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Tick Biology for the Homeowner

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Figure 1. A female American dog tick. (Copyright M. Plonsky, www.mplonsky.com/photo)

Figure 2. A male American dog tick. *Note the light colored vertical markings on most of the dorsal surface.* (Tom Murray, www.pbase.com/tmurray74)

Introduction: Ticks are arthropods that are sometimes mistakenly called insects. Insects have three body regions, six legs, and typically possess wings. Ticks lack wings, have two body regions, and depending upon their developmental stage, may have either six (larva) or eight (adults and nymphs) legs. Ticks possess tremendous potential for transmitting organisms that may cause disease in humans and other animals. These disease-causing organisms include protozoa, viruses, and bacteria. Bites from certain ticks can cause a rare limp paralysis starting in the lower limbs and moving upwards with death resulting if the tick is not promptly removed. Additionally, tick bites can cause skin irritations or even allergic reactions in sensitive people who are repeatedly bitten.

Taxonomy and Description: Ticks belong to the class Arachnida, which also includes spiders, scorpions, pseudoscorpions, and opiliones or *daddy-long legs*. Ticks comprise two main groups: hard ticks (family Ixodidae) and soft ticks (family Argasidae). This leaflet will cover hard ticks, which are of public health importance in the northeastern United States (including Long Island.)

Tick mouthparts are located on the capitulum (or head) and can be easily seen from a dorsal view. Specialized structures called stylets (chelicerae and hypostome) are used to penetrate and remain firmly anchored in the host skin during feeding. The idiosoma is the tick body region that greatly expands with blood during feeding. Attached to the idiosoma are the legs. Hard ticks have a thickened plate on the idiosoma that is called the scutum. The male tick's scutum covers the entire dorsal surface restricting expansion when blood feeding. As a consequence, males ingest smaller meals.

Biology and Behavior: Ticks undergo four developmental stages: egg, larva, nymph, and adult. Nymphs and adults have four pairs of legs, while larvae have three pairs. All developmental stages of ticks are obligate blood feeders. They must obtain a blood meal to molt to the next life stage and for female ticks to develop eggs. Males remain on their host and mate with several females; they too will eventually drop from their host.

Most hard ticks exhibit a three-host life cycle.[21,23] This means the tick will feed on three separate hosts. Ticks typically feed only once during each developmental stage. Duration of time larvae, nymphs, and adults spend feeding varies among species and developmental stages but typically takes several days.[21,23] After feeding, the larvae and nymphs drop from their host into the leaf litter to molt and then seek a new host. During favorable conditions the molting process can be completed in one to three weeks. Upon obtaining a blood meal adult females detach and drop into the leaf litter to lay a

Figure 3. A female lone star tick. *Note the characteristic white mark on the scutum.* (James Gathany, CDC Public Health Imagery Library)

Figure 4. A male lone star tick. *Note the reticulated pattern on the outer margins of the dorsal surface. Compare this to a male American dog tick.* (Dr. Michael Dryden, College of Veterinary Medicine, Kansas State University)

Figure 5. A female deer tick. (Copyright M. Plonsky, www.mplonsky.com/photo)

single batch of eggs. Adverse environmental conditions or a decline in day length may cause ticks to enter diapause where they may delay host seeking, development, or oviposition. Depending upon the species of tick, the number of eggs laid may range from a few hundred to several thousand. In most cases, the larger the volume of blood taken, the more eggs the female will be able to produce.[21] The egg-laying process may take from several days to two or three weeks to complete. The female dies shortly after laying her eggs. The developmental period for each tick stage varies, and the entire life cycle may take up to two years or more to complete.

Ticks spend periods of arrested development (quiescence) in the leaf litter, burrows, or in nests of their hosts.[21,22] These types of microhabitats provide adequate moisture and protection against adverse environmental conditions. This helps to ensure that a certain segment of the tick population is able to withstand a colder than normal winter or survive during dry spells.

Overall, ticks exhibit a wide range of host preferences from specialist feeding on one type of animal to generalists. Cues for host seeking include changes in temperature and day-length, and detection of carbon dioxide, ammonia, and host body heat.[22] Host finding strategies vary depending upon tick species and developmental stage. Ticks either crawl toward the potential host or stretch out the front legs waiting to attach to a passing host (questing behavior).[22] The front legs have specialized organs on them to detect carbon dioxide gradients from approaching hosts. Field studies have shown that some ticks will travel 23 yards (21m) toward a potential host while others do not move any appreciable distances.[22] Ticks do not jump or fly and must literally come in contact with a host. Favorite vegetation sites for adult ticks that quest include tall grass and shrubs. Immature ticks are more likely to remain near the leaf litter or lower in the vegetation where they are more likely to encounter small rodents and ground-visiting birds.

Tick Species in New York State: New York State has several species of ticks.[12] Those of greatest public health importance are the American dog tick, the lone star tick, the blacklegged (deer) tick, the brown dog tick, and the groundhog tick. This leaflet will cover the first 3 ticks, which are currently those commonly found on Long Island. Information on other tick species can be obtained from the Medical Entomology Extension at Cornell University web site http://www.entomology.cornell.edu/MedEnt/index.html

American Dog Tick (*Dermacentor variabilis*). American dog tick females are about 1/4 inch (6.35mm) long and are chestnut brown with a silvery-gray or creamy-white scutum (**Figure 1.**) Male ticks are slightly smaller, and are chestnut brown with similar

light-colored vertical markings on the dorsal surface (**Figure 2.**) Larvae feed on small mammals, and nymphs feed on small-to medium-sized mammals. Adults, sometimes called wood ticks, occasionally attack humans but are more common on dogs and other medium-sized animals.[12]

Dermacentor variabilis is a known vector of *Rickettsia rickettsii*, a bacterium that causes Rocky Mountain spotted fever in humans.

Figure 6. A partially engorged female deer tick. *Note the change in body color as the tick becomes engorged.* (Copyright M. Plonsky, www.mplonsky.com/photo)

Figure 7. A male deer tick. *Note the dark scutum covering most of its body.* (Tom Murray, www.pbase.com/tmurray74)

Most Rocky Mountain spotted fever cases are reported from the south Atlantic and south central states, but cases do occur each year in New York state, especially on Long Island. The average incubation period after an infected tick bite is seven days and results in fever, severe headache, and joint and body aches.[9,23] Within a few days a spotted rash appears on the wrists and ankles and spreads to the palms, soles, and eventually to the rest of the body. Rocky Mountain spotted fever is treatable with antibiotics but can be fatal if not treated promptly.[9,23] *Rickettsia rickettsii* can be transmitted to eggs. Consequently unfed larvae are capable of transmission, in addition to nymphs and adults.

The American dog tick plays a secondary role in the disease cycle of human monocytic ehrlichiosis. Please refer to the lone star tick section for details.

Lone Star Tick (*Amblyomma americanum*). All stages of *Amblyomma americanum* will aggressively attack people and other medium-to-large mammals.[12] Females are 1/4 inch (6.35mm) long and reddish brown in coloration. A distinctive white spot or "star" on the scutum is characteristic of females (**Figure 3.**) A reticulated pattern is apparent on the outer margins on the upper body surface of males (**Figure 4.**) Lone star ticks have long mouthparts but with care the stylets can be completely removed from the host skin. Even with successful removal of mouthparts the cementing substance is left in the bite wound. This cement material can causing itching, skin irritation, and localized swelling immediately around the bite. Please refer to the guidelines for safe tick removal in this fact sheet.

Several cases of human monocytic ehrlichiosis are reported annually in New York State with most cases reported from Long Island and the lower Hudson River Valley. The causative agent is *Ehrlichia chaffeensis*, a type of bacterium.[7] After an incubation period of 5 to 10 days nonspecific symptoms appear, including a high fever, severe headache, chills, aching muscles and joints, and fatigue.[8,9] Patients may exhibit a rash, but it is not a common clinical feature of the disease. Usually infection with *Ehrlichia chaffeensis* is mild, but severe manifestations of the disease may result in death. Human monocytic ehrlichiosis is treatable with antibiotics.[8,9,24]

Blacklegged Tick or Deer Tick (*Ixodes scapularis*). The blacklegged tick is the officially accepted common name for *Ixodes scapularis*, but many people refer to them as "deer ticks". Adult females are dark brown in appearance and are less than 1/8 inch (3.12mm) long (**Figure 5 & 6.**) Larvae and nymphs feed on small mammals and birds. The white-footed mouse is an important host for the immature ticks, while adults are more common on deer. All stages will bite humans, but due to their small size, attachment by larvae and nymphs often goes unnoticed.

The blacklegged tick is a vector of two bacterial diseases and one protozoan disease in New York state. Lyme disease is caused by infection with the bacterial spirochete *Borrelia burgdorferi*. Nymphs are considered to be the most important stage for transmission because they are easily overlooked due to their small size. Signs and symptoms of Lyme disease usually appear within 1 to 2 weeks (range 3-30 days) following an infected bite. In addition to flu-like symptoms roughly sixty to eighty percent of infected people develop a spreading rash (erythema migrans).[8,9] The rash slowly spread and has a distinctive bulls-eye appearance. The risk of contracting an infection from a tick is virtually nil during the first 24 hours of attachment, so promptly removing ticks can reduce your chances of contracting Lyme disease.[15,16,25] Untreated cases may resolve or progress to chronic joint, neurological, or cardiac problems. Lyme disease is treatable with antibiotics.[8,9,24] Serological tests are used to support the clinical diagnosis of Lyme disease. These tests are designed to detect antibodies against *Borrelia burgdorferi*. The reason that serological tests are not performed until several weeks after the appearance

of symptoms is because it takes time for the immune system to develop detectable antibodies. Most cases of Lyme disease are reported from Long Island and the lower Hudson River Valley.

Human granulocytic ehrlichiosis is caused by infection with the bacteria *Ehrlichia phagocytophilia*. The incubation period and symptoms are similar to human monocytic ehrlichiosis, except a rash rarely occurs.[8,9] Unlike Lyme disease, prompt removal of ticks does not seem to decrease one's chances of contracting an infection.[25] Dual infections of *Borrelia burgdorferi* and *Ehrlichia phagocytophila* have been documented in single populations of ticks and in individual ticks. Infections are treatable with antibiotics.[8,9]

Human babesiosis, caused by the protozoan *Babesia microti*, is rare but does occur in New York state, primarily on Long Island. Babesiosis causes a malaria-like illness after a 1 to 4 week incubation period. Symptoms include fever, chills, profuse sweating, headache, and muscle aches.[9] The disease can range from relatively mild to, in rare cases, death. Ticks must acquire the protozoan through feeding on an infected host. Treatment includes antimicrobial therapy.[9,24]

Other species of *Ixodes* occur in New York State and occasionally attack humans. Due to their small size and lack of distinguishing markings it is best to have *Ixodes* species identified by a trained professional. Additional information on *Ixodes scapularis* can be found in the fact sheet *"Integrated Pest Management for the DeerTtick"* by Carolyn Klass, which is available from Cornell Cooperative Extension – Suffolk County.

Guidelines on Safe Tick Removal. It is important to periodically check yourself, your children, and pets for ticks. Promptly removing a tick could reduce the likelihood of contracting certain types of tick-borne diseases such as Lyme disease.[15,16,25] It takes time for ticks to insert their mouthparts and secrete a glue-like substance called attachment cement. The cement will harden and helps to further anchor the tick firmly in place.

Using thin tweezers, grasp the tick as close to the skin as possible and pull gently and slowly away from the skin. Do not twist, jerk, or pull hard on the tick or you risk leaving the mouthparts in the skin. Detailed information on tick removal can be found on the Medical Entomology Extension at Cornell University web site http://www.entomology.cornell.edu/MedEnt/index.html

After tick removal, disinfect the bite wound. If you find yourself scratching the bite consider covering it with a bandage to prevent a secondary bacterial infection. It is a good idea to save the tick in case it is necessary for later identification. Place the tick in a vial. Label the container with a date and note the attachment site of the tick. If you experience a rash, headaches, fever and flu-like symptoms after a recent tick bite consult your physician.

Personal Protective Measures. Currently there are no protective vaccines for humans for the tick-borne diseases discussed above; consequently avoiding tick bites is the best disease-prevention strategy. You can take several to reduce your chances of being bitten by a tick.

- Avoid known or suspected areas of tick infestation, especially during tick season.
- Walk on cleared trails and avoid brushing up against vegetation and tall grass.
- Wear proper clothing while in tick habitat. Clothing should be light in color to allow you to spot crawling ticks more easily. Wear closed-toed shoes, socks, long pants, and a long-sleeved shirt. Tuck pant legs into the socks and the shirt into the pants in order to slow crawling ticks.
- Apply a tick repellent to exposed skin, around the tops of socks and waistband according to **product label directions**. Be sure that you understand the directions on the label. Some products can only be applied to clothing while others are applied to the skin. The label also contains important information on special precautions for children, hazards, and first aid. Carefully read and follow the label directions before each and every use.

  Products containing synthetic chemicals work best against ticks. Two such products have as active ingredients DEET (*N*,*N*-diethyl-*m*-toluamide) or permethrin. The decision of using or not using a repellent would depend upon whether you want to reduce your risk of being bitten, the species of ticks present in the habitat, the potential for tick transmitted diseases, and whether you will be in an area subjected to heavy tick pressure.

  DEET can be applied directly to the skin or clothing. However, DEET can damage some types of fabrics, watch faces, painted and varnished surfaces. DEET cannot be applied to skin that is covered with clothing. The United

States Environmental Protection Agency (EPA) has completed an extensive reevaluation of DEET and has *"concluded that as long as consumers follow label directions and take proper precautions, insect repellents containing DEET do not present a health concern."*

The range of protection provided by DEET varies among tick species, developmental stages.[1,2,10,14,18,19,20] In a field study, an aerosol application of 20% and 30% DEET applied only to clothing provided 86% and 92% protection, respectively, against the blacklegged tick.[20] The degree of protection of DEET formulated as a lotion was more variable. A 33.25% DEET extended lotion formulation afforded an average protection of 19% and 88% against nymphs and larvae of the blacklegged tick.[10] Separate research has concluded that treatment of skin with DEET is not effective in repelling the blacklegged tick.[1,18] As a result, ticks will continue to crawl until unexposed skin is encountered. A 20% concentration of DEET applied as an aerosol to clothing provided 85% protection, and a 33.25% extended-duration formulation (lotion) provided an average of 60% protection against lone star ticks.[10,14] The same extended-duration formulation of DEET showed a 50% protection against the American dog tick, and aerosol application of 20% DEET gave 94% protection.[10,14]

Permethrin cannot be applied directly to the skin. It should be applied to clothing and allowed to dry before the clothes are worn. Permethrin (0.5% concentration) provides a high level of protection and effectively kills all tick species and developmental stages that have been tested.[10,14,19,20] In one field study, most ticks removed from permethrin treated clothing were dead or had impaired mobility while 99% of ticks removed from DEET (33.25% lotion) treated and untreated clothing did not show any ill effects.[10] Tick species tested in these studies include the blacklegged tick, the lone star tick, and the American dog tick.

Botanical Repellents - There are non-DEET and non-permethrin repellents labeled for use against ticks but they do not provide the same degree of protection.[1,2] Active ingredients of these products include: oil of citronella, oil of eucalyptus (p-menthane-3, diol), and IR3535 (found in products sold by certain catalog cosmetic distributors).

- Conduct frequent tick checks while you are outside and examine yourself thoroughly once you come indoors. It takes time for a crawling tick to find a suitable feeding site. Thus, the more frequently you examine yourself for ticks the greater is likelihood that you will find them before they attach. Check your children thoroughly. Favorite sites for ticks to attach include but are not limited to the hairline, shoulders, armpits, waist, inner thighs, and groin area.
- Check your pets after they come indoors. Your pets are more likely to come in contact with ticks and bring them indoors.
- A recent study suggested that ticks could survive the cold/cold and hot/cold wash cycles of automatic washers. However, a one-hour high heat cycle in the dryer was sufficient to kill all developmental stages tested.[6]
- See *"Integrated Pest Management for the DeerTtick"* by Carolyn Klass for additional information on personal protection and *Ixodes scapularis*.

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The information for this leaflet and the pesticide recommendations have been obtained from *Tick Biology for the Homeowner*. Renee R. Anderson and Laura C. Harrington, Medical Entomology Extension at Cornell University, http://www.entomology.cornell.edu/MedEnt/index.html Please visit that web site for additional information.

This publication contains pesticide recommendations. Changes in pesticide regulations occur constantly and human errors are still possible. Some materials mentioned may no longer be available, and some uses may no longer be legal.

Read the label before applying any pesticide.

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