



Biology and Management of Ticks in New Hampshire

There are two families of ticks, the *Ixodidae* (hard ticks) and *Argasidae* (soft ticks). Those of importance to hikers, campers, and pet owners are in the family *Ixodidae*. Therefore, this publication covers species of that group. Several species are important because they bite people and/or pets. Some can also transmit diseases to the people or pets they bite.

This publication will help you learn what ticks look like, how they live, the diseases they spread, how to manage tick problems, and how to protect yourself from tick-borne diseases.

New Hampshire Tick Species



Questing American dog tick



Blacklegged tick larvae & pinhead

The American dog tick, *Dermacentor variabilis*, is the most frequently encountered tick in New Hampshire. It is about 1/8" (4-5mm) long, brown and tan, with an obvious mottled pattern of surface markings on the back (opposite the belly side). It is a "three-host tick," so named because it must find and feed on an animal three times to complete its two-year life cycle. This species has now spread to every county in the state. Parts of Cheshire, Sullivan, Grafton and northern Coos don't have many.

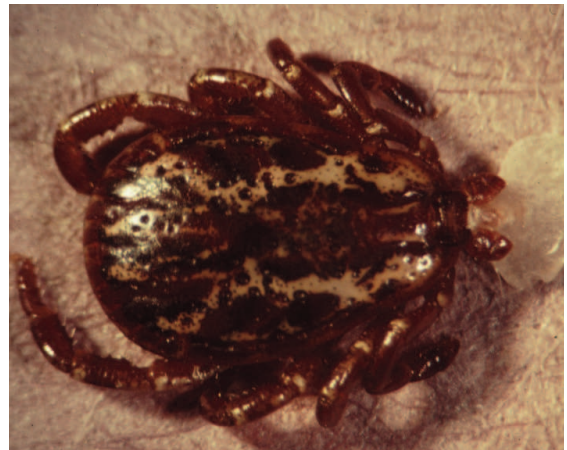
The dog tick begins life as an egg, one of hundreds laid in a mass on the ground by a female tick. The egg hatches into a larva, which has six legs. The larva remains on the ground in leaf litter, or in low vegetation while waiting for a small mammal to brush by. It attaches to the animal and feeds for several days.

Then it drops off and molts to the nymph stage, which has eight legs. Again it waits for a host to brush by. When that happens, the tick attaches and feeds on it for several days. When fully fed, it drops off and molts to the adult stage.

Adult ticks wait on shrubs or tall grass and attach to larger mammals such as people, deer, or pets. They also take several days to fully engorge (feed). A female fully engorged with a blood meal can be almost the size of a dime, appearing smooth and shiny. Mating takes place on the host, and when fully fed, the females drop off and lay eggs. The life cycle can be as short as three months, but typically lasts two years.

American dog ticks can survive a very long time without feeding. This species can transmit the organism that causes Rocky Mountain spotted fever, which is rare in New England but more common farther south. The tick is most active from May through July in New Hampshire.

Stories in the press have confused many people about the relationship of this tick and Lyme disease. Despite the fact the spirochete (bacterium) that causes Lyme disease has been found in American dog ticks, tests prove that the tick can't transmit the organism to its hosts. Therefore, it isn't involved in the spread of Lyme disease.



Male American dog tick



Female American dog tick

The winter tick, *Dermacentor albipictus*, is similar in size and appearance to the American dog tick. Unlike that species, the winter tick isn't active in the summer and it completes its entire development on one



Winter tick

host. It is often found on moose, deer, or horses during the fall, winter or spring. It doesn't commonly bite people, and does not transmit agents that cause disease in people. Eggs of this species hatch in the spring, but the larvae remain bunched together in a torpor all summer long. They don't become active until cold weather returns in the fall. As with other ticks, they wait on leaf litter or low vegetation for a host to brush by. After attaching to a suitable host, this species remains on the animal, feeding and molting until it has fully grown. Then it drops off, and eggs are laid on the ground in the spring.

In New Hampshire winter ticks have been collected as far south as Durham, Nottingham, Wilton and Roxbury, but the species is more common farther north. Hunters or other people active in the woods in October and November occasionally sit on, or place a hand on the ground in a group of larvae waiting for a host. As many as 50 larvae have been found on a glove or pant leg after such an encounter. The larvae are brown, slightly smaller than a pinhead. Sometimes moose are found in winter with large patches of bare skin, carrying hundreds of winter ticks. Such heavy infestations sometimes kill the moose. Normally ticks are found in lower numbers (not hundreds per animal) on moose and deer. Adult winter ticks look like slightly elongated versions of the American dog tick.



Brown dog tick

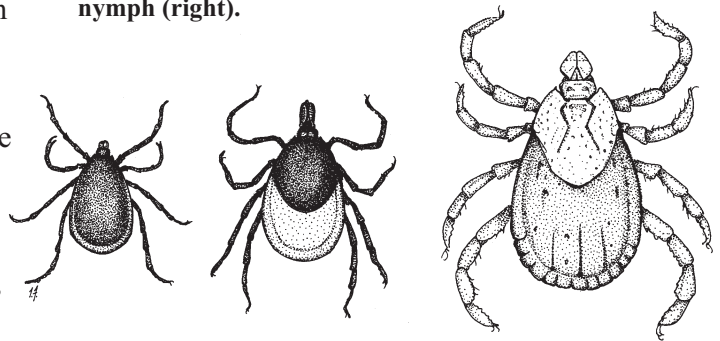
The brown dog tick, *Rhipicephalus sanguineus*, is uncommon in New Hampshire, though it probably occurs throughout the state. This species is slightly smaller and slightly different in shape than the American dog tick. It is reddish-brown in color and lacks the mottling the *Dermacentor* species have. It has a life cycle very similar to other three-host ticks (like the American dog tick). It can be a problem in kennels and zoos, but rarely bites people. It has a strong tendency to crawl upwards and hides in cracks in kennel roofs or in ceilings or porches. In heated buildings, it can appear at any time of the year. It is unlikely this tick would be found anywhere but in or adjacent to kennels or houses where dogs are kept. This species can spread two diseases to dogs: canine ehrlichiosis and canine babesiosis.

The blacklegged tick (deer tick), *Ixodes scapularis*, is our second most common species. Until 1993, northern specimens were considered a different species, called the deer tick (*Ixodes dammini*). It looks similar to the tick species mentioned above, but is smaller and more rounded. It lacks the mottling of *Dermacentor* species. Adult males are very dark brown, almost black. Adult females are two-toned: dark chestnut brown on head, legs and scutum, and orange-red on the rear half of the body. Nymphs are about the size of a pinhead (1-2mm), and adults are just over 1/16" (2-3 mm) long. When fully engorged with a blood meal, an adult female blacklegged tick can swell to 3/8-inch (10 mm) long.

This species has received much attention because it is the vector of (transmits) the organism that causes Lyme disease. A 2007 study also found two additional pathogens in some N.H. blacklegged ticks: the pathogens that cause babesiosis and anaplasmosis in people.



Blacklegged ticks: adult female (left), male (center) and nymph (right).



Blacklegged tick (left and center) and American dog tick (right). Drawing by Tess Feltes.

Results of my 19 years of surveying for this species are summarized on the map. Blacklegged ticks occur in all ten counties, but are most abundant in the southeast. About 85 percent were found within 35 miles of the coast. Most of these observations were compiled from tick identification requests, so that may bias the numbers in favor of locations close to UNH. But this pattern (most observations within 25 miles of coast, plus along major rivers and their tributaries) also occurs in Maine, Massachusetts, Connecticut, Rhode Island, and New York. In the western counties, most observations have been near the Connecticut River. This tick now occurs in New Hampshire in much higher numbers than a few years ago. This could be from many factors, including increasing deer numbers, increasing human population, and creating more edge habitat by building houses in wooded areas.

The life history of the blacklegged tick is typical of other three-host ticks. The life cycle takes two years. Larvae are most commonly found on mice, other small mammals, and birds. Nymphs commonly bite these hosts, as well as medium-sized animals and people. Adult ticks most commonly attach to large animals, such as white-tailed deer. They are most active from mid-September to mid-November, but activity continues in mild winter weather when there is little or no snow cover. Adults are also found in the spring. Nymphs are most active in June and July. This species will readily bite people. Scientists have shown that high populations of deer are necessary for this tick to be abundant. Observations in New Hampshire support this finding. In Massachusetts, the incidence of Lyme disease is strongly linked with high deer populations.

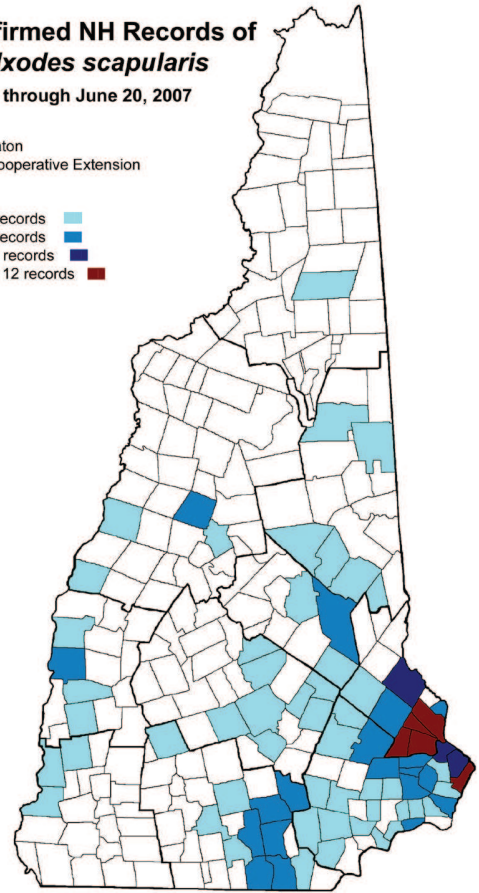
There are other New Hampshire ticks that are very similar to the blacklegged tick. *Ixodes muris* is a species that is commonly associated with mice and other small mammals (and their predators) and people. It is very similar to the blacklegged tick, especially in the nymph stage. Researchers in Maine recently proved that it can vector Lyme disease, but is a relatively poor vector, compared to blacklegged tick. They also reported that domestic animals bitten by this species sometimes show severe reactions (pain, swelling, lethargy, etc). In New Hampshire, *I. muris* records are predominately from Rockingham and Strafford counties.

Woodchuck tick, *Ixodes cookei*, is a species that occurs in every New Hampshire county. It is commonly found on a variety of small and medium sized mammals, as well as people. It is similar in size to the blacklegged tick, but under a microscope there are obvious differences. It is not involved in the spread of Lyme disease, but is the main vector for a rare, serious human disease called Powassan encephalitis. *Ixodes banksi* is strongly associated with beavers, sometimes muskrats. *Ixodes marxi* is strongly associated with squirrels.

**Confirmed NH Records of
Ixodes scapularis
through June 20, 2007**

Alan Eaton
UNH Cooperative Extension

1-2 records ■
3-6 records ■
7-12 records ■
over 12 records ■



The lone star tick, *Amblyomma americanum* rarely turns up in New Hampshire. It is unclear whether the specimens that are encountered actually overwintered here, or if they “hitchhiked” from farther south. Its reported range reaches to coastal Connecticut and Rhode Island. The adult females are red-brown, with a prominent white dot. The lone Star tick is the vector for *Ehrlichia chaffeensis*, the agent of human monocytic ehrlichiosis (HME), and *Ehrlichia ewingii*, which causes human and canine granulocytotropic ehrlichiosis. Lone star ticks cannot spread Lyme disease.

Although several other species of ticks live in New Hampshire, most people rarely encounter them.



Lone star tick

Tick-Borne Diseases

Ticks can spread several diseases, but except for Lyme disease, the incidence of such illnesses is rare in New Hampshire. Other illnesses include Rocky Mountain spotted fever, tularemia, tick paralysis, Powassan encephalitis, babesiosis, Colorado tick fever and ehrlichiosis.

Human Diseases Caused or Spread by Ticks, That Could be in New Hampshire

<u>Disease</u>	<u>Causal agent</u>	<u>Vector(s)</u>	<u>NH Incidence</u>
Anaplasmosis	<i>Anaplasma phagocytophilum</i>	<i>I. scapularis</i>	emerging
Babesiosis	<i>Babesia microti</i>	<i>I. scapularis</i>	emerging
Ehrlichiosis			
ewingii infection	<i>Ehrlichia ewingii</i>	unknown	possible?
HME	<i>Ehrlichia chaffeensis</i>	<i>A. americanum</i>	uncommon
Lyme Disease	<i>Borrelia burgdorferi</i>	<i>I. scapularis</i>	common, increasing
Powasan Encephalitis	Virus	<i>I. cookei</i>	possible
Rocky Mtn. Sp.Fever	<i>Rickettsia rickettsii</i>	<i>D. variabilis</i>	rare
Tick paralysis	toxin	<i>D. variabilis</i>	rare
Tularemia	<i>Francisella tularensis</i>	<i>D. variabilis</i>	rare
		<i>A. americanum</i>	

Lyme Disease

Lyme disease is the most common vector-borne (transmitted by insects or ticks) disease in the U.S. It was first identified in the U.S. near Lyme, Connecticut, in the mid 1970s. It is caused by a spirochete, an elongated, corkscrew-shaped bacterium named *Borrelia burgdorferi*. In the latest (2007) data from the Centers for Disease Control and Prevention, New Hampshire ranks third in the nation in the number of Lyme Disease cases reported per 100,000 people. In New Hampshire, most cases are reported from Rockingham, Hillsborough and Strafford Counties.

Number of Reported New Hampshire Lyme Disease Cases, 2003 to 2008*

	2003	2004	2005	2006	2007	2008*
Belknap	6	11	2	10	6	21
Carroll	2	9	4	5	20	13
Cheshire	7	3	6	12	13	31
Coos	1	2	4	4	3	2
Grafton	10	7	5	7	14	15
Hillsb.	37	39	77	151	221	412
Merrimack	10	16	9	28	45	94
Rockhm.	78	103	133	310	399	623
Strafford	37	37	31	88	181	230
Sullivan	4	1	0	2	3	11
Total	192	228	271	617	905	1513

Source: NH Department of Health & Human Services

*Pre 2008 data are confirmed cases. 2008 figures are presumed cases

In a fall 2007 survey for the N.H. Department of Health and Human Services, more than 50 percent of the **adult** blacklegged ticks tested in Rockingham, Strafford, and Hillsborough Counties were infected with the Lyme disease organism. Between 20 and 50 percent were infected in Merrimack County. Elsewhere, tick numbers were too low to estimate infection rate.

The cycle of transmission begins with a blacklegged tick larva or **nymph** feeding on an infected *reservoir host*. A reservoir host is one in which the bacterium builds up to relatively high levels in the blood. The white-footed mouse is the major reservoir host in New Hampshire. The feeding tick picks up the bacteria along with its blood meal. After feeding, the tick digests its meal and transforms to the next life stage. This takes weeks or months. When the tick attaches to another host and begins feeding again, the

bacteria multiply in the tick's gut. Some of them penetrate the gut wall and travel to the salivary glands. As the tick continues to feed, it injects some bacteria into the host, along with the tick's salivary secretions. Infected adult blacklegged ticks require more than 24 hours of feeding to transmit the bacteria. Nymphs may transmit the disease organisms to their host in 24 hours of feeding, or possibly less.

Symptoms of Lyme disease in people frequently (not always) begin with a characteristic red zone (rash) around the site of the bite. It usually appears three to 30 days after being bitten by an infected tick, and it slowly expands in size, then fades. Don't confuse this red zone with the red spot that appears **within hours** where you've removed a biting tick. The **Lyme disease** rash is often ring-shaped and warm to the touch. The photo shows it as fairly dark, but it can be much fainter. Fatigue, fever, headaches, stiffness and pain in muscles and joints often occur. They can appear from a few days to weeks after infection. If Lyme Disease is left untreated, dizziness, irregular heartbeat, arthritis, and nervous system disorders can follow after several months to years after infection. Arthritis, joint pain and swelling are common symptoms (especially knees) in untreated cases months or years later.



Lyme disease rash



Black legged tick biting a peson

Most cases of Lyme disease are contracted in June and July, when the nymphs are active. In people, most cases are transmitted by nymphs, because they are very small and easily overlooked. Also, nymphs can transmit the organism faster than adult ticks. Treatment is most successful in the early stages, and antibiotics are used. For a while there was a human vaccine for Lyme disease, first approved by the FDA in December 1998. It is no longer available. Dogs, horses and cattle also suffer joint disorders caused by the Lyme disease bacterium.

Ehrlichiosis

Ehrlichiosis is the name for several diseases of animals and humans. *Ehrlichia chaffeensis* is the agent of human monocytic ehrlichiosis (**HME**). *Ehrlichia ewingii* causes **human** and canine granulocytotropic ehrlichiosis. Victims usually report flu-like symptoms (headache, fever, muscle aches, fatigue) and sometimes gastro-intestinal symptoms or rash. Symptoms typically appear five to ten days after being bitten by an infected tick. The lone star tick (rarely encountered in N.H.) is the primary vector. Most cases appear in the southern, eastern and south-central states. Between 2003 and 2008, 15 cases of human ehrlichiosis were reported in New Hampshire. Forms of ehrlichiosis also occur in horses and dogs.

Anaplasmosis

Human granulocytotropic anaplasmosis is a new name for a relatively new tick-borne disease formerly called HGE (human granulocytic ehrlichiosis). The number of reported cases has been rising for several years, with the highest incidence in people over 60. In 2006, the highest incidence was reported from Minnesota, Wisconsin, New York, New Jersey and Connecticut. Between 2003 and 2008, 19 cases of human anaplasmosis were reported in New Hampshire. The majority of these cases were reported in 2008, indicating this is an emerging disease in NH.

The causal organism is a bacterium called *Anaplasma phagocytophilum*. In the eastern United States, blacklegged tick is the vector. Deer and wild rodents are thought to be the reservoirs for this disease. A 2007 study of **adult** blacklegged ticks from New Hampshire confirmed the presence of *Anaplasma*-infected ticks in Hillsborough and Rockingham Counties.

People with anaplasmosis commonly report flu-like symptoms (headaches, chills, fever, muscle aches), with the onset of symptoms 5 to 21 days after being bitten. Physicians treat the disease with antibiotics.

Babesiosis

Babesiosis is human disease caused by a protozoan (*Babesia microti*) that attacks red blood cells. The microorganism is related to malaria parasites, and there are similarities in the two diseases. Babesiosis is associated with voles, chipmunks, mice and shrews. The white-footed mouse is the primary reservoir host. Human cases have been increasing in the northeast since its recognition in the 1970s on Nantucket, Block Island, and parts of nearby states. Blacklegged tick is the main vector. Most human cases occur during summer, when blacklegged tick nymphs are active, but adults can also spread the disease.

Symptoms range from very mild to life-threatening, and include fever, fatigue, chills, sweats, headache, and more. Severe symptoms are more likely in people who are immunosuppressed, have had their spleen removed, and/or are elderly. Onset of symptoms is one to six weeks after the tick bite. Between 2005 and 2008, 17 cases of human babesiosis were reported in New Hampshire. The majority of these cases were reported in 2008, indicating this is an emerging disease in NH.

In a 2007 study for the NH Department of Health & Human Services, adult blacklegged ticks were collected across New Hampshire and analyzed. They detected low to moderate prevalence of *Babesia microti* in Strafford, Rockingham, Merrimack, Hillsborough and Carroll Counties.

Rocky Mountain Spotted Fever

This disease is caused by a bacterium called *Rickettsia rickettsii*. Until about 1930, it was thought to occur only in the Rocky Mountain region, hence its name. Today there are far more cases reported in the eastern states, especially in the South-Atlantic and West-Central states. North Carolina and Oklahoma have the highest number of cases. From 1997 to 2002, one case of Rocky Mountain Spotted Fever in a person was reported in New Hampshire. During that period, Connecticut had five cases; Massachusetts had 13, Rhode Island had nine, and there were none from Vermont or Maine.

The disease usually appears in late spring, summer or early fall. American dog tick is the principal vector, but brown dog tick has also been implicated. Two-thirds of the cases occur in children under age 15. Symptoms usually appear two to 10 days after being bitten by an infected tick. Headache, backache and fever are common symptoms. A spreading, spot-like rash usually develops, often beginning on wrists and ankles. Prompt diagnosis and treatment with antibiotics are important. Fifteen to 20 percent of untreated cases are fatal. The disease is treated with antibiotics.

Powassan Encephalitis

The causal agent of this very rare, sometimes fatal disease is a virus (a flavavirus). Recent cases appeared in Wisconsin, Michigan, New York, Maine and Vermont. It was first described from Powassan, Ontario in 1958. The first U.S. case was 1970, in New Jersey. *Ixodes cookei* is the principal vector. The virus has also been found in *Ixodes marxi*, but that species hasn't been proven as a vector. Encephalitis is a disease that causes swelling of the brain. As with Eastern equine encephalitis, some survivors have long-term neurological problems. Recent screening for West Nile virus has increased the number of cases discovered. As this is written (Feb. 2009), no cases are known from New Hampshire. There are no drugs to treat the disease, just supportive care.

Tularemia

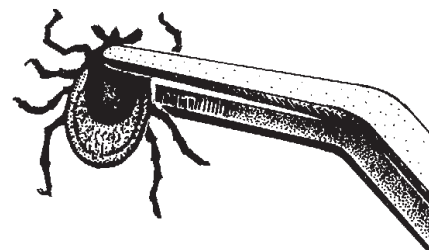
“Rabbit fever” is caused by the bacterium *Francisella tularensis*. The disease can be contracted from skinning and cleaning infected rabbits or from being bitten by infected ticks. Tularemia occurs throughout the United States, but is rare in New Hampshire. Most U.S. cases occur in Missouri, Arkansas and Oklahoma. In the East, most cases occur in the fall and winter and are presumed to be associated with hunting rabbits or other small animals. Symptoms depend on the route of infection. When acquired by a tick bite, an ulcer often forms at the site of the bite. Fever is a common symptom. Swelling of nearby lymph nodes sometimes occurs. Antibiotics can be used to treat the disease. The American dog tick is the vector species that occurs in New Hampshire. Lone star tick (very rare in N.H.) can also spread the disease. Several cases are known from Martha's Vineyard, Massachusetts.

Tick Paralysis

Tick paralysis is caused by toxic substances in the secretions of some feeding ticks. In people, it occurs most frequently in children under the age of seven. Young girls are common victims (probably because it is difficult to detect ticks in long hair). The most frequent site of biting that causes “paralysis” in people is the back of the neck, close to the hair line. Victims have difficulty moving or controlling arms or legs. When you discover and remove the feeding tick, these symptoms disappear within an hour or two. In the United States, it is more frequently seen in the Southeast and Northwest. The American dog tick can cause tick paralysis. The condition is also reported in dogs.

Safe Removal of Ticks

Since tick bites are painless, ticks are often discovered after they have begun to feed. Removal is fairly easy, provided it is done correctly. We recommend using tweezers to grasp the tick, rather than using bare fingers. Using bare fingers may contaminate them with a disease-causing organism. Also, it is easier to get a firm grip of the head with tweezers. Firmly grasp the tick as close to its head as possible, and pull gently, using slow, steady pressure. DO NOT yank it or pull it sideways, since this could cause its head to break off inside the wound. It might take as long as two or three minutes for removal. Touching a hot match to an embedded tick, or covering it with Vaseline or other substances aren't recommended. The photographs should help determine if all of the head has come out. It may be wise to apply an antiseptic to the wound after removing the tick.



Drawing by Tess Feltes



Black legged mouth parts. SEM photo

Tick Testing

Many people ask to have ticks tested for the presence of the Lyme Disease organism. UNH Cooperative Extension doesn't encourage this, but we can provide information on labs that do such testing. The information changes rapidly, so isn't printed here. If you are in New Hampshire, contact the Family, Home & Garden Education Center 1-877-398-4769 or Dr. Alan Eaton 603-862-1734 to learn more. There are problems with relying on testing to evaluate risk. Testing is expensive, often \$75 or more per specimen. It takes days to get results. The accuracy of some tests is affected by how ticks are stored or preserved. Some tests have a relatively high rate of false results. Some labs send back results with a disclaimer that says they can't be relied on for diagnosis. Your risk of getting a disease depends in part on how long the tick was biting and the species of tick. If it was biting a short time, the risk is probably very low or zero. Labs don't screen for all diseases that ticks can carry. In New Hampshire, blacklegged ticks have been found with pathogens of Lyme disease, Babesiosis, and Anaplasmosis.

Protecting Yourself From Tick Bite

The most obvious way to avoid contact with ticks is to stay away from tall grass and brushy areas that are prime tick habitat. May through August are prime months for the American dog tick. April through July, and October through mid-November are periods when blacklegged tick nymphs or adults are most active. If you do spend time in tick-infested areas, wear proper clothing. Wear good shoes (no sandals or bare feet) and long pants tucked into your socks. A long sleeved shirt with snug collar and cuffs will also offer protection, if it is tucked in at the waist. Dressing this way helps keep ticks you do encounter on the outside of your clothing, where they may be spotted or brushed off. Light colored pants and shirt allow you to easily spot crawling ticks.

There are also several forms of tick-proof or tick-resistant clothing. Some are made of tightly woven, slick material to which ticks can't easily attach. "Tick Chaps" is one example. Others are made of fine mesh netting through which adult ticks can't pass, like "Bug Baffler." Other examples are the stretch materials that fit like spats over pant cuffs and boots. They also work by making it very difficult for ticks to get under your pant legs.

You can treat clothing with tick repellent for added protection (see below). There are several effective active ingredients. Socks, ankles, legs and pant legs are the best places to treat. Always read and follow label directions, when using repellents.

Pressurized spray products containing the insecticide permethrin are registered for protection against ticks. They are sprayed on clothing, and repel and/or kill ticks that attach themselves to the clothing. Such products should never be applied to skin. After spraying on your clothing, allow it to dry an hour or more before you put it on. Permethrin adheres very well to cotton, and is long lasting (often through numerous washings).

If you have been in tick-infested fields or woods, monitor yourself, your children, and pets every day. Inspect your clothes, and undress to check for ticks. A full length mirror or family member can help you see ticks on your back or other difficult to see areas. Don't neglect to check your head, especially if you have long hair. Ticks tend to crawl upward, and if they can't get inside your clothing, they will end up on your head or neck. If you find a tick that has already begun to feed, carefully remove it as described above. If you are concerned it might be a type that transmits disease, place it in a container and take it to UNH Cooperative Extension or the State Entomologist for identification (addresses at end).

Be sure to record the date and location of the bites. If possible, record the date and where (town) you probably picked up the tick. This can simplify its identification.

If a tick is attached to your skin for less than 24 hours, your chance of getting Lyme disease is extremely small. But just to be safe, monitor your health closely after a tick bite and be alert for any signs and symptoms of tick-borne illness. If symptoms show up, consult your physician for advice. Be sure to give your doctor details about where and when you were bitten, and any symptoms. If your pet has joint disorders, you may wish to see your veterinarian for advice.

Repellents

The most effective repellents for ticks contain a material called n, n-diethyl-m-toluamide or "Deet." The label will tell if your repellent contains this material. Socks, ankles, legs and pant legs are the best places to treat, if ticks are the target. When applying to the skin, use Deet sparingly, with care. A small segment of the population may be sensitive to it. Be careful not to get it in eyes or mucous membranes, and be especially cautious of its use on young children. It should not be used on infants. Deet has some other drawbacks. It can dissolve some plastics and some finishes, and it has a greasy feel.

Picaridin is a repellent that works very well on mosquitoes, and does fairly well against ticks. It has been available in New Hampshire since about 2006. For people who are concerned about sensitivity to deet, this is a good alternative. Some NH-registered picaridin repellents list ticks on the label, and others do not. This may reflect differences in concentration --- the ones that list ticks usually have a higher percentage of picaridin.

IR3535 [ethyl butyl acetyl aminopropionate] has several chemical names. The chemical was designed in the early 1970's, and has been available in Europe since the mid-1970's. Tests show that it works moderately well on mosquitoes, and fairly well on blacklegged tick. At least three manufacturers (Sawyer, Chattem, and Avon) make products that combine sunblock and insect repellent, contain this chemical, and are registered for use in NH. The Chattem ("Bullfrog Mosquito Coast") and Sawyer products typically have 20% IR3535 and are registered for mosquitoes. The Avon products have lower % active ingredients, and are registered for "biting midges, black flies, deer ticks, gnats, mosquitoes, no see-ums, and sandflies".

A repellent recently registered with EPA, 2-undecanone, is derived from wild tomato plants. Some chemical registries refer to the same compound as methyl nonyl ketone. It worked as well as or better than deet in preliminary published tests on American dog tick. BioUD is a trade name for products with this active ingredient. As this is written it is not yet available in New Hampshire. Other tick repellents reported in scientific journals include A13-37220 and tansy essential oil. Perhaps these will eventually appear in commercial tick repellents.

Amitraz and permethrin are two pesticides for ticks that show what is sometimes called repellency. Rather than being true repellents, they seem to create irritation and toxicity symptoms in ticks, which cause ticks to drop off and prevents them from attaching. Tick control products containing fipronil can also prevent tick attachment, which some people interpret as "repellency".

Reducing the Threat of Ticks on Your Property

Probably the greatest natural mortality factor for ticks is dry conditions. There are a number of steps you can take on your property to make vegetation and leaf litter dry out faster, and be less favorable for ticks. One is to keep the lawn mowed, and keep a mowed strip between play areas and thick brush. Removing dense brush might also be helpful in some situations. A second technique is to reduce human contact with the tall grass or thick brush that holds ticks. This could be by widening paths through the woods, moving play equipment away from the woods edge, or mowing the edges of paths. You might consider using black plastic landscape netting or other fencing to limit people from walking into thick vegetation along paths. This might be effective for property open to the public, like parks. (Ticks often occur in high numbers right next to roads, paths, and game trails.) Spraying is another option (see below).

Spraying with Pesticides

There are many products that can be sprayed to kill ticks. Most are intended for outdoor use. Indoor treatment might be helpful to control brown dog tick. Some pesticides are registered for use on pets, as sprays, topical spot treatments, or collars. The pesticide label will specifically indicate where and how these can be used. For controlling ticks outdoors, an early June insecticide spray to the leaf litter can be effective to control the nymphs of blacklegged ticks in your yard. The perimeter of yards, shaded perennial beds, along woods trails, and stone walls are important target areas. Lawns are not important areas to spray (too dry). A sprayer that has enough pressure to turn over leaves and vegetation, and reach into crevices is most effective. In many cases, this means hiring a professional pesticide applicator. Treatment in October can be effective on blacklegged tick adults if the lower three feet of brush and shrubs are targeted. To control American dog ticks, a spring (after May 15) treatment can be effective. As with any pesticide purchase, it is essential that you first read the pesticide label to be certain that the one you intend to buy is registered for the intended use. The target pest (ticks) must be in the label instructions, along with the site. Application of any pesticide “in a manner inconsistent with its labeling” is a violation of both state and federal laws. For those people with restricted use pesticide licenses, there are many more options. Chemical choices for outdoor spraying include carbaryl, synthetic pyrethroids, and some products with essential oils.

Indoor treatment might be helpful to control brown dog tick. That species has a strong tendency to crawl upwards and lay eggs in crevices of kennel roofs or ceilings. The immatures then move downwards and hide in cracks and crevices of walls, floors, windows, etc.

Some products contain pesticides that have relatively low risk of causing problems, thus are available to anyone (“general use materials”). Others have a greater risk of causing problems if users do not carefully follow directions. These (restricted use products) are available only to licensed pesticide applicators or professional pest control personnel.

Pesticides Used for Tick Control

Carbamates

Carbaryl (“Sevin”) is a broad spectrum insecticide which controls ticks well. Broad-spectrum means that it kills a very wide range of insects, including many beneficial species. Outdoors, the sunlight, oxygen and moisture work to break down the chemical relatively quickly. Residues typically kill pest insects for 5 to 10 days after spraying. Carbaryl is incorporated into some tick collars, plus some sprays around your home. It is very toxic to bees and many other beneficial insects, and moderately toxic to mammals.

Propoxur is another carbamate chemical that controls fewer kinds of insects ("narrower spectrum"). It is in some tick collars, and is highly toxic to mammals, so is used at low concentrations.

Formamidines

Amitraz is the only current tick-registered chemical in this group. It is in some tick collars for pets. It is a somewhat narrow spectrum material, effective on mites, ticks, and some insects. It has slight toxicity to people.

Insect Growth Regulators

These are relatively new chemicals. They interfere with the hormones that control insect development, which are quite different from human hormones. Immature stages of insects (and some mites and ticks) are vulnerable, but adults are not. These chemicals generally have very low risk of mammalian toxicity. Pyriproxifen and s-methoprene are in this group, and are in some flea & tick collars, and some indoor treatments. Both have low toxicity to people and other mammals. Methoprene is not very effective on ticks, but does kill fleas.

Organo-phosphates

Formerly there were several insecticides in this group that were widely used for tick control, including chlorpyrifos (Dursban) and Diazinon. The Food Quality Protection Act (1996) initiated a review of the safety and toxicity of these materials, and neither is available for this purpose today.

Rabon (tetrachlorvinphos) is a relatively long-lasting organo-phosphate in some tick collars and some sprays. It has moderately low toxicity to humans, and has been used as a livestock feed additive to control flies.

Phenylpyrazoles

Fipronil is used in products to protect pets from ticks and fleas. It dissolves in the oils on the skin, spreads over the body, and collects in sebaceous glands, where it is slowly released over several weeks. It is slow acting, and is highly toxic to people. "Frontline" is a product with fipronil.

Pyrethrins

Pyrethrum is a mixture of many "pyrethrins", which are chemicals produced by a flowering plant, *Chrysanthemum cinerariaefolium*. Pyrethrins have been used for many years to control insects. They have rapid knock-down effects on most insects, but some species recover from this. For this reason, pyrethrins are often mixed with other insecticides or a synergist. The most common synergist is piperonyl butoxide, sometimes abbreviated PBO. Another is n-octyl bicycloheptene dicarboximide. The synergist greatly enhances the effectiveness of pyrethrins. Pyrethrins are rapidly broken down by sunlight, moisture and oxygen, often within hours of application. They are generally low in toxicity to mammals, which is one reason they are often labeled for indoor use and on pets. They are not good choices for treating outdoors, because they have such short lived action.

Synthetic Pyrethroids

Pyrethroids are **artificial** chemicals that were invented after chemists studied pyrethrins. Pyrethroids are very broad spectrum insecticides with long residual action. They are much more slowly broken down than pyrethrins, so the residues sometimes kill insects for weeks after application. Common examples for tick control include bifenthrin, cyfluthrin, cypermethrin, cyphenothrin, deltamethrin, lambda-cyhalothrin, permethrin, and phenothrin. Many products with these chemicals are registered for spraying outdoors. Deltamethrin is used in some tick collars. It has fairly low toxicity to mammals, and fairly long residual action. Permethrin is used for some clothing spray-on treatments, and sprays in and around

homes. It has low toxicity to most mammals, has low volatility, low water solubility, and is nearly odorless. It has long residual action. Phenothrin and Cyphenothrin are in some pet topical spot treatments and shampoos. They have low toxicity to mammals. Most of the other chemicals are used outdoors (or indoors by trained pest control people).

“Soft” Pesticides

Many people want to use a "green" or "soft" pesticide. Some are not very effective, yet are allowed on the market. The Environmental Protection Agency de-regulated "natural" products on the GRAS list (**G**enerally **R**egarded **A**s **S**afe) in May 1996. Since then, manufacturers of GRAS list products do not have to prove that they are effective, to get EPA registration as pesticides. For all other chemicals, manufacturers must prove that they work to get them registered for use in the US. There is one group of “soft” materials that holds promise for tick control. Several products incorporate essential plant oils and mineral oil. One such product performed relatively well in recent pilot tests on blacklegged ticks --- Eco Exempt IC2. The largest active component [rosemary oil] is potentially toxic if ingested, but specific toxicity information on GRAS list products is hard to find. Testing of new products goes on continuously, so we may find others in the future.

Soap-based insecticides might kill ticks, but they have disadvantages. They work by contact action, so the tick has to be directly hit by the spray. They don't leave residues that kill. No soap-based insecticides that I can find have ticks listed on the label, which means you couldn't legally use them to control ticks. The pesticide label is the law --- you must follow it.

Pesticides Aimed at Ticks on Small Wild Mammals

One way to reduce the threat of ticks around your home is to aim control chemicals at ticks on small mammals living in the vicinity. Two products have attempted this, and both ran into problems. One example is “Damminix tick tubes”. They are cardboard tubes filled with pesticide-treated cotton. The pesticide (permethrin) is very long-lasting, and effective on ticks. The idea is to spread these around the property, in places where mice and chipmunks will find it, and take the cotton as nesting material. Then, ticks feeding on them and dropping off in the nest would die. Most field trials with the product had disappointing results, but it is still available for sale in NH.

A newer product was a bait-station available only to licensed pest control operators, called “Maxforce Tick Control System”. It incorporated another pesticide (fipronil) in a bait station to lure mice and chipmunks. The same pesticide is used on pets, sold as “Frontline”. The idea of this system was to control ticks on the small mammals that live around your property. It may have worked best when several adjacent property owners together cooperate on the project, rather than when one homeowner tries it alone. It worked primarily on immature ticks, so it took a year or more to reduce tick numbers. You had to hire a pest control company to apply this product for you, since it was not available for private use. This approach ran into problems, too. Squirrels chewed into the bait stations, making them no longer child-proof. The company stopped manufacturing it in 2005, and it is no longer offered in NH. Perhaps if the squirrel problem can be solved, the product will re-appear.

Protecting Pets

Your veterinarian can suggest materials to protect pets from ticks. Options include sprays, dips, shampoos, powders, collars, and topical spot treatments. Some can control ticks on dogs and cats for up to a month. Others work for a very short time. Shampoos can kill ticks on the animal, but have very short residual killing effect, if any. Fipronil topical spot treatment is absorbed by the body and gets concentrated in sebaceous glands (at the base of hairs) and their secretions. One treatment can kill ticks for weeks.

Some methoprene (primarily acts on fleas), phenothrin, permethrin, and pyriproxifen products are applied as topical spot treatments too, and can last a long time. Tick collars usually contain the pesticides amitraz, deltamethrin, naled, propoxur (Baygon), or tetrachlorvinfos (Rabon) which are slowly released over time. Collars control ticks for a fairly long period of time. Some of them work by emitting toxic vapors. Others work by having the pesticide absorbed by the animal, and translocated throughout the body. Tick powders, shampoos and dips provide short term removal of ticks on an animal, rather than protect it for a long time. Usually they contain methoprene, permethrin, pyriproxifen, tetrachlorvinfos or pyrethrins plus synergists like piperonyl butoxide or n-octyl bicycloheptene dicarboximide.

Dog owners in areas with Lyme disease risk may wish to consult their veterinarian about vaccination, which is an option for some situations. Vaccination will not protect the animal from other tick-borne diseases. One obvious approach to protect pets is to regularly check for ticks, and remove them. This can be difficult, since small ticks are hidden by dense fur. Well engorged ticks are easier to find, but they have already had a chance to feed, possibly spreading disease to your pet.

Help and Information Sources

New Hampshire Division of Health and Human Services has Lyme Disease and other tick-borne disease information and maps at <http://www.dhhs.state.nh.us/DHHS/CDCS/lymedisease.htm>

The US Centers for Disease Control and Prevention has fact sheets, maps and information on many diseases at <http://www.cdc.gov/>

Tick Identification (two places)

- 1) The State Entomologist identifies ticks, and the submission form is at:
<http://www.dhhs.state.nh.us/DHHS/CDCS/lymedisease.htm>
New Hampshire Department of Agriculture
Markets & Food State Lab Building
29 Hazen Dr
Concord, NH 03301

- 2) UNH Cooperative Extension Arthropod Identification Center:
G28 Spaulding Hall
38 Academic Way
Durham, NH 03824
There is a \$5 fee per specimen. The instructions (and submission form) are available at:
<http://extension.unh.edu/Agric/AGPDS/ArthroID.htm>

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For the latest information on registration of a pesticide in New Hampshire, contact the Pesticide Control Division of the NH Dept. of Agriculture at 603-271-3550 or visit their website at:
http://agriculture.nh.gov/divisions/pesticide_control/pesticide_registration.htm

UNH Cooperative Extension's web site is at: <http://extension.unh.edu>

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