *Aedes aegypti* and *Aedes albopictus* mosquitoes. Unlike WNV, humans (or wild primates) are the primary reservoir for the virus. In addition, the Zika virus may be spread through sexual transmission, blood transfusion, mother to unborn child, and during birth. Most infections, however, occur as the result of the bite of an infected mosquito.

On average, 20 to 25 percent of the people who become infected will develop symptoms, which typically last between 2 to 7 days. The most common symptoms are mild and include fever, skin, rash, red eyes (conjunctivitis) and joint pain. Some patients also report muscle pain, general malaise, headache, and vomiting.

An association between pregnant women infected with Zika virus and microcephaly in newborns is being investigated in Brazil, with the greatest risk occurring when a mother was infected during the first trimester. Microcephaly is a medical condition that results in a small head because the brain has stopped growing or has not developed properly.

Although an association between Zika and microcephaly has not been firmly established, the U.S. Centers for Disease Control and Prevention has issued a travel alert for all travelers, especially pregnant women and those that might become pregnant. Men who travel to Zika-affected areas are encouraged to abstain from sex or use condoms during and upon return from travel.

Chikungunya virus

The Chikungunya (CHIK) virus is transmitted primarily by *Aedes aegypti* and *Aedes albopictus* mosquitoes. In humans, it causes a severe fever and incapacitating joint arthritic pain. Humans are the primary reservoir, and 72 to 97 percent of the population will be infected with clinical signs. Symptoms will resolve in 7 to 10 days, but the pain can linger for years, and mortality is very rare.

International travelers brought imported cases (patients contracting the disease while out of the country) of the CHIK virus to the United States in 2014. Florida has been the only state to have reported cases acquired locally through the bite of mosquitoes.

Dengue

Another virus-caused disease transmitted by mosquitoes is dengue, or breakbone fever. The more serious manifestations of this disease are called dengue hemorrhagic fever and dengue shock syndrome. It is transmitted from infected humans to susceptible humans by mosquitoes.

A dengue outbreak occurred in Texas in 1999, with 62 cases reported to the DSHS, including one death. From 2003 through 2012, Texas recorded 154 cases, all imported. Sporadic outbreaks have occurred in the Gulf Coast and extreme southern regions of Texas.

Dengue is usually a severe but nonfatal disease. Symptoms include the sudden onset of high fever, severe headache, backache, joint pains, and a rash that appears on the third or fourth day of the illness.

In Texas, the mosquito primarily responsible for transmitting dengue to people is *Aedes aegypti.* Mosquitoes obtain dengue virus from the blood of infected humans during the period from the day before the person has a fever through the third or fourth day of illness.

The virus then multiplies in the mosquito and invades the mosquito's salivary glands, making the mosquito infectious to humans from 8 to 14 days after taking the infected blood meal. The mosquito then may remain infectious for the rest of its life, able to transmit the disease during any blood feedings it takes on susceptible people.

Yellow fever

Historically, yellow fever is one of the most feared epidemic diseases in the United States because the mortality rate in humans can reach 85 percent. Although the last case originating in the United States occurred in 1911, it is still regarded as so dangerous that U.S. law requires that cases of yellow fever be reported immediately.

The symptoms are high fever, internal bleeding, and jaundice. Illness from yellow fever may be acute and fatal, or so mild that it is unapparent.

In the classical "urban type" of yellow fever, epidemics are the result of transmission from human to mosquito to human. The virus is spread by the yellow fever mosquito, *Aedes aegypti*.

An extremely slight infection risk exists for tourists who visit countries where yellow fever is present. To enter many of those countries, visitors must take a highly effective and well-tolerated vaccine. Occasionally, people who have contracted yellow fever in other countries have returned to the United States infected with the virus.

Malaria

Although malaria had disappeared as a significant problem in the United States by the early 1950s, it is still one of the most serious communicable diseases affecting people worldwide.

Malaria in humans is an acute or chronic disease caused by four species of microscopic parasites belonging to the genus *Plasmodium*. Symptoms vary from a moderately severe to highly fatal, depending on the mosquito species and the person's health when infected.

Malaria causes fever and flu-like symptoms that may include chills, headaches, muscle aches, fatigue, nausea, vomiting, and diarrhea.

The parasites are transmitted by *Anopheles* mosquitoes. Although at least 16 species of *Anopheles* occur in the United States, only two species are known to be significant vectors of malaria: *Anopheles freeborni* and *Anopheles quadrimaculatus*.

In the blood of humans, these parasites invade individual red blood cells, eventually destroying them. The parasites leave these cells and invade new red blood cells as the blood-cycling phase progresses. If not treated properly, a malaria infection may persist in a human for many months or even years. During that time, it can be continuously or periodically able to infect mosquitoes.

People in areas where malaria is common may be infected repeatedly, which can result in them developing a "tolerance" for the parasite. Although this "tolerance" may prevent severe acute consequences, it does not prevent a chronic, often debilitating infection.

Dog heartworm

Dog heartworm is caused by a mosquito-borne filarial worm (a threadlike parasite) called *Dirofilaria immitis*. The adult stages of this worm amass in the heart cavities of dogs and cats, causing heart damage, blockages, and eventually death if the infestation grows too large (Fig. 8).

Heartworm can cause severe circulatory problems in dogs and symptoms such as coughing, labored breathing, and general loss of vitality in advanced stages.

D. immitis is normally transmitted from dog to mosquito to dog. We do not know definitely what the mosquito vectors of dog heartworm are in Texas, but several mosquito species are suspected from the genera *Culex, Aedes,* and *Anopheles*.

Figure 8. Dog heart infected with dog heartworms.
Source: Lone Star Shih Tzu and Lhasa Apso Rescue

Mosquitoes can also transmit *D. immitis* to people, where the parasite usually migrates to the lungs and less often to the heart. It causes a condition known as eosinophilia. Some people also have allergic reactions. Fortunately, human cases of *D. immitis* are rare.

Although dog heartworm is fairly widespread in the United States, it is most prevalent along the Atlantic and Gulf Coasts from Massachusetts to Texas and up the Mississippi River Valley to Minnesota.

Pet owners should make mosquito control a high priority. Because it is very difficult to protect dogs and cats from mosquitoes, the most effective way to control heartworm is to prevent the worms from reaching the adult stage. Veterinarians can prescribe drugs to protect dogs during the mosquito season, which is year-round in Texas.

Contact your doctor if you develop symptoms of any of these diseases. Current information on human diseases is tracked by the Centers for Disease Control. Your veterinarian can recommend management strategies for animal diseases.

For more information

http://medicalento.tamu.edu

Acknowledgments

John A. Jackman, former Extension Entolmologist, and Jim K. Olson, formerly of Texas A&M University, contributed to the original manuscript. Gabriel Hamer of Texas A&M University and Mike Merchant, Wizzie Brown, and Molly Keck of the Texas A&M AgriLife Extension Service reviewed the manuscript of this publication.

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Texas A&M AgriLife Extension Service is implied.

Texas A&M AgriLife Extension Service
AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Texas A&M AgriLife does not discriminate on the basis of race, color, religion, sex, national origin, disability, age, genetic information, veteran status, sexual orientation or gender identity and provides equal access in its programs, activities, education and employment.

The Texas A&M University System, U.S. Department of Agriculture, and the County Commissioners Courts of Texas Cooperating.

Revision