Taking Care of the Gardener: Don't let Ticks and Mosquitoes Vector in on you!

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The American Center for Disease control (CDC) and local authorities are now on alert for the Zika virus, but it is not a major threat in the USA yet and especially not in Pennsylvania. Actually ticks are the biggest threat to the gardener in our area with mosquitoes a distant second. Both are called vectors because they are biting animals that may transmit a disease or parasite from one animal to another. It is important to be aware of what problems they can cause.

Pennsylvania has been referred to as the "Lyme disease capital of the world" the last three years, and West Nile virus is now becoming an emerging threat. We should be able to recognize the symptoms and the vectors causing the problem, especially the ticks. In fact, one of the best treatments against ticks is to make sure we don't have any attached to our bodies when we come in from gardening. Preventing tick and mosquito bites is very important and fairly easy to do if we think of it in advance.

What Diseases do they Spread?

The diseases caused by ticks and mosquitoes are many and include some nasty ones. Because ticks can harbor more than one disease-causing agent, patients can be infected with more than one pathogen at the same time, compounding the difficulty in diagnosis and treatment. If you know you have been bitten by a tick, always tell medical professionals about this when reporting any new symptoms. The symptoms are very non-specific and are often misdiagnosed unless a possible cause is mentioned to the doctor.

1. Lyme disease

Lyme disease is an infection caused by the spirochete bacteria *Borrelia burgdorferi* which is transmitted to humans by blacklegged ticks, or deer ticks. The blacklegged

tick (*Ixodes scapularis*) spreads the disease in the northeastern, mid-Atlantic, and north-central United States, while the western blacklegged tick (*Ixodes pacificus*) spreads the disease on the Pacific Coast. It is a complex illness sometimes characterized initially by a bull's eye shaped rash. If you are infected and get the rash, you are lucky since it is easily treated at this stage. If the rash is not present, you can get many combinations of symptoms including headache, fever, sore throat, nausea, etc. If left untreated, these can turn into late phase symptoms which may progress to debilitating arthritic, cardiac, and neurologic conditions, but rarely directly to death. There are several tests for Lyme disease, but treatment is often started before test results are in if the bull's eye rash is present.

The bull's eye rash appears as a red rash and expands to cover a large round region at least two inches (five cm) in diameter over a period of days or weeks. The center of this lesion often tends to progressively clear, giving the name "bull's eye rash." The bull's eye rash is generally accompanied with intermittent fatigue, fever, headache, a stiff neck, muscle aches, and/or joint pain. The joint pain can be mistaken for other types of arthritis, such as juvenile rheumatoid arthritis (JRA), and neurologic signs of Lyme disease can mimic those caused by other conditions, such as multiple sclerosis (MS) and amyotrophic lateral sclerosis (ALS).

Early diagnosis is important in preventing late-stage complications. When detected early, Lyme disease can be treated with antibiotics. Left untreated, the disease can spread to the joints, heart and nervous system. Classic signs of untreated cases can include migratory pain or arthritis, impaired motor and sensory skills and an enlarged heart.

2. Rocky Mountain spotted fever

Rocky Mountain spotted fever was first recognized in the United States during the 1890s, but until the 1930s it was reported only in the Rocky Mountains. By 1963, over 90 percent of all cases were reported east of the Rockies. In the east, cases occur when people come in contact with infected ticks from their pets or in their yards.

Rocky Mountain spotted fever is caused by very small bacteria, *Rickettsia rickettsii.* There are three tick vectors, the American dog tick (*Dermacentor variabilis*), the Rocky Mountain wood tick (*Dermacentor andersoni*), and the Brown dog tick (*Rhipicephalus sanguine*). The vector in the east is the American dog tick.

Symptoms include a red-purple-black rash, usually on the wrists and ankles, which appears from two days to two weeks after infection. A fever, headaches, and listlessness also are characteristic. Broad-spectrum antibiotics are used to treat Rocky Mountain spotted fever. Diagnosis can be made with a blood test, but treatment should not wait for lab confirmation, as fatalities do occur.

3. Tularemia

Known as rabbit fever, tularemia is carried by ticks of the genera *Amblyomma*, *Dermacentor*, *Haemaphysalis*, and *Ixodes*. Rodents, rabbits, and hares often serve as

reservoir hosts, but waterborne infection accounts for 5 to 10% of all tularemia in the US. Tularemia can also be transmitted by biting flies, particularly the deer fly, *Chrysops discalis*. The causative bacteria is *Francisella tularensis*. In 1989, 144 cases were reported in the US, compared to nearly 2,300 cases in 1939. Between 1990 and 2000, the rate was less than one per 1,000,000, meaning the disease is extremely rare in the US today.

Symptoms include fever, chills, loss of appetite, general body aches, and swollen lymph nodes. An ulcer forms at the site of the bite. Blood tests are used in diagnosis, and treatment consists of antibiotics. If not treated, symptoms intensify. Tularemia causes a few deaths each year.

4. Babesiosis

Babesiosis is a malaria-like parasitic disease caused by infection with *Babesia*, a genus of *Apicomplexa*. Human babesiosis is an uncommon but emerging disease in the Northeastern and Midwestern United States and parts of Europe, and is sporadic throughout the rest of the world. It occurs in warm months. Ticks transmit the human strain of babesiosis, so it often presents with other tick-borne illnesses such as Lyme disease. In cattle, a major host, the disease is known as Texas cattle fever, redwater, or piroplasmosis**.**

Caused by the sporozoan parasite, *Babesia microti*, the disease in the USA is transmitted by the blacklegged tick. Fatigue and loss of appetite are followed by a fever with chills, muscle aches, and headaches. In more extreme cases, blood may appear in the urine. Babesiosis is more severe in older people and those with no spleen, and fatalities can occur in older patients. The condition is treated with drugs that are used to treat malaria, but with limited success. Generally, the disease is self-limiting and symptoms disappear on their own.

5. Anaplasmosis

Anaplasmosis is a disease caused by a rickettsial parasite of ruminants, *Anaplasma phagocytophilum*. Anaplasmosis is transmitted to humans by tick bites primarily from the black-legged tick and the western black-legged tick in the south and west where the tick hosts *Ixodes* spp. are found. Early in the 20th century, this disease was considered one of major economic consequence in the western United States. However, in the 1980s and 1990s, control of ticks through new acaricides and practical treatment with prolonged-action antibiotics, notably tetracycline, has led to the point where the disease is no longer considered a major problem.

Synptoms may be severe anemia and result in cardiovascular changes such as an increase in heart rate. Blood in the urine may occur due to the lysis of red blood cells. General systemic signs such as diarrhea, anorexia and weight loss may also be present.

Fig. 1. West Nile activity by state.
(source: https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata/activitystatedate.html)

6. Tick paralysis

Tick paralysis is not a disease, but a condition caused by toxins that a tick injects into its host during feeding. Most mammals seem to be affected, but smaller and younger mammals, including children, are more susceptible.

Symptoms begin a day or two after initial attachment. The victim loses coordination and sensation in the extremities. The paralysis progresses in severity, the legs and arms becoming useless; the face may lose sensation; and speech becomes slurred. If the breathing center of the brain is affected, the victim may die. If the tick or ticks are found and removed, recovery begins immediately.

This condition is associated with ticks attached around the head area, particularly at the base of the skull. Ticks that have been implicated in tick paralysis are the Rocky Mountain wood tick, the lone star tick (*Amblyomma americanum*), and the American dog tick. Some individual ticks cause tick paralysis. The toxin that causes this condition is part of the salivary fluid that the tick injects. Because the problem is associated with ticks attached on the head, and because recovery is quick upon removal of the tick, it is theorized that the toxin acts locally and is broken down in the body rapidly. The important thing is to be aware that it exists and, when symptoms occur, to attempt to find the tick and remove it.

7. West Nile virus

In Pennsylvania, the risk of contracting a mosquito-borne disease has recently increased with the introduction of West Nile virus (WNV). Fortunately, WNV poses

little risk unless individuals have compromised immune systems.

West Nile virus is a mosquito-borne disease that can cause encephalitis, a brain inflammation. WNV is closely related to the St. Louis encephalitis virus that is found in the United States and was first detected in North America in 1999 in New York, and in Pennsylvania in 2000.

Infected mosquitoes pass the virus onto birds, animals and people. West Nile virus cases in Pennsylvania occur primarily in the mid-summer or early fall, although mosquito season is usually April-October.

People with mild cases of West Nile virus may experience fever, headache, body aches, skin rash and swollen lymph glands for a few days, the department said, but most people who are infected will not have any symptoms.

There are no medications to treat or vaccines to prevent WNV infection. Fortunately, most people infected with WNV will have no symptoms. About one in five people who are infected will develop a fever with other symptoms. Less than 1% of infected people develop a serious, sometimes fatal, neurologic illness known as West Nile encephalitis or meningitis, with symptoms including headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis. In those cases, symptoms may last several weeks, and neurological effects may be permanent.

Which Ticks and Mosquitoes?

Many species of ticks can transmit diseases from an infected host to other uninfected hosts. Some of the more frequently transmitted organisms include parasitic worms, viruses, bacteria, spirochetes and rickettsias. Most important to Pennsylvanians are spirochetes that cause Lyme disease, and rickettsias that cause Rocky Mountain spotted fever.

More than 25 species of ticks have been identified in Pennsylvania but only four species account for 90% of all submissions to Penn State University for identification. They are: 1) the American dog tick, 2) the blacklegged tick, 3) the lone star tick, and 4) the groundhog tick, *Ixodes cookei.*

1. American dog tick, *Dermacentor variabilis.*

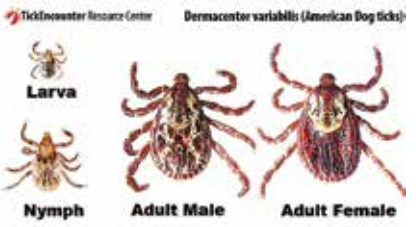


Fig. 2. American dog tick occurrence in the USA in yellow.
(source: http://www.cdc.gov/ticks/geographic_distribution.html)

American dog ticks are widely distributed east of the Rocky Mountains but also occur in limited areas on the Pacific Coast. American dog ticks are found mostly in areas with little tree cover, such as grassy fields and scrubland, as well as along walkways and trails. They feed on hosts, ranging in size from mice to deer. Nymphs and adults can transmit diseases such as Rocky Mountain spotted fever and Tularemia. American dog ticks can survive for up to two years at any given stage. Females can be identified by their large off-white scutum against a dark brown body.

Maps: The tick distribution maps here and following are not meant to represent risks for a specific tick-borne disease, because disease transmission is influenced by multiple factors beyond mere tick presence. These maps have been designed to answer the question "What ticks should I be concerned about at a regional scale?" (source: http://www.cdc.gov/ticks/geographic_distribution.html)

Adult males and females are active from April to early August, and are mostly found in tall grass and low lying brush and twigs. They feed on wildlife hosts, including raccoons, skunks, opossums and coyotes, as well as domestic dogs, cats and man. Adult American dog ticks commonly attack humans. Male ticks blood feed briefly but do not become distended with blood. Once finished feeding, males mate with a female while she feeds, which can take over week. Once engorged, female dog ticks detach from their host and drop into the leaf litter, where they can lay over 4000 eggs.

Larvae are active from late April to September, and can be found on voles, mice, raccoons, opossums, etc. in the leaf litter. In Pennsylvania, larvae overwinter and are

most abundant in the spring and early summer. After blood feeding for three to four days, larvae detach from their host and fall into the grass/meadow thatch and leaf litter where they molt into nymphs.

Nymphs are active from May to July and feed on animals, such as mice, voles, rabbits, raccoons and skunks. Nymphal dog ticks rarely attach to humans. Once engorged, nymphs detach from their host, falling into the grass/meadow thatch and leaf litter where they molt into adults.

2. Blacklegged tick *(Ixodes scapularis)* and **the Western blacklegged tick (*Ixodes pacificus*).**

Blacklegged ticks (deer ticks) take two years to complete their life cycle and are found in the east predominately in deciduous forests. Their distribution relies greatly on the distribution of its reproductive hosts, white-tailed deer in the east and black-tailed deer in the west. Both nymph and adult stages transmit diseases such as Lyme disease, babesiosis, and anaplasmosis.

Adult males and females are active from October-May, as long as daytime temperature remain above freezing. Preferring larger hosts, such as deer, adult blacklegged ticks can be found questing about knee-high on the tips of branches of low growing shrubs. Adult females readily attack humans and pets. Once females fully engorge on their blood meal, they drop off the host into the leaf litter, where they can over-winter. Engorged females lay a single egg mass of up to 1500-2000 eggs in mid to late May.

Larvae emerge from eggs later in the summer. Unfed female blacklegged ticks are easily distinguished from other ticks by the orange-red body surrounding the black scutum. Males do not feed. The six-legged larvae are active from July-September and can be found in moist leaf litter. Larvae hatch nearly pathogen-free from eggs, and remain in the leaf litter where they will attach to nearly any sized mammal and many species of birds. Preferred hosts are white-footed mice. Larvae remain attached to their host until replete, which usually requires three days. Once fully engorged, the larvae drop off of the host and molt, re-emerging the following spring as nymphs.

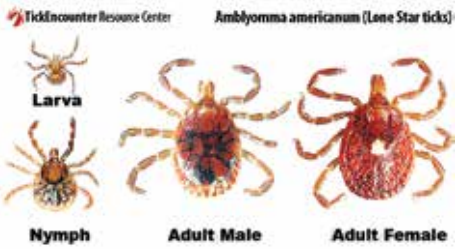
Nymphs are active from May-August, and are most commonly found in moist leaf litter in wooded areas, or at the edge of wooded areas. The eight-legged, pin-head sized nymph typically attaches to smaller mammals such as mice, voles, and chipmunks,

Fig. 3. Blacklegged tick occurrence in the USA in yellow.
(source: http://www.cdc.gov/ticks/geographic_distribution.html)

Fig. 4. Western blacklegged tick occurrence in the USA in yellow.
(source: http://www.cdc.gov/ticks/geographic_distribution.html)

requiring three to four days to fully engorge. Nymphs also readily attach to and blood feed on humans, cats and dogs. Once fed, they drop off into rodent burrows or leaf litter in animal bedding areas where they molt and emerge as adults in the fall.

3. Lone star tick (*Amblyomma americanum*)



Lone star ticks are found mostly in woodlands with dense undergrowth and around animal resting areas. The larvae do not carry disease, but the nymphal and adult stages can transmit the pathogens causing Monocytic Ehrlichiosis, Rocky Mountain spotted fever and 'Stari' borreliosis. Lone star ticks are notorious pests, and are human biters.

Adults are active from April-August and can be found questing for larger animals, such as dogs, coyotes, deer, cattle and humans on tall grass in shade or at the tips of low lying branches and twigs. Females are easily recognized by a single white dot in

Fig. 5. Lone star tick occurrence in the USA in yellow.
(source: http://www.cdc.gov/ticks/geographic_distribution.html)

the center of a brown body, with the males having spots or streaks of white around the outer edge of the body. Females require a week to ten days or more to engorge and can lay 2500-3000 eggs.

Nymphs are active from May-August, and can be found questing for deer, coyotes, raccoons, squirrels, turkeys and some birds as well as cats, dogs and humans. Where abundant, nymphs seemingly swarm up pant legs and can become attached in less than ten minutes. Nymphs typically take five to six days to become replete, and once fully engorged, they fall off of the host into the leaf litter, where they molt into adults.

Larvae are active from July-September and quest for a wide variety of animals, including cats, dogs, deer, coyotes, raccoons, squirrels, turkeys, and some small birds. After feeding for around four days, they drop off of the host and bury themselves in the leaf litter, where they molt into nymphs.

4. Groundhog tick (*Ixodes cookei*)

The groundhog tick, *Ixodes cookei*, can be found east of the Rocky Mountains into New England and southeast Canada. The tick mostly feeds on rodents and medium-sized mammals, especially groundhogs and skunks. It will feed on a variety of animals including humans. Although *Ixodes cookei* is common in areas with groundhogs, it is not considered to be an important vector of Lyme disease and is not a known vector for any other zoonoses

An adult groundhog tick is about the size of a sesame seed and has a tan body with a reddish-tan plate on its back behind its head. Nymphs and larvae are a lighter tan color and are much smaller than adults. Groundhog ticks feed on small mammals such as skunks, raccoons and groundhogs.

Groundhog tick larvae, nymphs, and adults will readily bite humans and dogs. Groundhog ticks become active in the spring and remain a nuisance through mid-August, with peak activity occurring during late June.

Groundhog ticks may be found in brushy areas and along trails bordered by tall grass or weeds. They are also common in unused human dwellings since these environments are nesting places for small mammals

5. Northern house mosquito (*Culex pipiens*)

Pennsylvania has 60 species of mosquitoes. The mosquito most often discovered in urban areas of Pennsylvania is the northern house mosquito, *Culex pipiens*. This is also the mosquito that is thought to transmit the most human cases of West Nile virus in Pennsylvania and consequently poses the greatest annoyance and risk to our citizens.

Some mosquito species can complete their life cycles in as little as seven days but the northern house mosquito requires a minimum of 10-14 days—more often closer to a month.

Adult female mosquitoes require a blood meal in order to produce viable eggs. While feeding, the females inject saliva-containing anticoagulants that prevent the blood from clotting. Because mosquitoes take numerous blood meals, they can acquire disease organisms from an infected host and later transmit those organisms to previously uninfected hosts.

Considered to be a medium-sized mosquito, the adult *Culex pipiens* may reach up 0.25 in (six mm). The House mosquito species' body is usually brownish or grayish brown. The proboscis and wings are usually brown.

Larvae are known as wigglers since they seem to move in that manner. They feed on fungi, bacteria and other tiny organisms through straw-like filters. These larvae will undergo growth throughout this stage.

Pupae are known as tumblers because of the way they seem to "tumble" through the water. Their rounded, comma-like shape makes this mode of movement easy. These pupae do not eat during the one to two days in which they will become an adult mosquito.

Control of this mosquito is achieved through meticulous removal of water holding containers. Birdbaths and pet bowls should be scrubbed and the water changed at least every few days. For the gardener, check stacks of pots and saucers that are exposed to rain and make sure they are dry. Gutters and downspouts should also be free of leafy debris that might retain rainwater. Still-water ponds, water features, and wet ditches can be treated with the biological control bacteria, *Bacillus thuringiensis israelenis*, sold as Mosquito Dunks or Mosquito Bits or Aquabac (in Canada).

Protect Yourself!

The best advice for preventing Lyme disease, West Nile virus, and other tick and mosquito-borne diseases is to:

1. Wear treated light-colored SPF clothing while outdoors, including a broad-brimmed hat, a long-sleeved shirt, and long pants tucked into the socks.

Permethrin-treated clothing will kill ticks that are crawling. Spray-on applications can last five or six washings. Pretreated clothing may remain effective up to 70 washings.

It is for use on clothing only. It does not harm or irritate skin, but it offers no benefits if applied to skin. It is considered totally safe to people, the environment, and to clothing.

2. If in a place where ticks may occur, check your body daily for the presence of ticks. Self-examination is recommended after spending time in infested areas. If an embedded tick is found, it should be removed with fine tweezers by grasping the head and pulling with steady firm pressure. The tick should not be grabbed in the middle of its body because the gut contents may be expelled into an individual's skin. The use of heat (lit match, cigarette, etc.), or petroleum jelly is NOT recommended to force the tick out. These methods will irritate the tick, and may cause it to regurgitate its stomach contents into the individual, thereby increasing the possibility of infection.

3. Use tick and mosquito repellents. DEET, Picaridin and Oil of Lemon Eucalyptus have proven to repel both ticks and mosquitoes for up to eight hours. These are the most effective formulations.

30 to 40% DEET such as Sawyer Ultra 30 and 3M Ultrathon offer up to twelve hours protection. Weaker formulations protect for shorter periods of time. **WARNING:** DEET can damage plastics but will not damage cotton, wool or nylon. For children, do not use concentrations stronger than 30%. Do not apply to open cuts.

Picaridin was developed as an alternative to DEET. With a concentration of 20%, Sawyer Picaridin offers up to eight hours protection. Care should be taken when using near plastics.

Oil of Lemon Eucalyptus such as Repel 30% Lemon Eucalyptus provides up to seven hours of protection. It is totally safe around all materials and people. It is an ingredient in Vicks VapoRub.

Natural plant oils such as citronella, cedar, geranium, etc. offer limited protection.

The first line of defense against ticks and mosquitoes is to take precautions in the outdoors by using insect repellents, wearing long sleeve shirts and long pants treated with permethrin, checking for, and promptly and properly removing any ticks if found, and showering shortly after exposure.

What to do if You get Bit!

Tick Bites. Usually, removing the tick, washing the site of the bite, and watching for signs of illness are all that is needed. When you have a tick bite, it is important to determine whether you need a tetanus shot to prevent tetanus (lockjaw).

Many of the diseases ticks carry cause flu-like symptoms, such as fever, headache, nausea, vomiting, and muscle aches. Symptoms may begin from one day to three weeks after the tick bite. Sometimes a rash or sore appears along with the flu-like symptoms. Tick paralysis is a rare problem that may occur after a tick bite.

Though rare, tick bites can trigger a severe anaphylaxis reaction. If epinephrine is available, do not hesitate to use it. Using an epinephrine auto-injector as a precaution

will not harm you and could save your life. Call 911 after using the EpiPen.

Call your doctor or seek immediate medical care if: you have signs of infection, such as:

- Pain, swelling, warmth, or redness around a bite.
- Red streaks leading from the bite.
- Pus draining from the bite.
- A fever.

Watch closely for changes in your health, and be sure to contact your doctor if:

- You develop a new rash.
- You have joint pain.
- You are very tired.
- You have flu-like symptoms.
- You have symptoms for more than 1 week.

Mosquito Bites. Mosquito bites can be an itchy nuisance. They'll go away on their own. For relief in the meantime, apply a hydrocortisone cream or calamine lotion to the bite. A cold pack or baggie filled with crushed ice may help, too.

In the United States, mosquitoes can spread West Nile virus. For about 80% of people who are infected, this virus causes no symptoms. But in some people, West Nile virus can cause severe illness and even death. Those more at risk for getting sick from West Nile virus are people over 50 and older. In mild cases, symptoms may include:

- Fever
- Body aches
- Headache
- Vomiting
- Swollen glands

Serious symptoms require a doctor's care. They include:

- High fever
- Muscle weakness
- Vision loss
- Neck stiffness
- Disorientation or stupor
- Tremors, convulsions, numbness, paralysis

Symptoms usually occur three days to two weeks after a bite from an infected mosquito. If you notice any severe symptoms, see your doctor right away. You can usually treat less severe symptoms, such as a mild fever or headache, at home.

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