By Max Sherman

Similar to mosquitoes, ticks are capable of carrying, supporting and injecting more kinds of disease-causing microbes than almost any other creature, and knowing about them is essential to prevention. Residents in the Midwest, California and northeastern parts of the US in particular are generally aware that ticks carry the bacteria that cause Lyme disease. However, all of us should know that ticks are responsible for other fatal diseases as well. The worst is Powassan disease, which generally kills about 10% of its victims and leaves half of the survivors with permanent neurological damage.1 Ticks carry other pathogens that cause such human diseases as anaplasmosis, babesiosis, Ehrlichiosis, *Rickettsia parkeri*, Rocky Mountain spotted fever, Southern tick-associated rash disease, tick-borne relapsing fever, tularemia and Rickettsiosis.2 This article will describe the life stages of ticks, methods of spreading disease, Lyme and other diseases and prevention.

**Description of Ticks and Their Lifecycle**

Ticks (*Ixodes scapularis*, *I. pacificus* and others) are not insects but instead are close relatives of mites and spiders. In fact, they may have evolved from mites more than 94 million years ago.3 Like many of their arthropod relatives, ticks grow through four distinct stages: egg, six-legged larva, eight-legged nymph and adult. The lifecycle for ticks generally lasts two years.4 Adult ticks are approximately the size of a poppy seed. They have eight legs and flat bodies. Like crabs and lobsters, ticks have a hard exterior covering that must be shed periodically if they are to grow.

The biggest problem for ticks is finding an appropriate host for their next blood meal. (Ticks must have a blood meal after the eggs hatch to survive and grow.) Ticks cannot fly; they crawl slowly and generally cannot travel without help. A tick may crawl onto a blade of grass or a twig and wait for the right host to come along. Using its lower legs for leverage, it holds its upper pair of legs outstretched, waiting to climb aboard. Ticks do not see...
well but have extremely sensitive and rapid responses to whiffs of carbon dioxide or faint odors of butyric acid exuded from the skin of many animals.\(^5\) They can feed from mammals, birds, reptiles and amphibians.

**Dissemination of Bacteria**

Depending on the species and life stage, a tick’s preparation to feed can take from 10 minutes to two hours. When the tick finds a feeding spot, it grasps the skin and cuts into the surface with the hypostome inside its mouth. The tick then inserts its feeding tube, which may have barbs to help keep the tick in place. Many species also secrete a cement-like substance that keeps them firmly attached during the meal. Further, a tick can secrete small amounts of saliva with anesthetic properties to prevent the animal or person from feeling that the tick has attached itself. Tick saliva also contains anticoagulants, anti-dykinins and serotonin- and histamine-blocking proteins that help evade host defenses.\(^6\)

Some ticks attach to the host and suck blood slowly for several days. If the host has certain blood-borne infections, such as the *Borrelia burgdorferi* spirochete, the agent that causes Lyme disease, the tick may ingest the pathogen and become infected. Adult *I. Scapularis* preferentially feed on white-tailed deer, which carry Lyme disease. If the tick later feeds on a human, that human can become infected. Once infected, a tick can transmit the infection throughout its life.\(^7\) Transmission of *B. burgdorferi* generally requires at least 36 hours of tick attachment. More information about this organism written in an entertaining and fascinating manner can be found in Arno Karlen’s book, *Biography of a Germ*.\(^8\)

**Lyme Disease and Its History**

Lyme disease is the most widespread tick-borne disease in the US but is not confined to North America. Infection of both people and animals occurs worldwide. Researchers have even located infected ticks on gulls and albatrosses in the Arctic Ocean and Antarctica.\(^9\) Some 30,000 cases of Lyme disease are reported to the US Centers for Disease Control and Prevention (CDC) each year, but most cases go unreported because the symptoms are mild or mimic other diseases. The CDC recently estimated there may be 300,000 cases a year in the US, making Lyme disease a tremendous public health problem.\(^10\)

Three other diseases—anaplasmosis, babesiosis and illnesses caused by *Borrelia miyamotoi*, a newly described human pathogen—are transmitted by the same ticks that carry Lyme disease. They cause severe disability and sometimes death.\(^11\) In rare cases, a single tick could make a person sick with several diseases at the same time, greatly complicating diagnosis.\(^12\)

The multiple symptoms of Lyme disease are caused by the *B. burgdorferi* spirochete, a type of bacteria characterized by a thin, spiral structure. The pathogen is named after Willy Burgdorfer, MD, PhD, who discovered the spirochete in 1982 while working for the National Institutes of Health in Montana. By 1996, more than 100 diverse bacterial strains had been identified in the US alone. Worldwide, 300 strains of the spirochete have been found, three times the number recognized when the Lyme Disease Foundation was established in 1988.\(^13\) In Europe and Asia, *B. afzelii* and *B. garminii* also cause disease in humans. The tick vectors are *I. ricinus* in Europe and *I. persulcatus* in Asia.\(^14\)

Many scientists contributed to today’s understanding of Lyme disease, but a team from the Yale School of Medicine is widely credited with the discovery. Stephen Malawista, MD, and Allen Steere, then a postdoctoral student, defined the ailment.\(^15\) The story began in 1975, when two mothers—one from Lyme, Connecticut, and the other from adjacent Old Lyme, were distressed by the odd rashes, neurological symptoms and swollen joints their families and others were experiencing. Unable to find answers, each approached Yale independently.\(^16\) The initial diagnosis was juvenile rheumatoid arthritis, but the disease had never been known to appear in population clusters. Doctors at Yale counted 51 cases, about 100 times the rate normally expected to occur in the towns’ combined population of 12,000. The cases also occurred almost exclusively in warm weather months. Because the disease was clustering, it appeared there had to be a vector, an agent such as an insect that transmitted the disease. Malawista and his associates made the compelling link between ticks and Lyme disease by noting that cases were 30 times more prevalent on the east side of the Connecticut River, where Lyme is situated, than on the west side. Ticks feed and breed on deer, and there are far more deer on the east side.\(^17\)
**Prevention**

Lymerix, a vaccine for Lyme disease, was approved in 1998, but withdrawn from the market in February 2002 because of low sales. The manufacturer put the vaccine on the market before it had been tested on children, so it could be prescribed only to adults. The biggest blow to marketing came from a group of volunteers who had been involved in the prelicensure studies who reported developing arthritic symptoms after being vaccinated. Although the rate of arthritis in the vaccinated persons was the same as the rate in the control group, some Lyme disease activists concluded that the vaccine caused, rather than prevented, Lyme disease. In 1999, a class action suit was filed against the manufacturer. After that sales dropped, and in 2002, the manufacturer withdrew the vaccine from the market. An effort to bring back the vaccine is now being made by Stanley Plotkin, MD, professor of pediatrics at the University of Pennsylvania, who is urging patients and physicians to press federal health officials to revisit the need for a vaccine.

Several points in the transmission cycle provide opportunities to prevent Lyme disease. However, no prevention strategy can be effective unless people at risk accept and use it. People can be cautioned to avoid tick-infested areas. There is good evidence that removal of ticks within 36 hours after attachment will reduce the risk of infection. Daily tick checks are thus advised. People can also wear protective clothing, tuck their pants into their socks and use repellents. For tick control, the most consistently effective method is to spray or otherwise broadcast acaricides onto vegetation where the ticks live. Acaricides are pesticides that kill ticks and mites. Acaricides are toxic and should be applied as sparingly as possible.

For prophylactic treatment, a single, 200 mg dose of the antibiotic doxycycline administered within 72 hours after a recognized *I. scapularis* bite had an efficacy rate of 87% in preventing certain symptoms.

**Final Thoughts**

The tick that carries Lyme disease is spreading to new areas. Although early antibiotic treatment can kill the bacteria, the diagnosis is frequently missed at the beginning of the disease. This article does not include the myriad symptoms and current treatment methods, but this information is readily available on the CDC website (www.cdc.gov/lyme). Fortunately, some progress toward a vaccine is being reported in the scientific literature.

**References**

6. Op cit. 3.
7. Ibid.
17. Ibid.

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