

Tick Biology for the Homeowner

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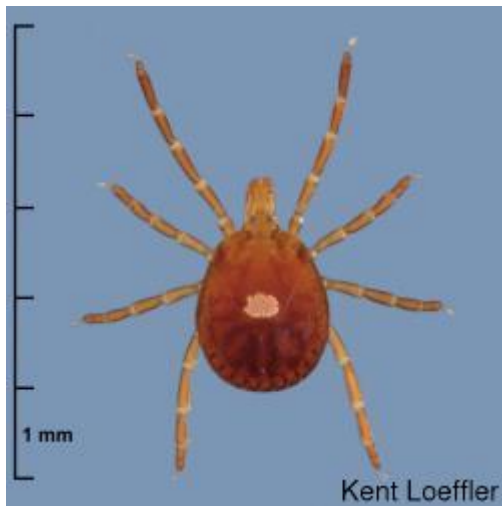
Introduction

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 or eight legs. Ticks possess tremendous potential for transmitting disease-causing organisms to humans and other animals. These 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

Animals in the phylum Arthropoda (known as arthropods) share several key characteristics including: a segmented body arranged in two or three groups; paired, segmented appendages; and an exoskeleton made of chitin. Examples of commonly encountered arthropods include crustaceans, spiders, insects, millipedes, and centipedes. The Arachnida is a class within the phylum Arthropoda. Arachnids include spiders, scorpions, pseudoscorpions, and opiliones or *daddy-long legs*. The class Arachnida is further divided into smaller groups

called orders. The Acari is a name for one of these orders. All mites and ticks belong to this order. Ticks comprise two main groups: hard ticks (family Ixodidae) and soft ticks (family Argasidae).



An image of a hard tick, *Amblyomma americanum*. The scale along the left side is in millimeter increments.



Argas persicus, a soft tick. The scale along the left side is in millimeter increments.

Tick mouthparts are located on the capitulum (or head) and can be easily seen from a dorsal view (top of back). Specialized structures called stylets (chelicerae and hypostome) are used to penetrate and firmly anchor the tick in 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. Soft ticks lack a scutum, the integument is textured in appearance, and the capitulum can only be seen ventrally. Soft ticks are a common public health problem in arid regions. Information in this fact sheet pertains specifically to hard ticks because they are of public health importance in the northeastern United States.

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 single batch of eggs. Adverse environmental conditions or a decline in day length may cause ticks to enter a state of arrested development, called quiescence, 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 several 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 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 and other volatile odors from approaching hosts. Field studies have shown that some ticks will travel as far as 21m toward a potential host while others move negligible distances.²² Ticks do not jump or fly and must literally come in contact with a host. Favorite vegetation sites for adult host-seeking ticks 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 brown dog tick, the lone star tick, the groundhog tick, and the blacklegged tick.

American Dog Tick (*Dermacentor variabilis*).



The American Dog Tick, *Dermacentor variabilis*. Clockwise: nymph, larva, male, female.

American dog tick females are about 1/4 inch (6.35mm) long and are chestnut brown with a silvery-gray or creamy-white scutum. Male ticks are slightly smaller, and are chestnut brown with similar light-colored vertical markings on the dorsal surface. 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. 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 vertically (from mother to her eggs). Consequently unfed larvae are capable of pathogen 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.

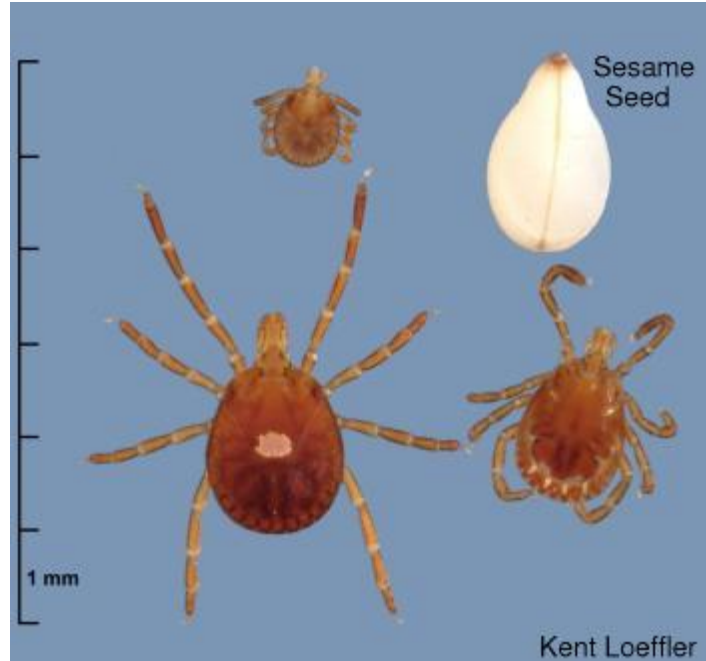
Brown Dog Tick (*Rhipicephalus sanguineus*).



The Brown Dog Tick, *Rhipicephalus sanguineus*. Starting with the upper left and going clockwise: fully blood-engorged female, female, larva, male.

Brown dog ticks are reddish-brown with a dark brown scutum. Unfed females are about 3/16 inch (4.76mm) long. All stages feed almost exclusively on dogs and can become established in kennels. Although brown dog ticks can be found crawling on humans they rarely attach and feed on humans. This tick is considered a nuisance species and is not known to transmit disease-causing organisms to humans in the United States.

Lone Star Tick (*Amblyomma americanum*).



The Lone Star Tick, *Amblyomma americanum*. Clockwise from upper left: nymph, male, female.

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. A reticulated pattern is apparent on the outer margins on the upper body surface of males. Lone star ticks have long mouthparts, but with care the tick and its stylets can be completely removed from the host skin. Even with successful removal of mouthparts the cementing substance generated by the tick remains in the bite wound. This cement material can cause 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 (HME) 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}

Ixodes cookei (*Ixodes cookei*).



Ixodes cookei. Clockwise from upper left: female, nymph, larva.

Ixodes cookei has no official common name but it has been called the groundhog, woodchuck, or carnivore tick. Groundhog ticks are very similar in appearance to blacklegged ticks (*Ixodes scapularis*), thus microscope examination is required to properly distinguish between these two species. *Ixodes cookei* has been found to parasitize a wide variety of carnivores and rodents but can be especially abundant on groundhogs (*Marmota monax*).^{4,11} The groundhog tick rarely quests for hosts on vegetation. Rather, they are found in the burrow of their host. This tick is primarily considered a nuisance, but it has been associated with the transmission of a virus that causes Powassan encephalitis (POW).^{4,5,26} Powassan encephalitis is not as common as Lyme disease, and relatively small numbers of cases have been reported in New York State since its discovery in Canada in 1958.²⁷ Normally there are 0-3 human infections in New York annually. This is probably a reflection

of the low contact rate between humans and infected vectors.^{5,11} Infection with Powassan virus can cause inflammation of the brain (encephalitis) and sometimes meningitis.^{4,5,13}

Blacklegged Tick or Deer Tick (*Ixodes scapularis*).



The Blacklegged Tick, *Ixodes scapularis*. From left to right: female, nymph, male.

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. 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.^{28,29} All stages will bite humans, but due to their small size, attachment by larvae and nymphs often go unnoticed.³⁰ The blacklegged tick is a vector of two well-described 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).^{8,9,30} The rash slowly spreads and has a distinctive bulls-eye appearance. The risk of contracting an infection from a tick is virtually zero during the first 24 hours of attachment, so promptly removing ticks can significantly reduce your chances of contracting Lyme disease.^{15,16,25,30} Untreated cases may resolve or progress to chronic joint, neurological, or cardiac problems. Lyme disease is treatable in the acute phase with antibiotics.^{8,9,24,30} 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. An average of 4,560 laboratory confirmed cases of Lyme disease are reported in New York State annually. Most of these cases occur in residents of Long Island and the lower Hudson River Valley. However, case numbers in humans and dogs have recently increased in central and northwestern regions of New York State. Recent studies conducted on Lyme disease-vector ticks, including *I. scapularis*, established the presence of a previously undescribed bacterium, *Borrelia miyamotoi*. This spirochete is genetically related to the species of *Borrelia* that cause relapsing fever.^{33,34} To date little is known about the

bacterium, disease symptoms or prevalence. For additional information, see <http://news.yale.edu/videos/borrelia-miyamotoi-infection-new-deer-tick-borne-disease>.

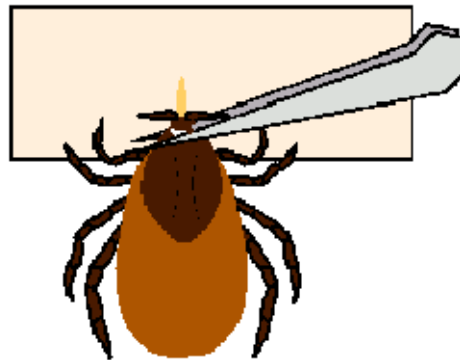
Human granulocytic ehrlichiosis (HGE) is caused by infection with the bacteria *Ehrlichia phagocytophila*. The incubation period and symptoms are similar to human monocytic ehrlichiosis, except a rash rarely occurs.^{8,9} Unlike Lyme disease, prompt removal of ticks does not seem to decrease one's chances 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 deer tick*" by Carolyn Klass. The fact sheet can be viewed at <http://entomology.cornell.edu/cals/entomology/extension/idl/index.cfm>.

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.



Proper grasp on a tick with forceps for removal.

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. 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.

NEVER use petroleum jelly, fingernail polish, a lit match, rubbing alcohol, or similar substances to remove a tick. These methods are not effective and may cause the tick to regurgitate pathogens into the bite wound.¹⁵

Identification of Ticks

Ticks can be submitted to the Insect [Diagnostic](#) Lab at [Cornell University](#) for identification. A \$25.00 identification fee applies per sample. Please do not mail ticks in in alcohol due to mail regulations.

The Diagnostic Laboratory does not test ticks for any disease agents. If you want the tick tested please check with your physician or local county health office for the names of laboratories performing tick-testing services. Be sure to ask for information regarding price, response time, and proper procedure for mailing. Some laboratories perform tests only on living or recently dead ticks, while other laboratories test ticks preserved in alcohol.

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 measures 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.



Avoid game trails.

- 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 repellent before entering tick infested habitat.

- 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 ($C_{12}H_{17}NO$), permethrin ($C_{21}H_{20}Cl_2O_3$) and picaridin ($C_{12}H_{23}NO_3$). 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.

DEET can be applied directly to the skin or clothing. However, DEET can damage some types of fabrics, watch faces, painted and varnished surfaces. 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.

Permethrin (a synthetic pyrethroid) 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. In recent years, pyrethroid-resistance has been detected in several US tick species signaling a possible reduction in its effectiveness against ticks.³¹

Picaridin

This is a synthetic substitute carbamate used to repel all insects and ticks. Some claim it is as effective as DEET but without the skin irritation and damage to synthetic materials experienced with DEET.³⁵ It can be applied directly to the skin either as aerosol spray, cream or wipe. Originally, picaridin was developed in the 1980's and was made to resemble the substance piperine found in black pepper.³⁶ Comparative trials indicate picaridin holds significant repellent effects up to 12 hours post application and repels nymphs of Lone Star ticks effectively when compared to DEET and IR3535.³⁷

IR3535

This is another synthetic repellent which has proven effective against mosquitoes mainly and less so for ticks.³⁸ IR3535 has been on the market as a repellent in Europe for 10-20 years prior to its introduction in the US market. It is recommended as an alternative repellent to DEET by the CDC and demonstrated similar efficacy to DEET in laboratory tests.³⁹

For additional information on picaridin and other repellents please visit the National Pesticide Information Center fact sheets web site at: <http://npic.orst.edu/factsheets/PicaridinGen.html>.

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), (found in products sold by certain catalog cosmetic distributors), and nootkatone (from essential oil of grapefruit).³²

- 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 the likelihood 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 deer tick*" by Carolyn Klass for additional information on personal protection and *Ixodes scapularis*. The fact sheet is available through the Cornell University Insect Diagnostic Laboratory at <http://www.entomology.cornell.edu/IDL>.

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This work was supported by funds from Hatch 2010-11-184 and NYC 2011-12-219 through the Cornell University Agricultural Experiment Station.

Using Insect Repellents Safely

(From: <http://epa.gov/pesticides/insect/safe.htm>)

For the safe and effective use of pesticide products, always read the product label before using the product. Apply just enough repellent to cover exposed skin and/or clothing. Remember these important points to use repellents safely:

- Follow the label directions to ensure proper use.
- Repellents should be applied only to exposed skin and/or clothing. Do not use under clothing.
- Store insect repellents safely out of the reach of children, in a locked utility cabinet or garden shed.
- Do not apply near eyes and mouth, and apply sparingly around ears.
- When using sprays, do not spray directly into face; spray on hands first and then apply to face.
- Never use repellents over cuts, wounds, or irritated skin.
- Do not spray in enclosed areas. Avoid breathing a spray product, and do not use it near food.
- After returning indoors, wash treated skin and clothes with soap and water.
- Do not use any product on pets or other animals unless the label clearly states it is for animals.
- Most insect repellents do not work on lice or fleas.
- [Use other preventive actions to avoid getting bitten](#) .
- [Read more about active ingredients](#).

Repellents and Children

EPA does not recommend any additional precautions for using registered repellents on pregnant or lactating women, or on children, other than those listed on the label. For example, some repellents are eye irritants and those labels would have a specific caution about keeping the product away from your eyes.

Because children frequently put their hands in their eyes and mouths, [EPA recommends that all repellent products](#) have the following precautionary statements related to children on their labels:

- "Do not allow children to handle this product, and do not apply to children's hands. When using on children, apply to your own hands and then put it on the child.
- After returning indoors, wash your child's treated skin and clothes with soap and water or bathe."

According to the label, oil of lemon eucalyptus products should not be used on children under the age of three.

Always store insect repellents safely out of the reach of children.

If you are concerned about using repellent products on children you may wish to consult a health care provider for advice or contact the National Pesticide Information Center (NPIC) through their toll-free number, 1-800-858-7378 or npic.orst.edu

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. All pesticides distributed, sold or applied in New York State must be registered with the New York State Department of Environmental Conservation (DEC). Questions concerning the legality and/or registration status for pesticide use in New York State should be directed to the appropriate Cornell Cooperative Extension Specialist or your regional DEC office. **READ THE LABEL BEFORE APPLYING ANY PESTICIDE.**

This factsheet was updated on August 6 2013